EPAC'08 11th European Particle Accelerator Conference
Magazzini del cotone, Genoa, Italy / June 23-27, 2008

LHC HARDWARE COMMISSIONING SUMMARY

Roberto Saban
on behalf of the Hardware Commissioning Team

Status
Results
Issues
Outlook

PR

INTRO | NONCONFORMITIES | SAFETY | TYPICAL HC PROGRAMME | ACCESS | TEAM | MEETINGS & SCHEDULES | CONTACTS | THE FIELD

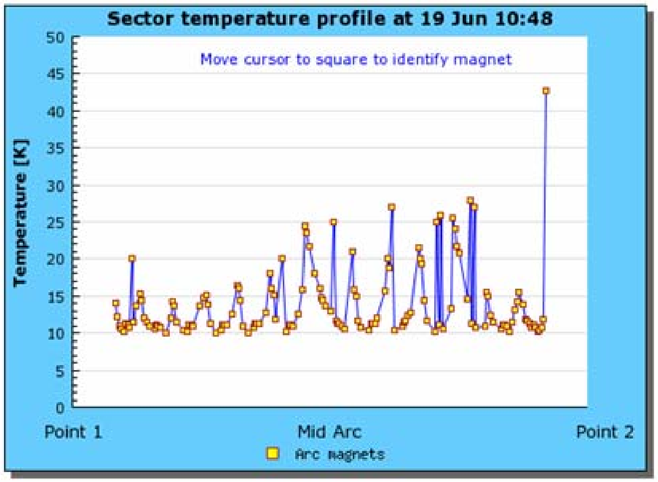
- MAIN PAGE
- TWIKI
- WORKSHOPS
- MEETINGS
- MTF
- DOCUMENTS
- ELOGBOOK
- WORKING GROUPS
- POWERING PROCEDURES

- CERN
- LHC
- TIMBER
- METER
- EDMS
- CDD
- LAYOUT DATABASE

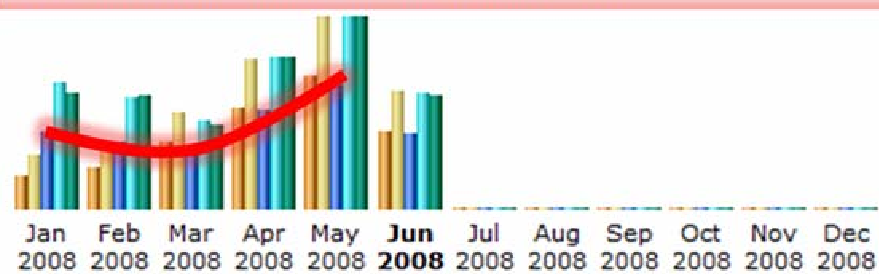
Sector 12

updated by Maria Paz Casas Lino and Carlos Fernandez Robles on 18th of June

The cool down of the sector is ongoing.
The current leads anti-condensation system installation is foreseen to be completed this week (25).
After the successful low intensity beam tests in TI2 carried out last week-end, the normal access conditions have been reestablished.



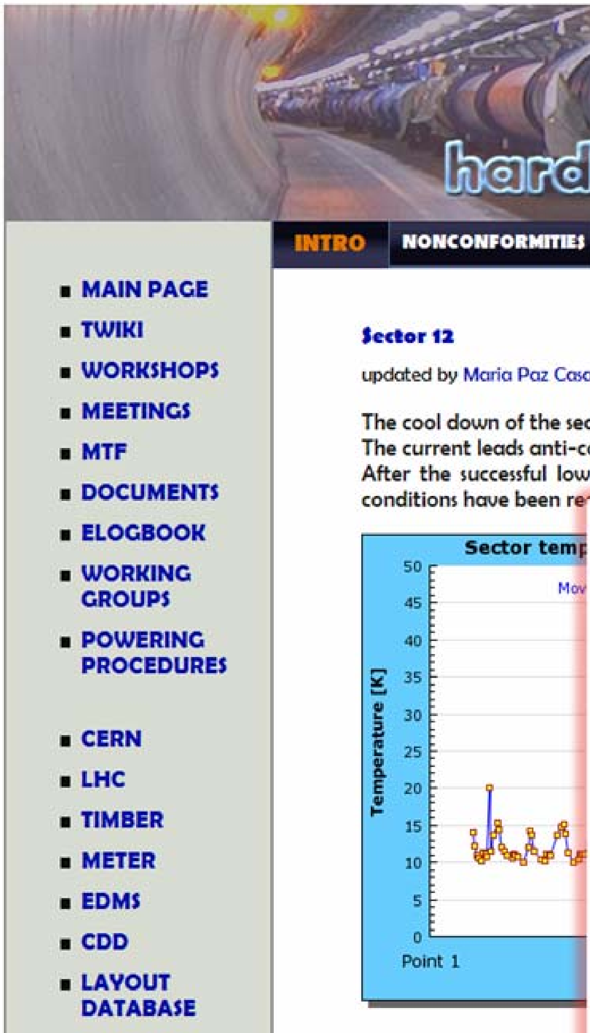
PR

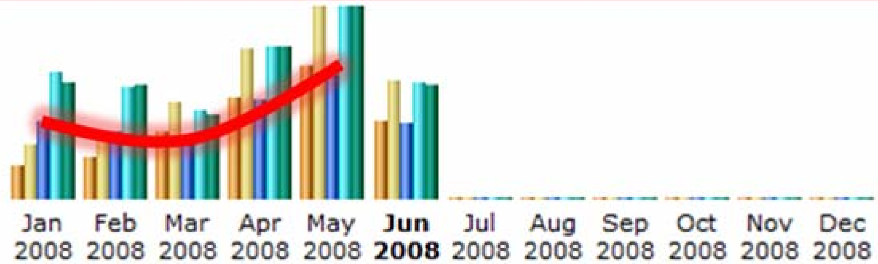


Month	Unique visitors	Number of visits	Pages	Hits	Bandwidth
Jan 2008	7180	11939	749626	1212259	27.92 GB
Feb 2008	9382	14812	641279	1058475	27.48 GB
Mar 2008	15042	21592	530157	840462	20.38 GB
Apr 2008	22828	33476	944916	1458259	36.72 GB
May 2008	29615	42937	1180863	1825603	46.35 GB
Jun 2008	17334	26594	728704	1112377	27.64 GB

58 visits/hour

PR





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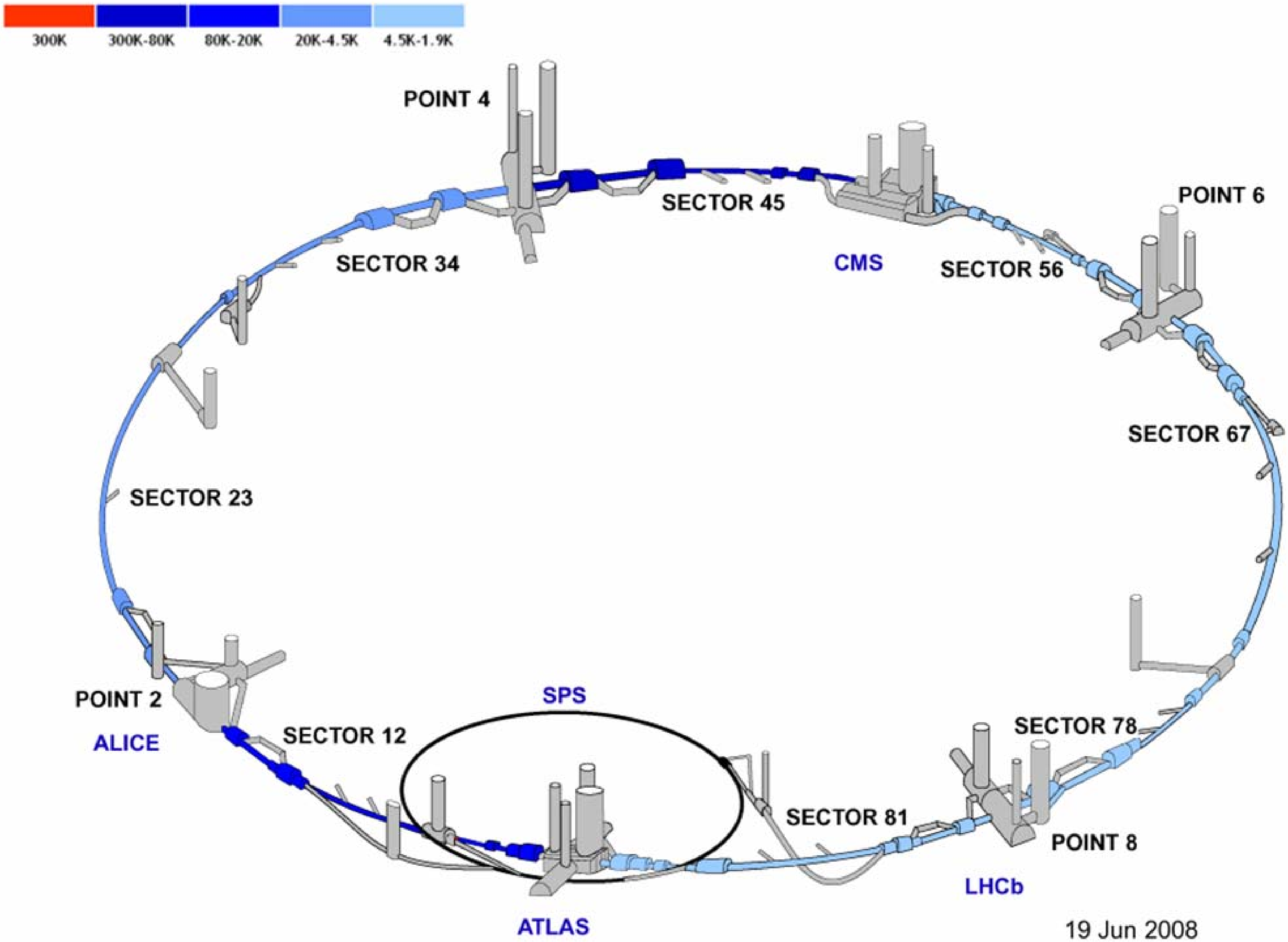
status



300K
300K-80K
80K-20K
20K-4.5K
4.5K-1.9K
POINT 4
SECTOR 45
CMS
POINT 6
SECTOR 34
SECTOR 56
SECTOR 67
SECTOR 23
POINT 2
ALICE
SPS
SECTOR 12
SECTOR 78
SECTOR 81
POINT 8
LHCb
ATLAS
19 Jun 2008

status

Cooldown → Electrical QA → Individual System Tests → Powering Tests

Sector	T[K]
12	15 K
23	2 K
34	4.5 K
45	120 K
56	2 K
67	3 K
78	2 K
81	2 K

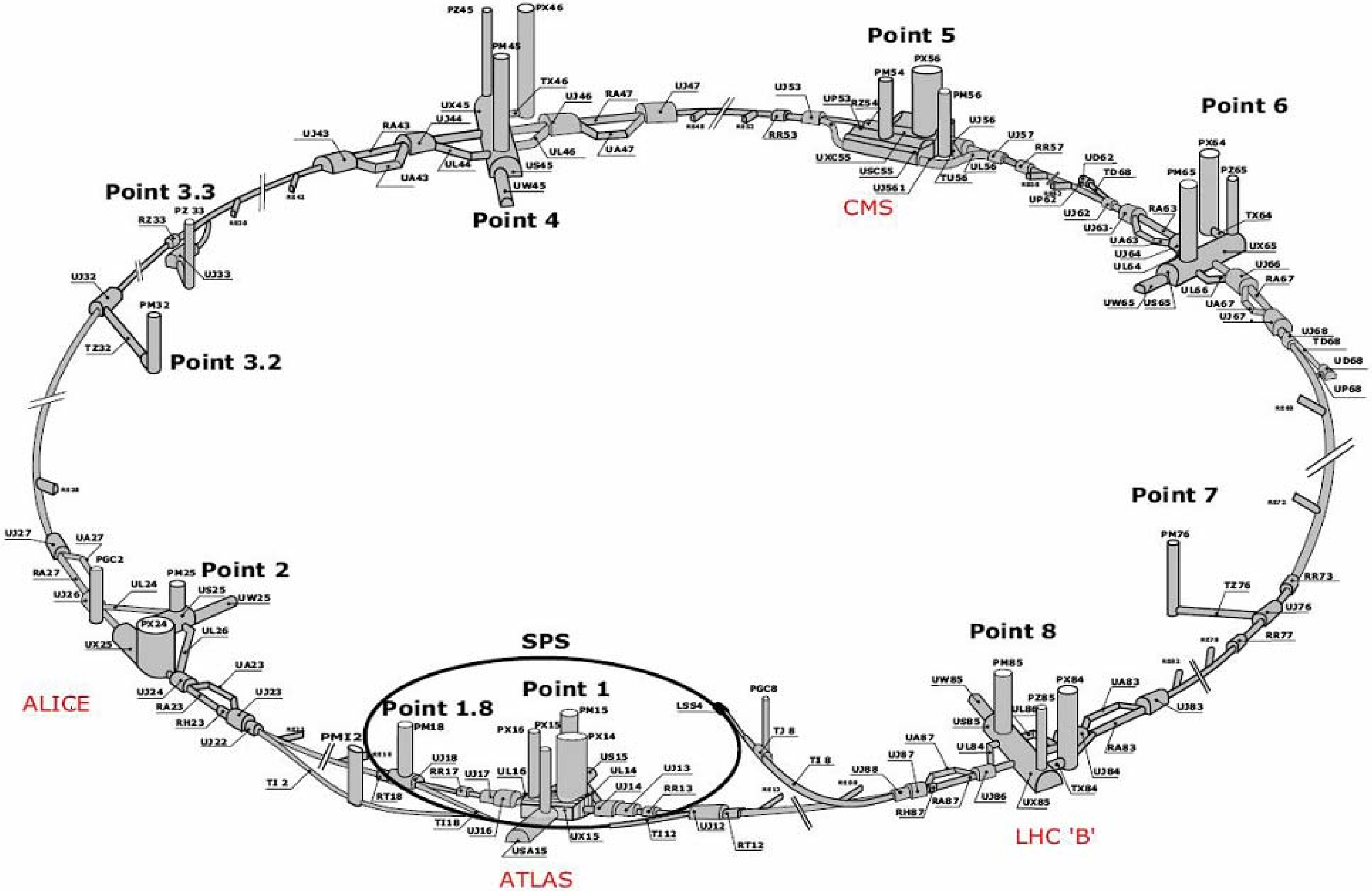
status

Cooldown → Electrical QA → Individual System Tests → Powering Tests

Sector	T[K]	State	Comments
12	15 K	CD	Cooling down
23	2 K	IST	Individual system tests ongoing
34	4.5 K	CD	Cooling down to 4.5K. Electrical quality assurance expected to start in 2 weeks
45	120 K	CD	Commissioned for the first time beginning of this year. Being cooled down after consolidation work and the connection of the inner triplet left of Point 5
56	2 K	PT	Dipoles commissioned to 6.58 TeV. Almost all other circuits are compatible with 7 TeV operation. The sector was handed over to operation.
67	3 K	ELQA	Cooling down to 2K. Electrical quality assurance started.
78	2 K	PT	Commissioned for the first time last year. Second commissioning almost completed after consoldiation work and the connection of the inner triplet left of Point 8
81	2 K	PT	Powering tests ongoing

the sectors of LHC

The LHC is composed of
•eight cryogenically independent sectors



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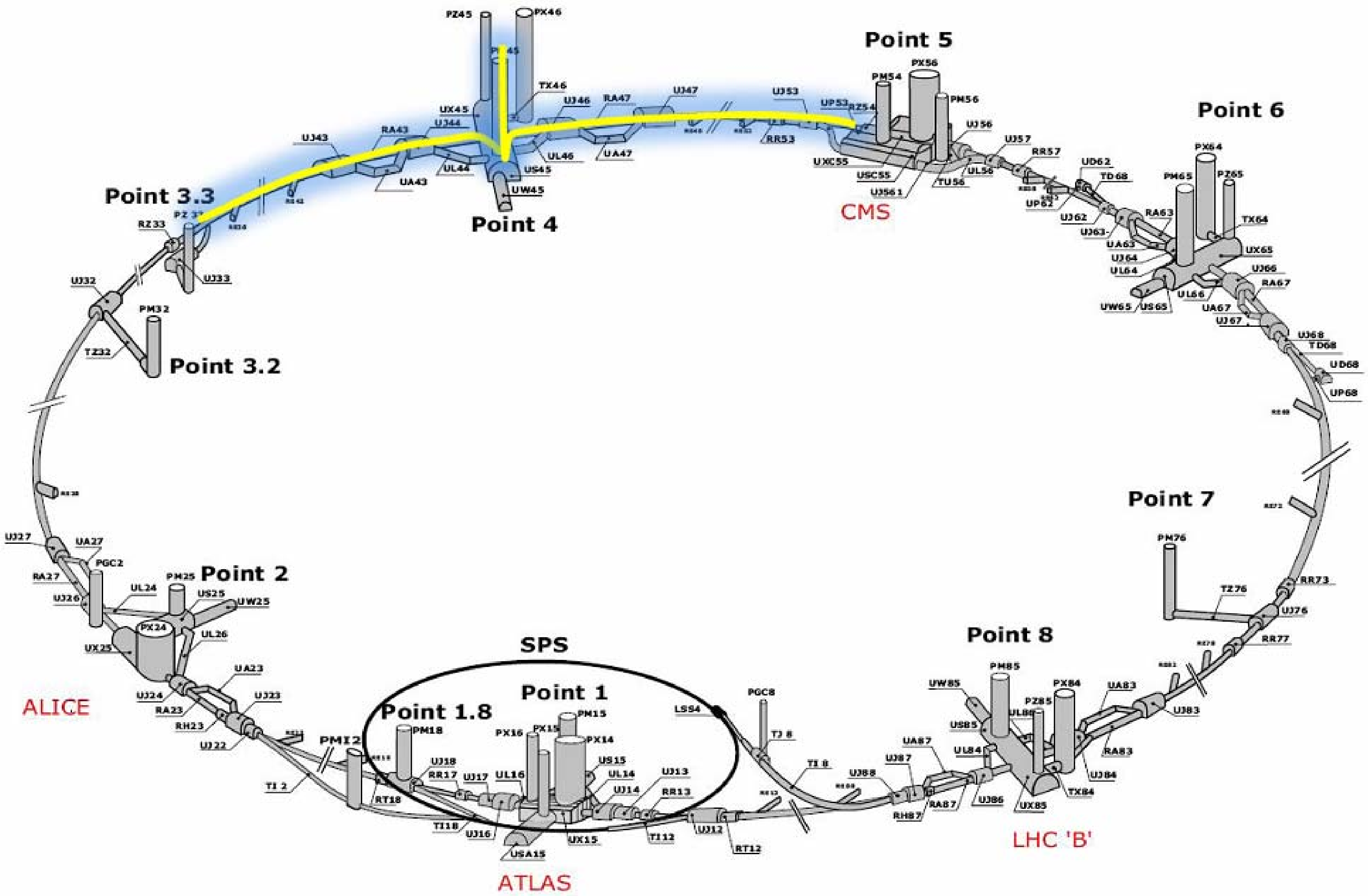
The LHC is composed of
- eight cryogenically independent sectors
- fed from four feed points



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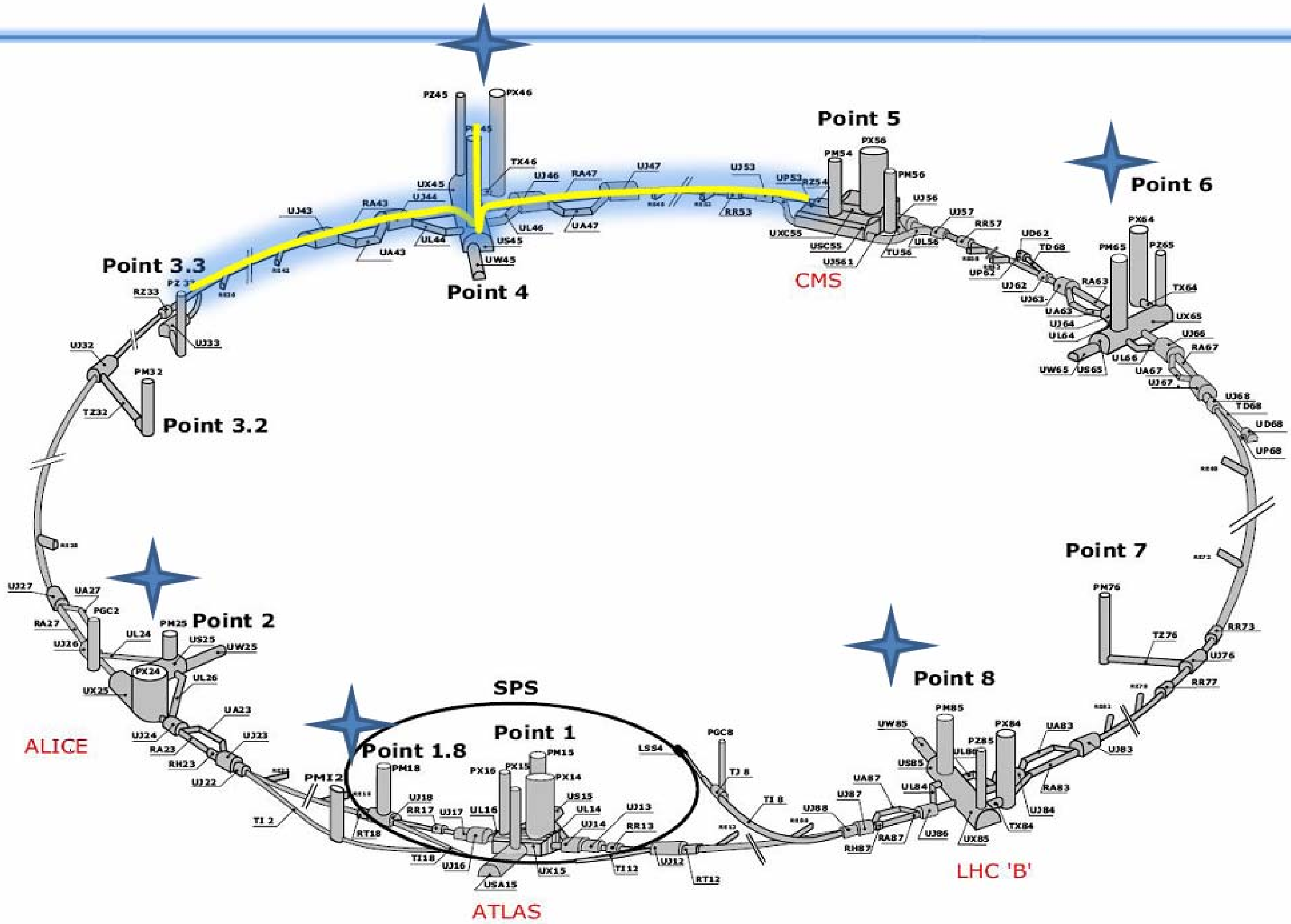

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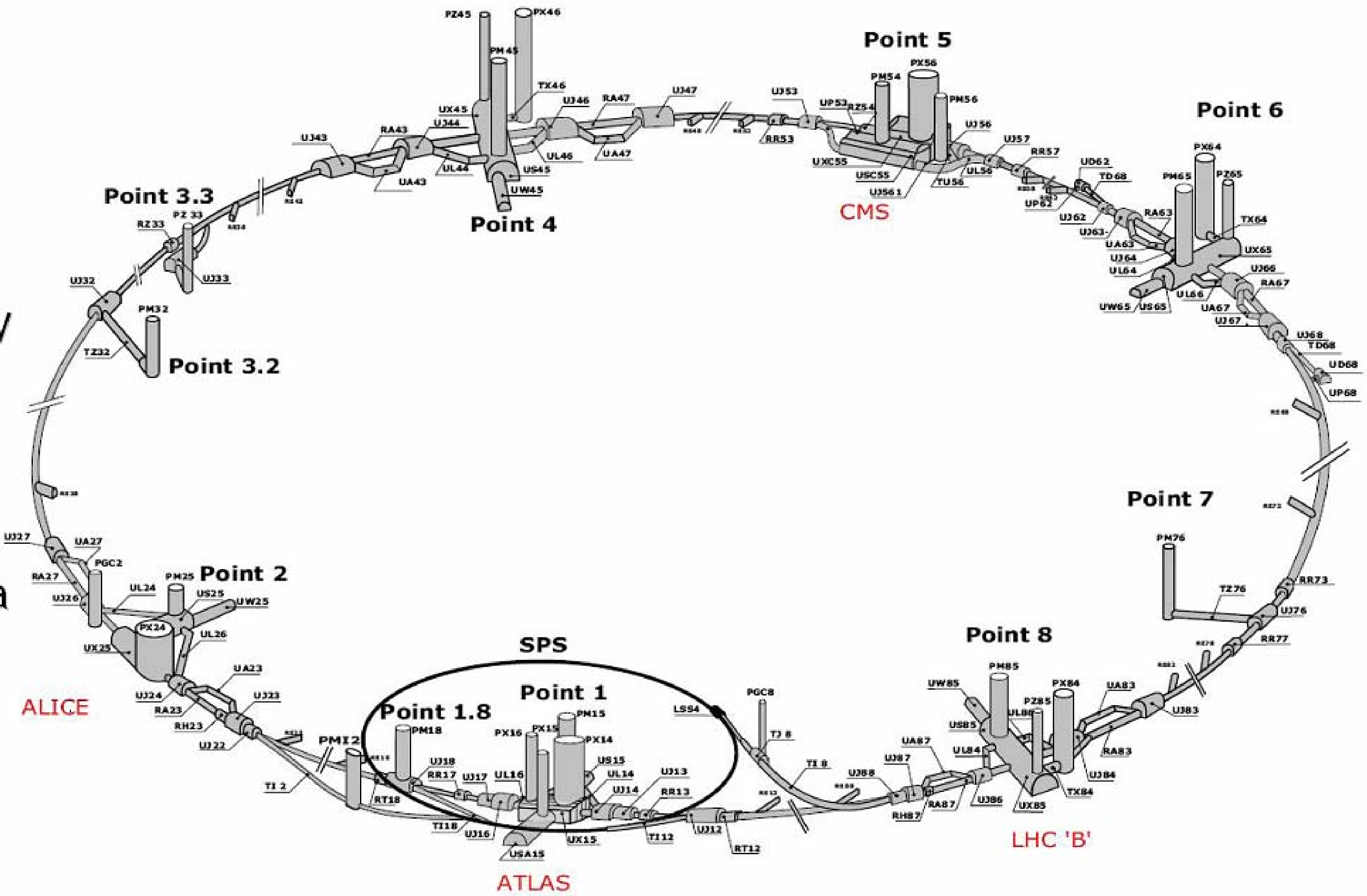
The LHC is composed of

- eight electrically independent sectors
- each fed from a UA, an RR, a UJ and sometimes a USC



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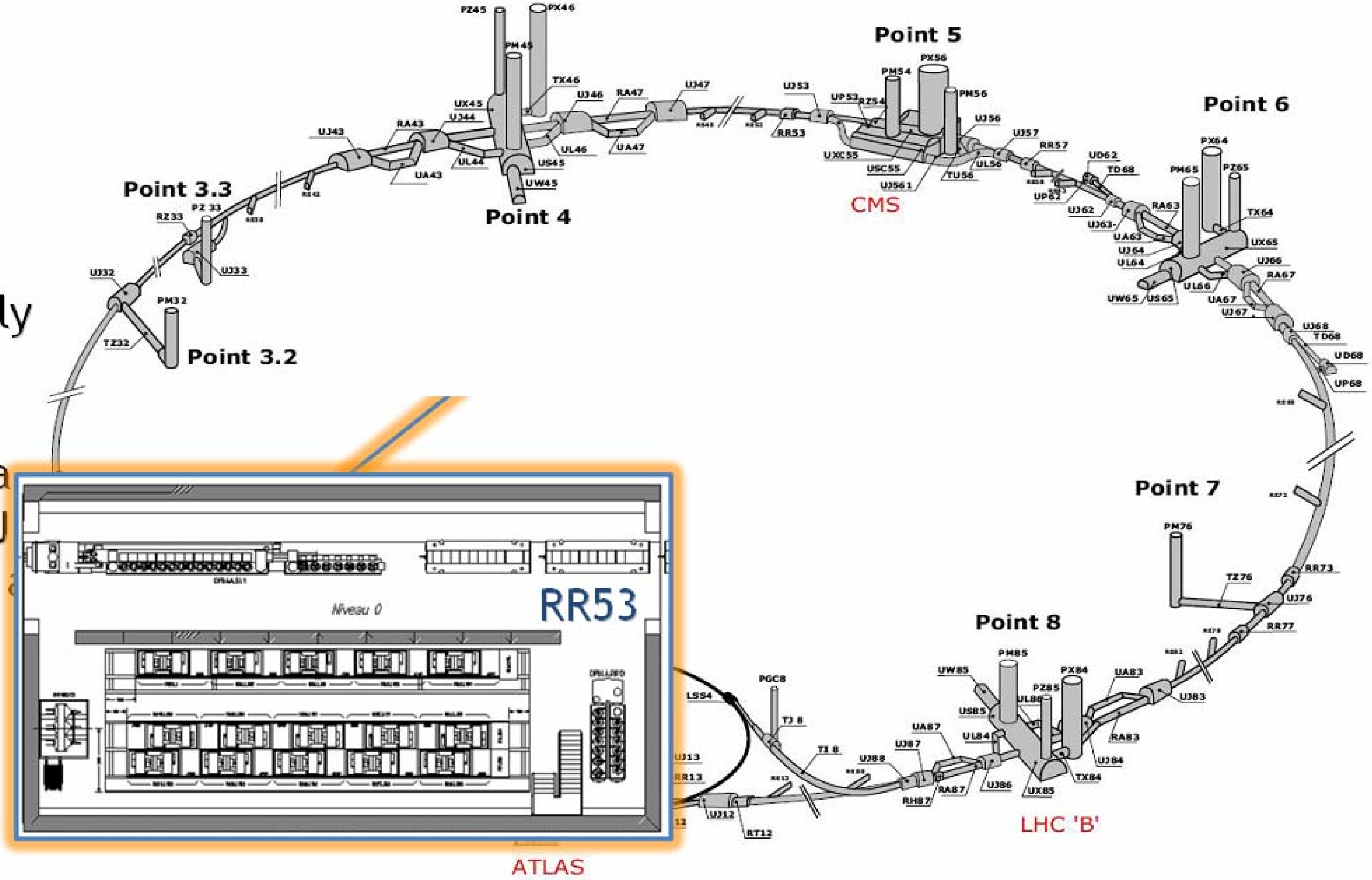

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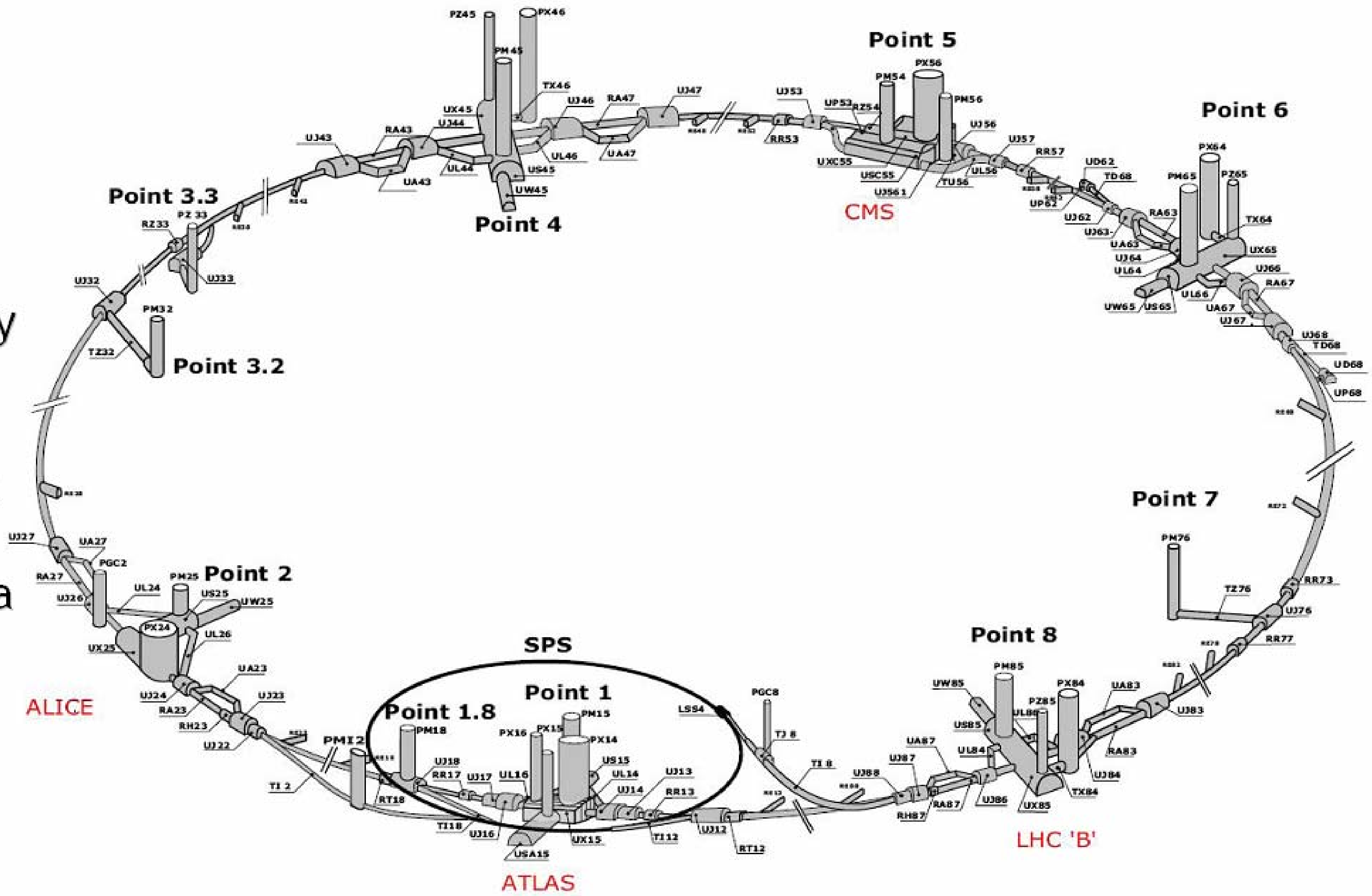

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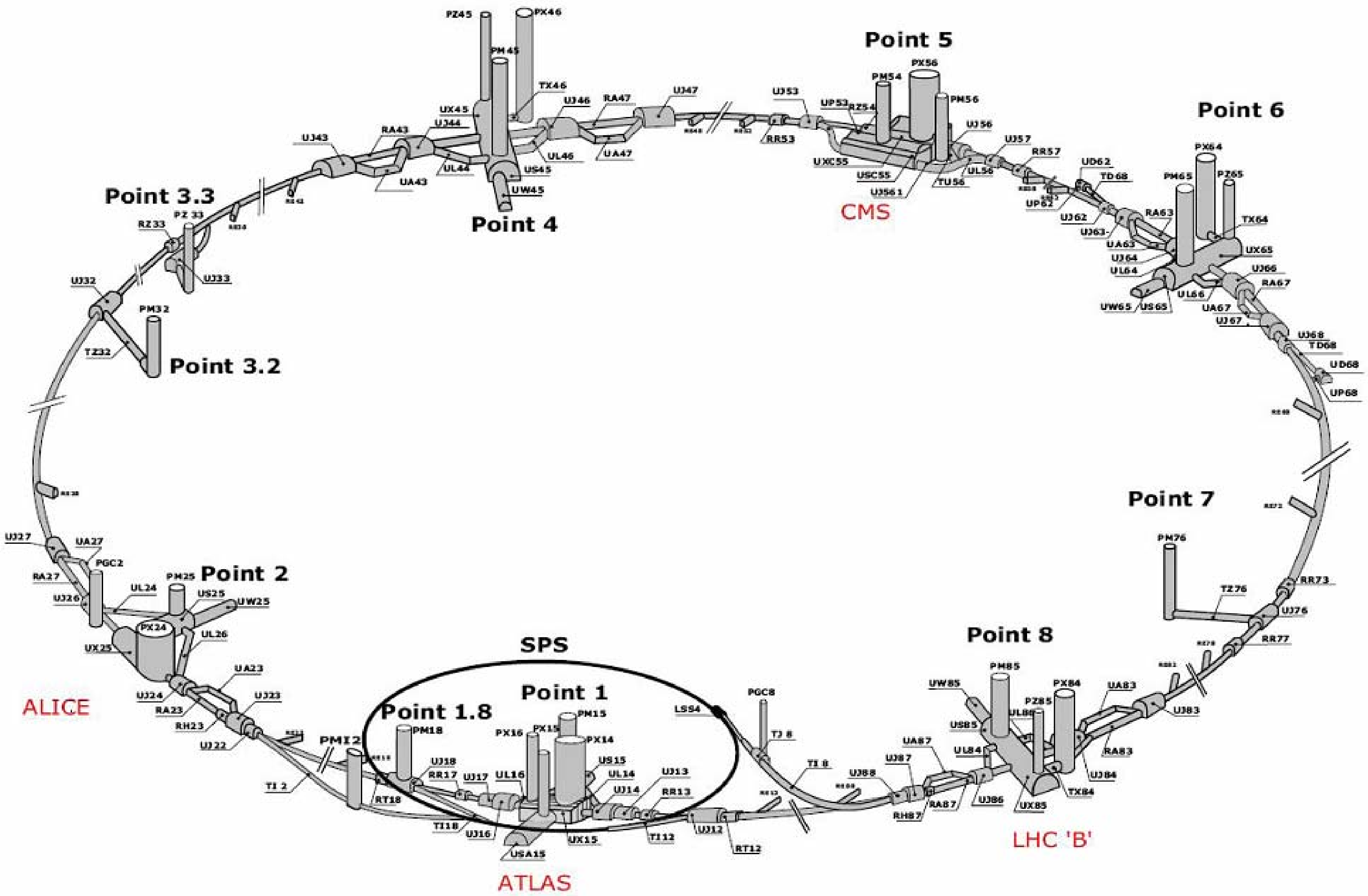
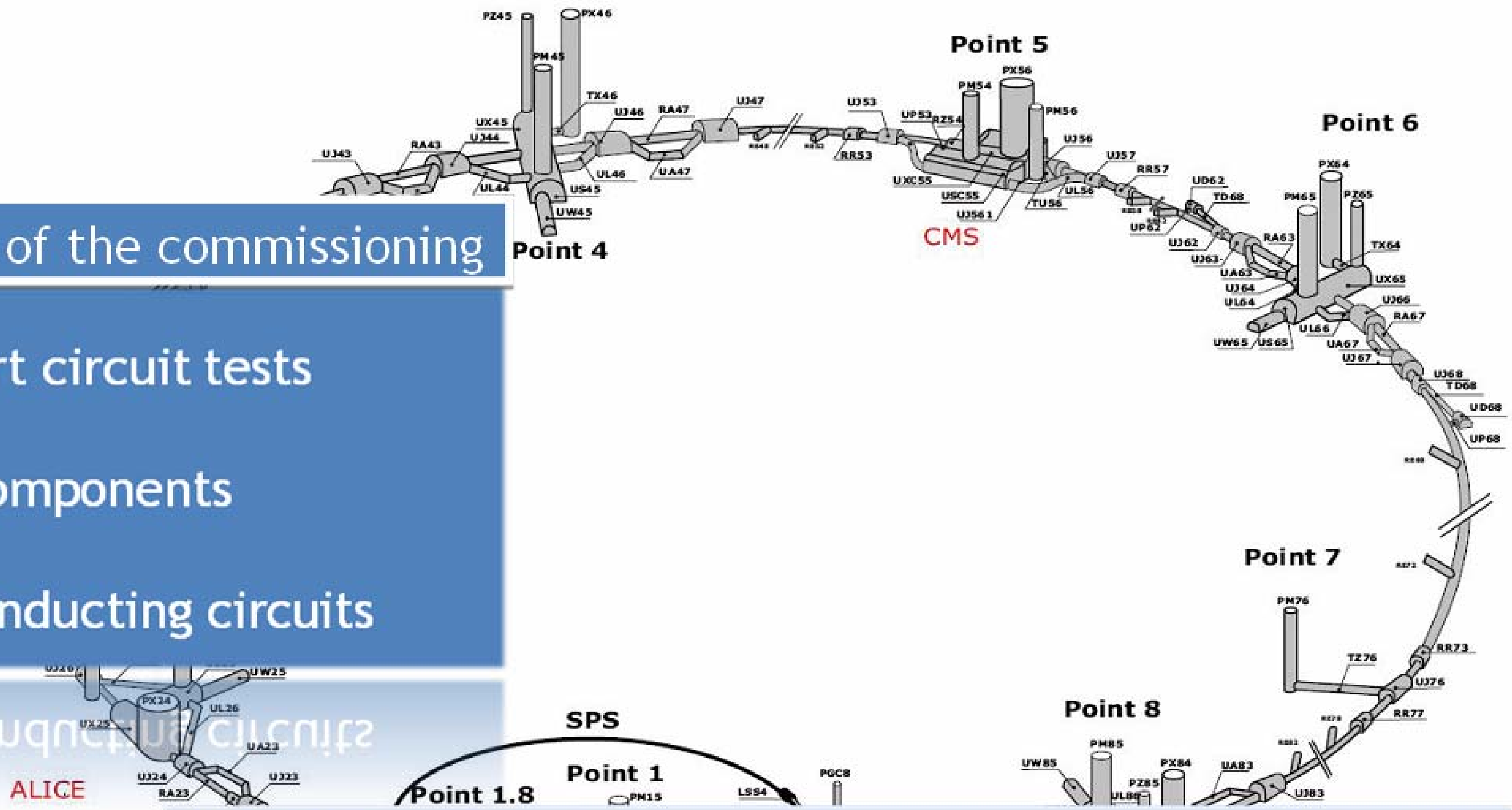


This permitted the independent commissioning of each one of the eight sectors.

the sectors of LHC



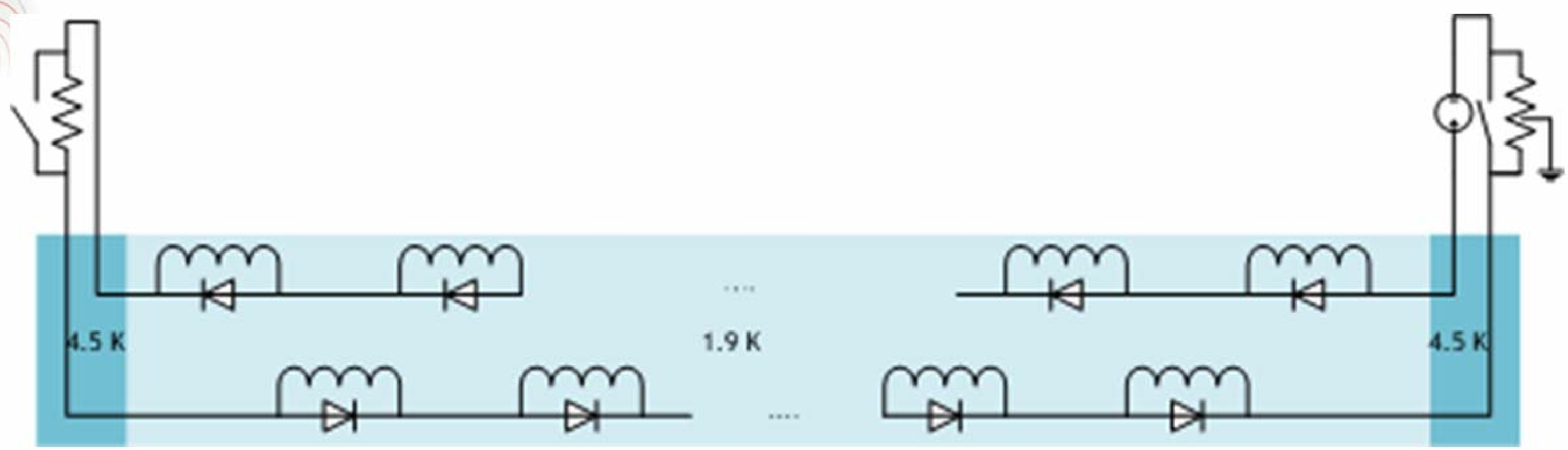
The phases of the commissioning

1. The short circuit tests
2. Warm components
3. Superconducting circuits

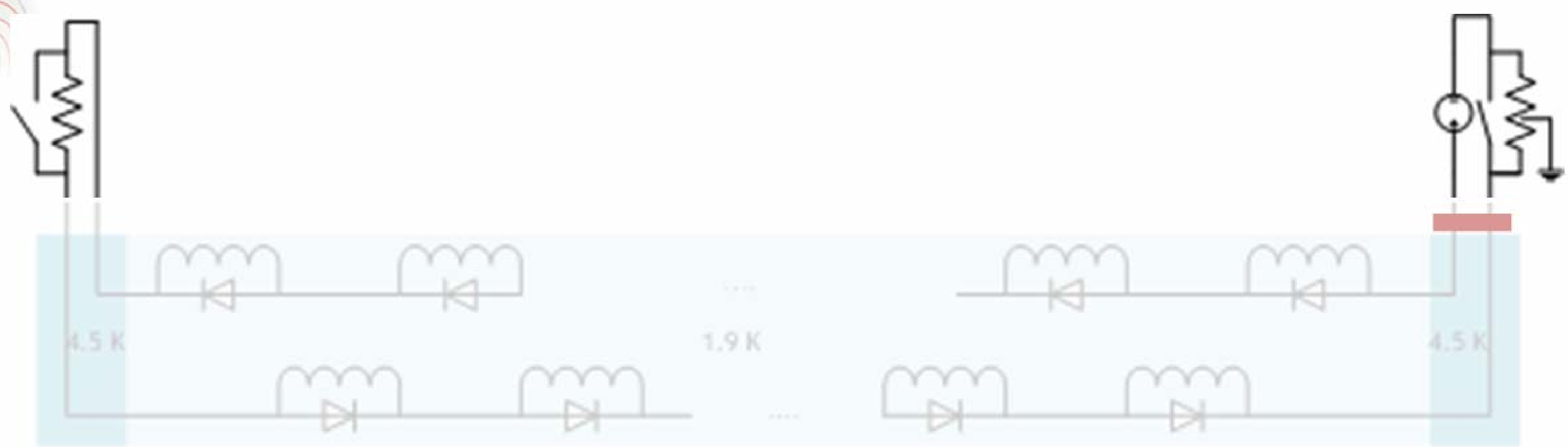
MOPC118 Coordination of the Commissioning of the LHC Technical Systems — R.Schmidt

This permitted the **independent** commissioning of each one of the eight sectors.

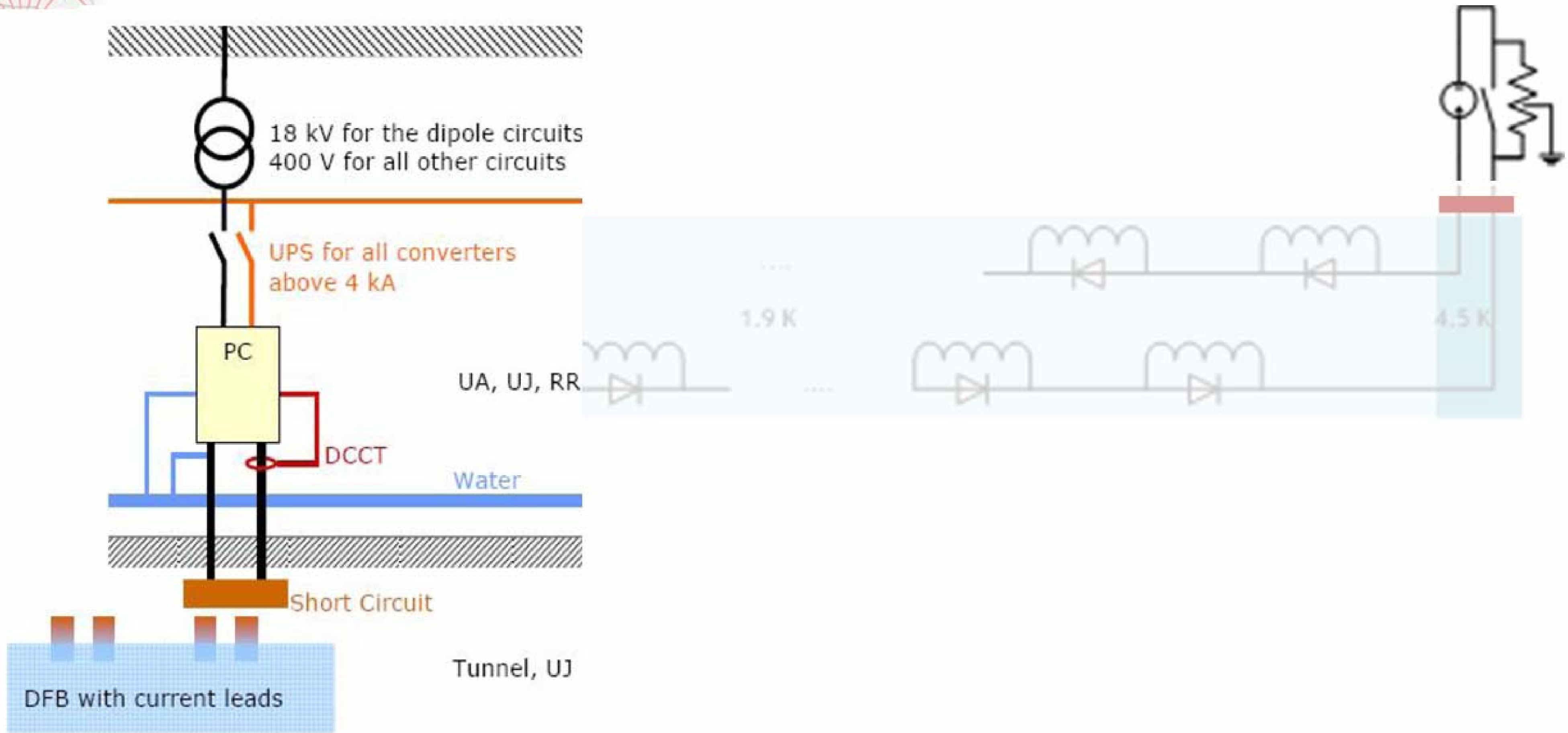
the short circuit tests



the short circuit tests



the short circuit tests



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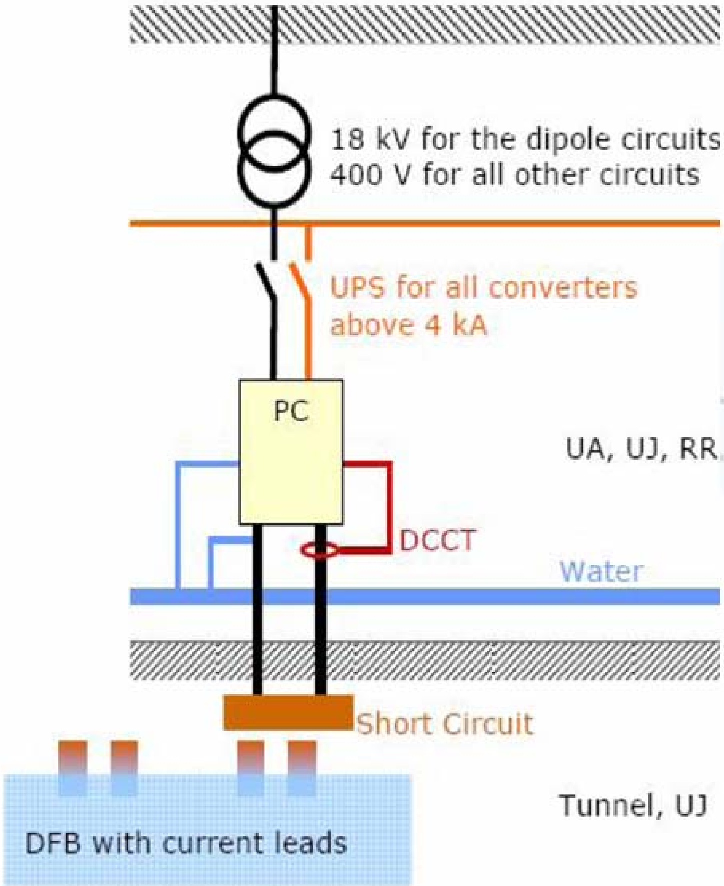
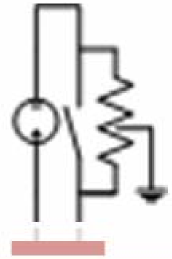




The objectives

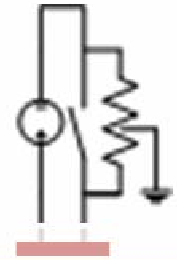
the validation of the warm part of the superconducting circuits from the 18 kV and 400 V AC feeds down to the water and air-cooled cables before their connection to the superconducting elements

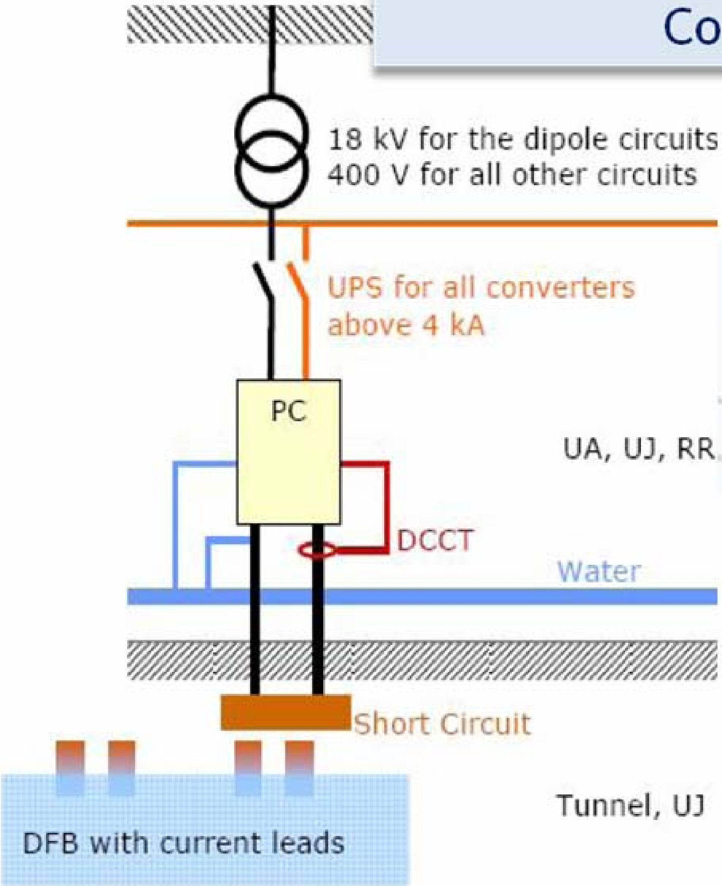
The results

the verification of the individual and global thermal aspects, the verification of the interlocks and the calibration of the power converters

the short circuit tests

MOPC103	Short Circuit Tests: First Step of LHC Hardware Commissioning Completion	B.Bellesia





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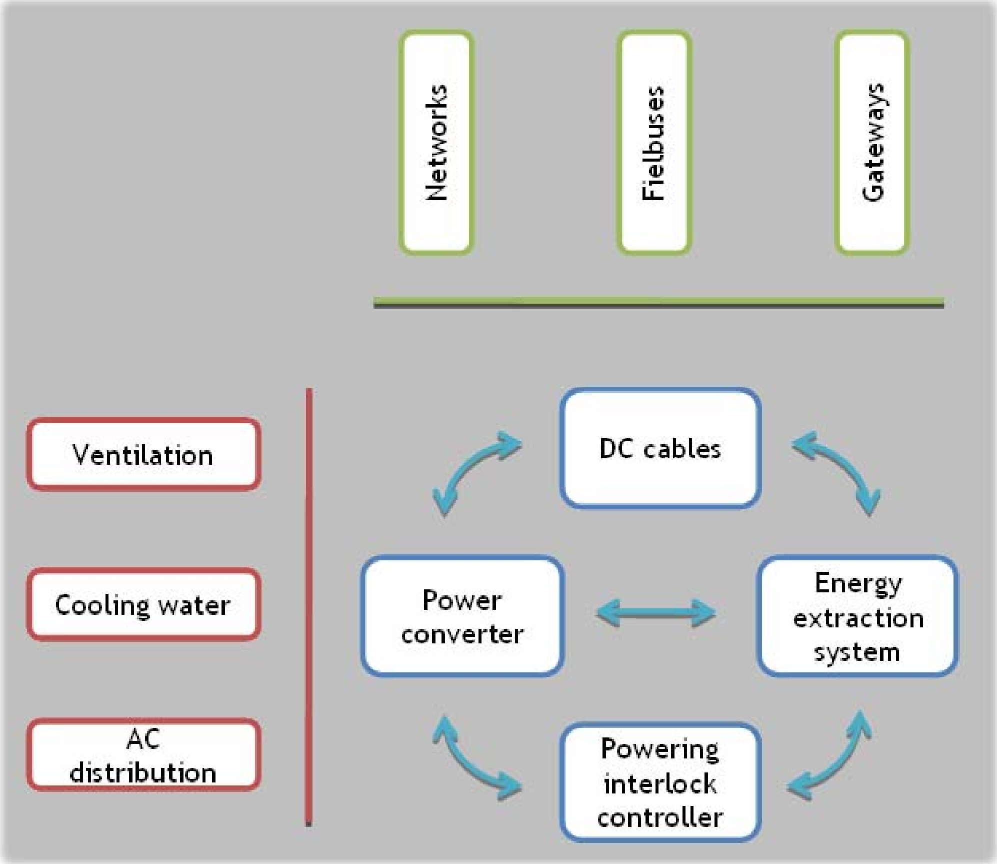

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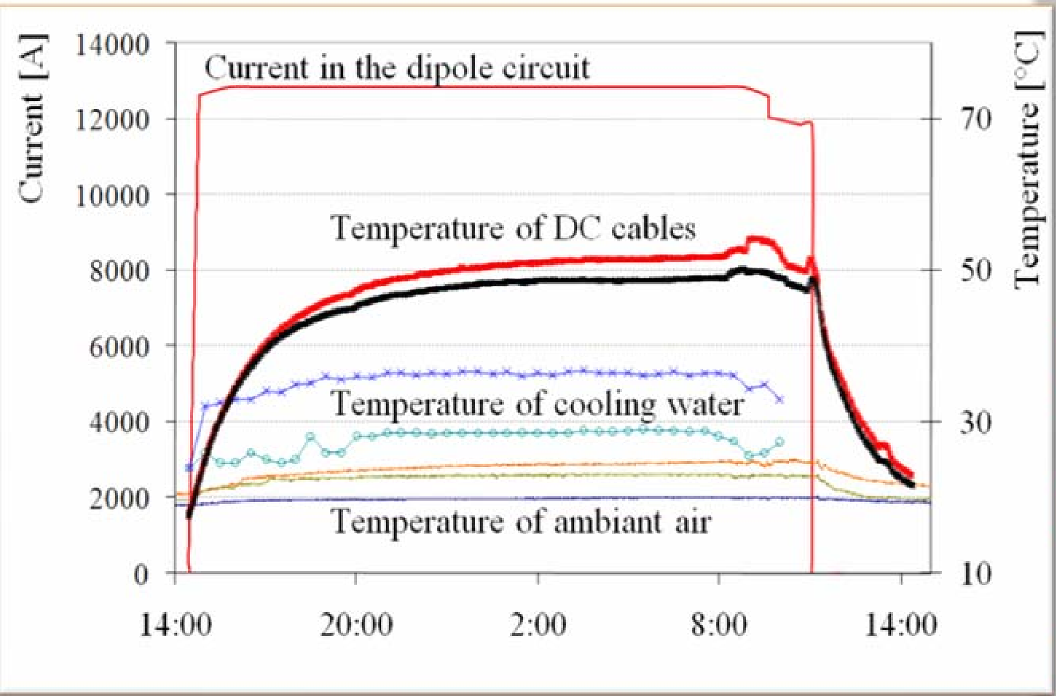
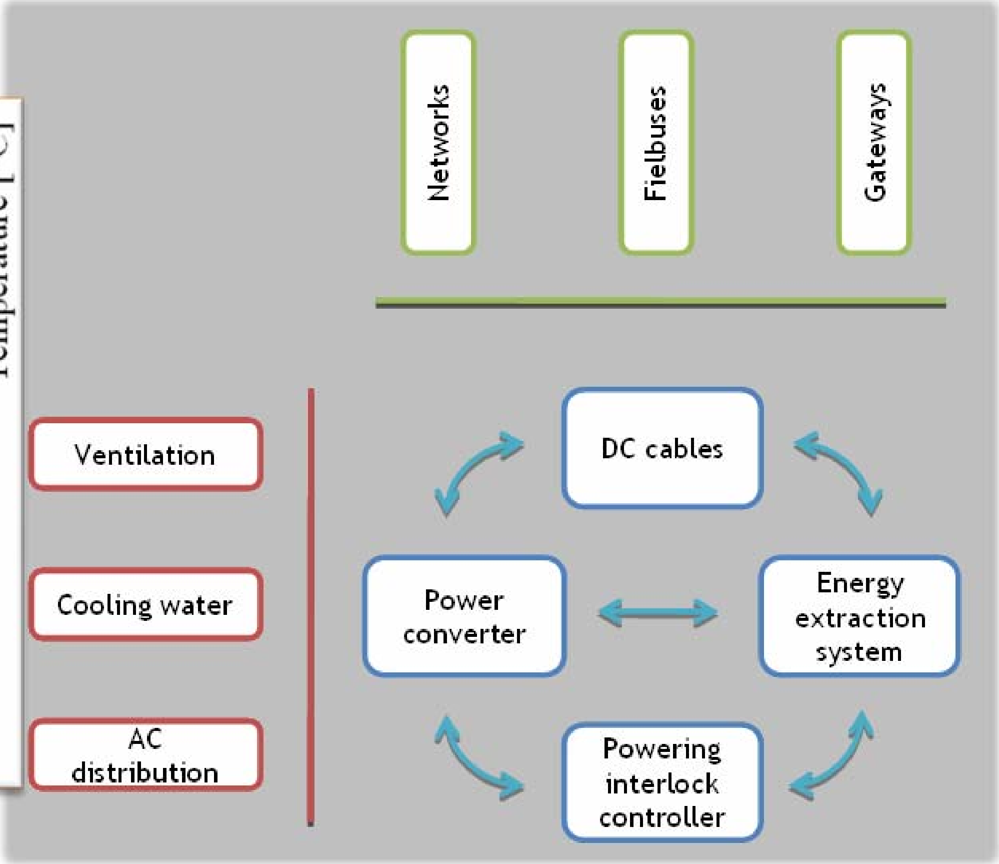
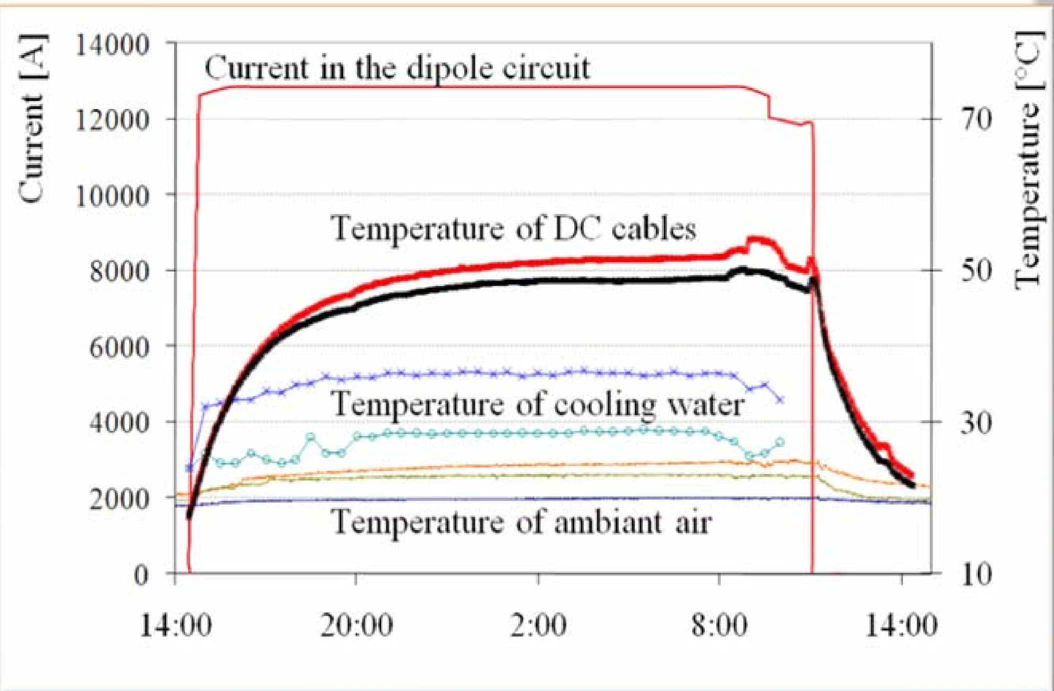


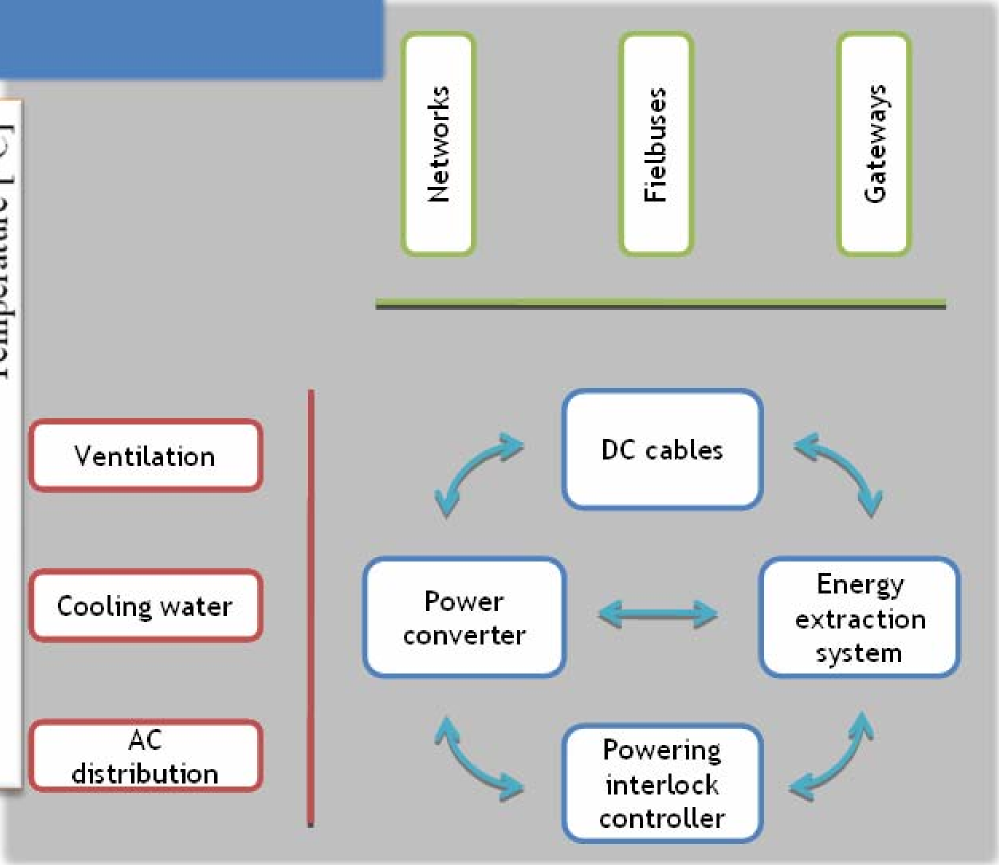


the short circuit tests

Non-conformities

- signal cabling errors
- loosely bolted power cables leading to poor quality contacts
- cabling layout
- layout of air cooling ducts





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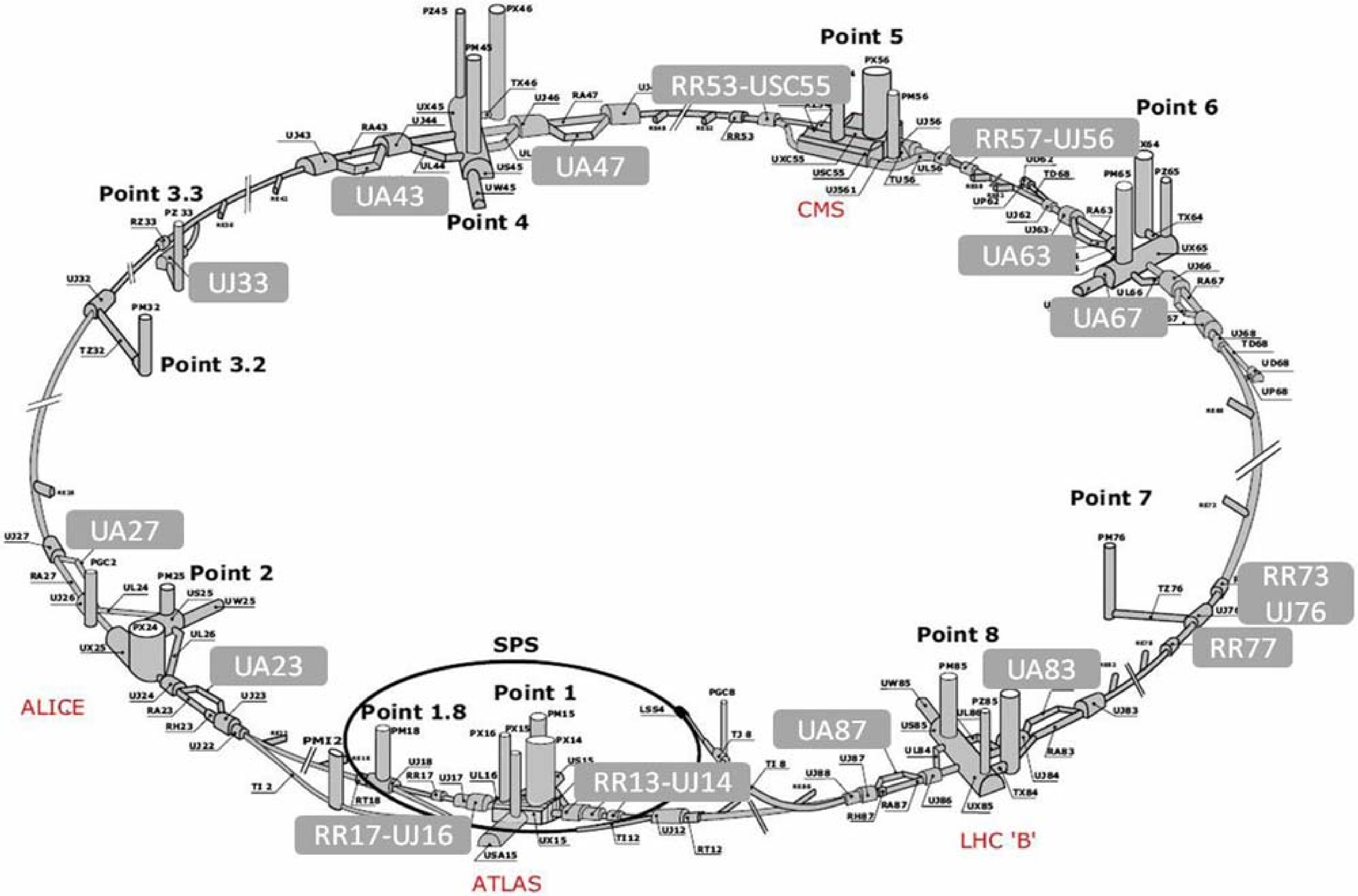
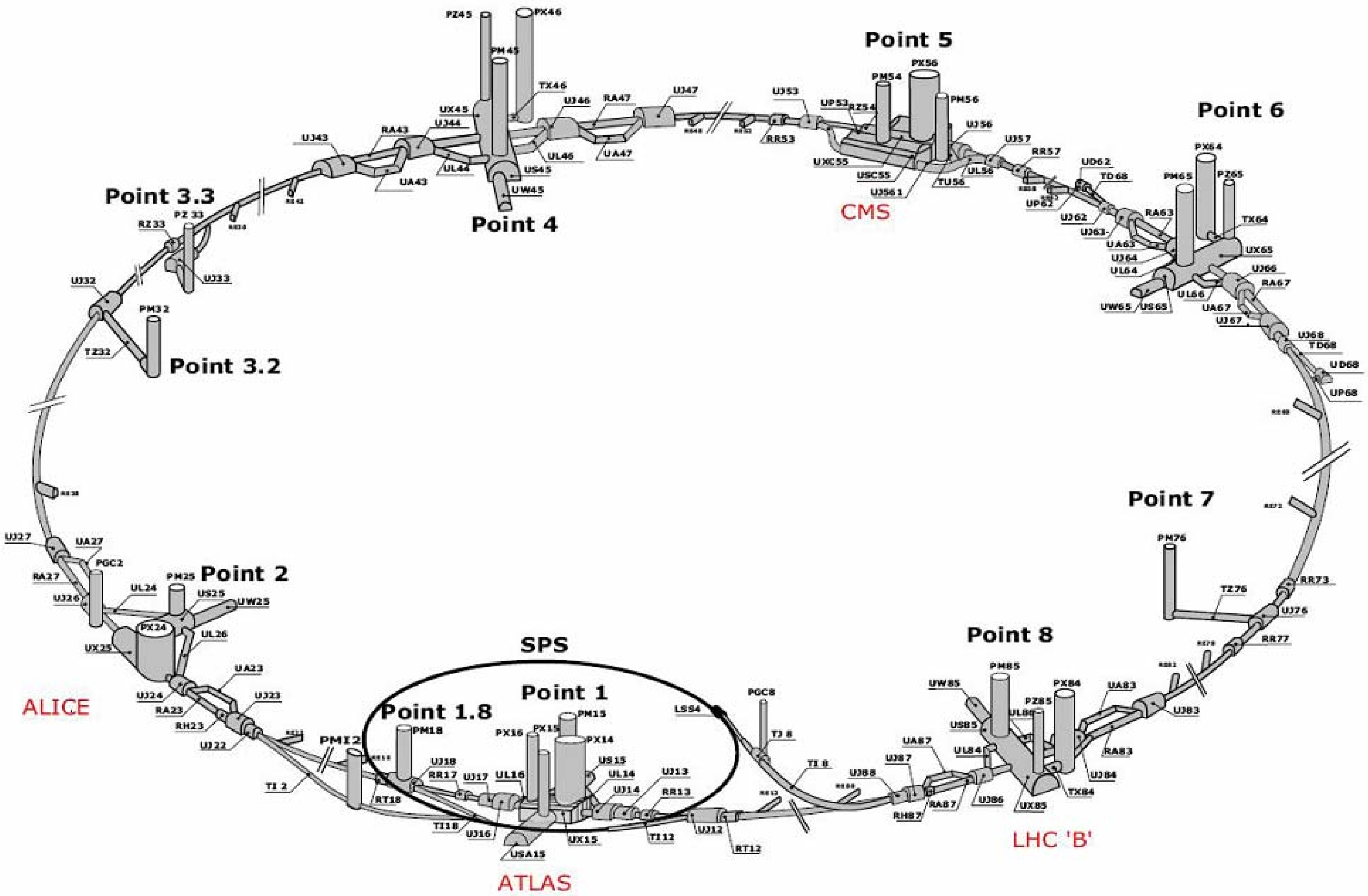


the circuits of a sector of LHC



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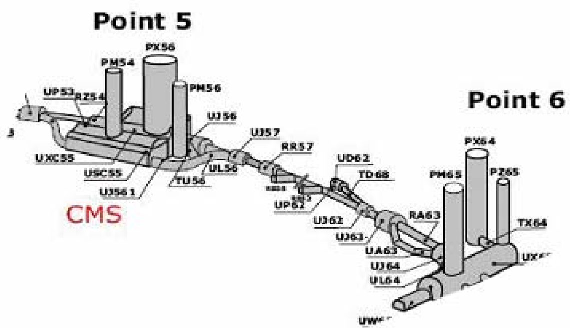
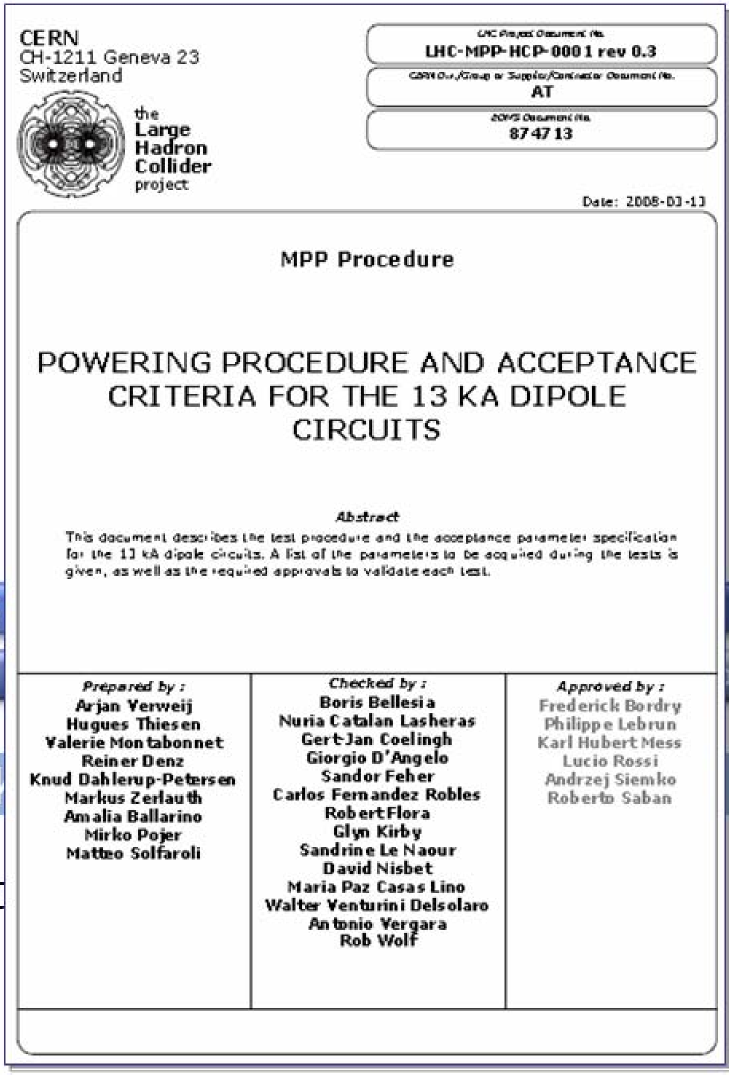


XR5			LR5			A56							ML6	
IT	600A	80 120A	IPQ	IPD	80 120A	RB	QD	QF	IP	80 120A	600A	60A	IPQ	80 120A
1	7	5	3	1	10	1	1	1	7	14	39	94	2	4
1.9 K			4.5 K			1.9 K							4.5 K	
13 circuits			14 circuits			157 circuits							6 circuits	

Totalling 190 circuits

the circuits of a sector of LHC



CERN
CH-1211 Geneva 23
Switzerland

the Large Hadron Collider project

LHC Project Document No.
LHC-MPP-HCP-0001 rev 0.3

CERN Div./Group or Supplier/Contractor Document No.
AT

EDMS Document No.
874713

Date: 2008-03-13

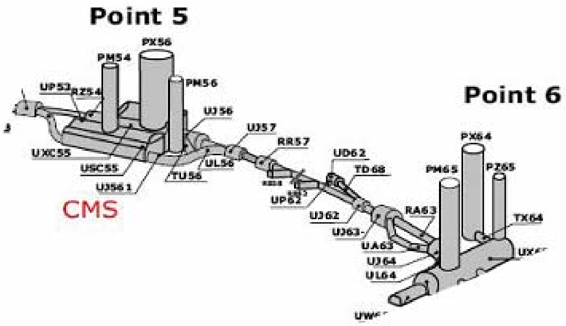
MPP Procedure

POWERING PROCEDURE AND ACCEPTANCE CRITERIA FOR THE 13 KA DIPOLE CIRCUITS

Abstract

This document describes the test procedure and the acceptance parameter specification for the 13 kA dipole circuits. A list of the parameters to be acquired during the tests is given, as well as the required approvals to validate each test.

Prepared by :	*Checked by :*	*Approved by :*
Arjan Verweij Hugues Thiesen Valerie Montabonnet Reiner Denz Knud Dahlerup-Petersen Markus Zerlauth Amalia Ballarino Mirko Pojer Matteo Solfaroli	Boris Bellesia Nuria Catalan Lasheras Gert-Jan Coelingh Giorgio D'Angelo Sandor Feher Carlos Fernandez Robles Robert Flora Glyn Kirby Sandrine Le Naour David Nisbet Maria Paz Casas Lino Walter Venturini Delsolaro Antonio Vergara Rob Wolf	Frederick Bordry Philippe Lebrun Karl Hubert Mess Lucio Rossi Andrzej Siemko Roberto Saban



XR5 | A56 | ML6

IT 1 | 600A 7 | QF 1 | IP 7 | 80 120A 14 | 600A 39 | 60A 94 | IPQ 2 | 80 120A 4

1.9 K | 1.9 K | 4.5 K

13 circ[uits] | 157 circuits | 6 circuits

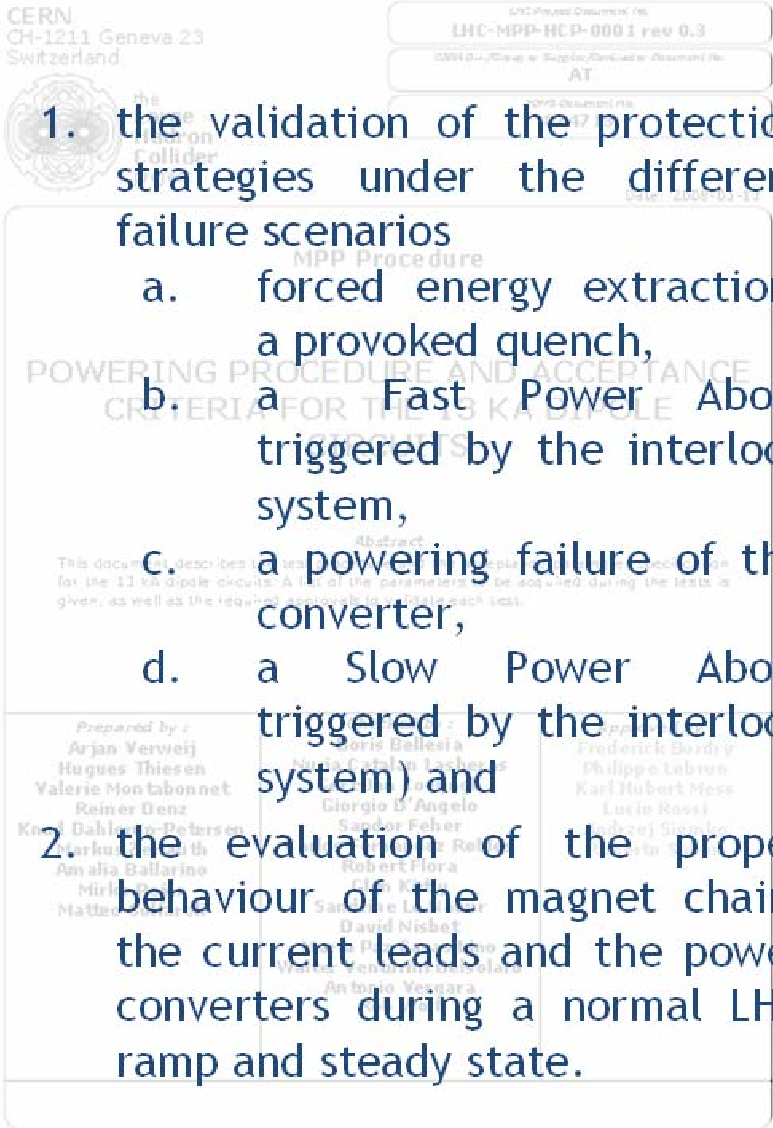
Totalling 190 circuits

the superconducting circuits of LHC

Circuit Type	Sector								LHC
	1-2	**2-3**	**3-4**	**4-5**	**5-6**	**6-7**	**7-8**	**8-1**	
13 kA	3	3	3	3	3	3	3	3	**24**
Indipendently Powered Dipoles	3	2	2	3	1	0	2	3	**16**
Indipendently Powered Quadrupoles	14	7	6	13	12	5	7	14	**78**
600A with Energy Extraction	23	27	28	24	23	27	27	23	**202**
600A Energy Extraction in Converter	14	20	20	14	14	20	20	14	**136**
600A no Energy Extraction	16	9	2	9	9	2	9	16	**72**
80-120A Correctors	50	37	22	33	33	22	37	50	**284**
TOTAL	**123**	**105**	**83**	**99**	**95**	**79**	**105**	**123**	**812**

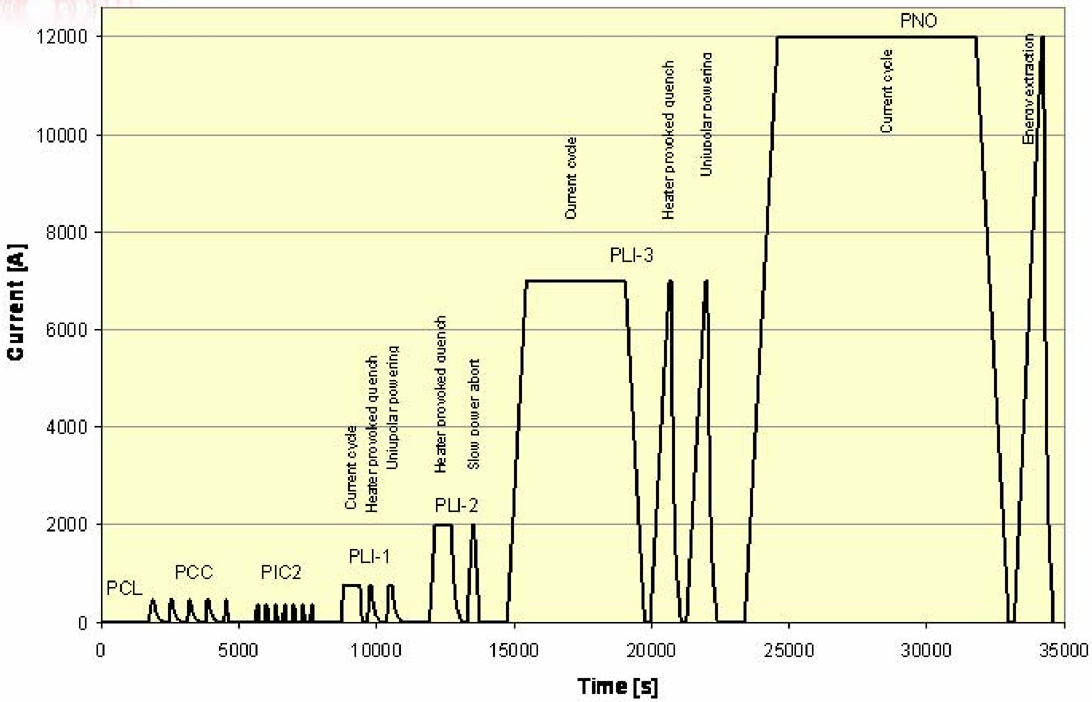
Circuit Type	Sector								LHC
	1-2	**2-3**	**3-4**	**4-5**	**5-6**	**6-7**	**7-8**	**8-1**	
60A Closed Orbit Correctors	94	94	94	94	94	94	94	94	**752**

Procedures



1. the validation of the protection strategies under the different failure scenarios
   a. forced energy extraction, a provoked quench,
   b. a Fast Power Abort triggered by the interlock system,
   c. a powering failure of the converter,
   d. a Slow Power Abort triggered by the interlock system) and
2. the evaluation of the proper behaviour of the magnet chain, the current leads and the power converters during a normal LHC ramp and steady state.

Procedures



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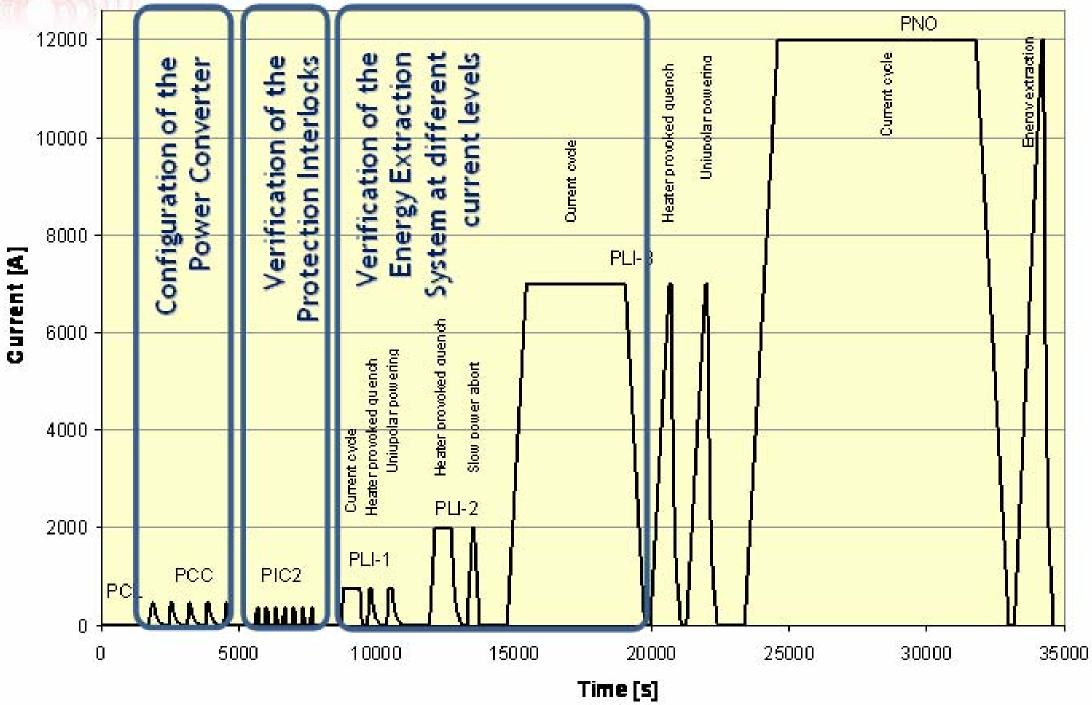

They are used to program the sequencer and are reviewed following each commissionig campaign

The objectives are:

1. the validation of the protection strategies under the different failure scenarios
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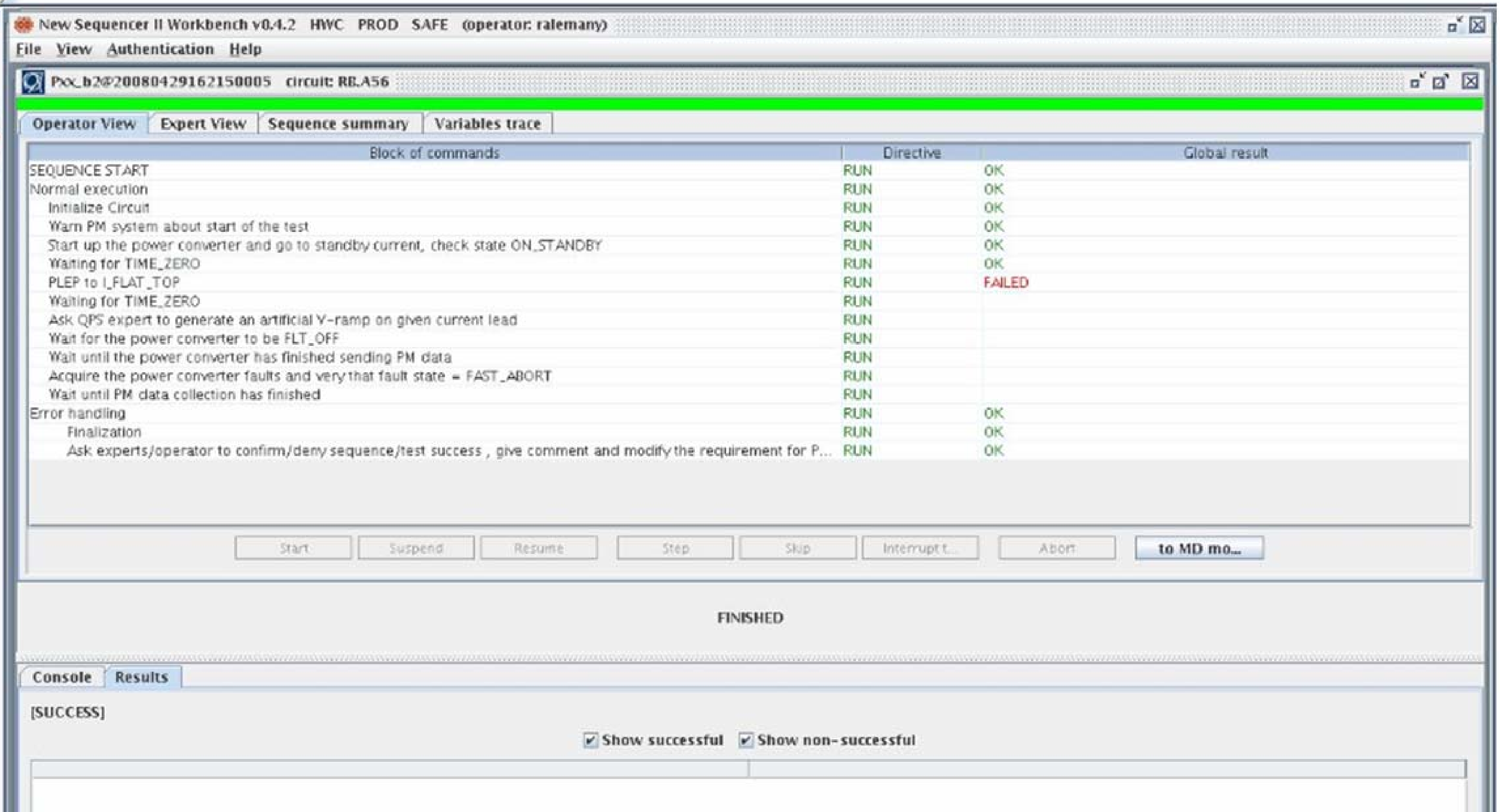
automation of procedures

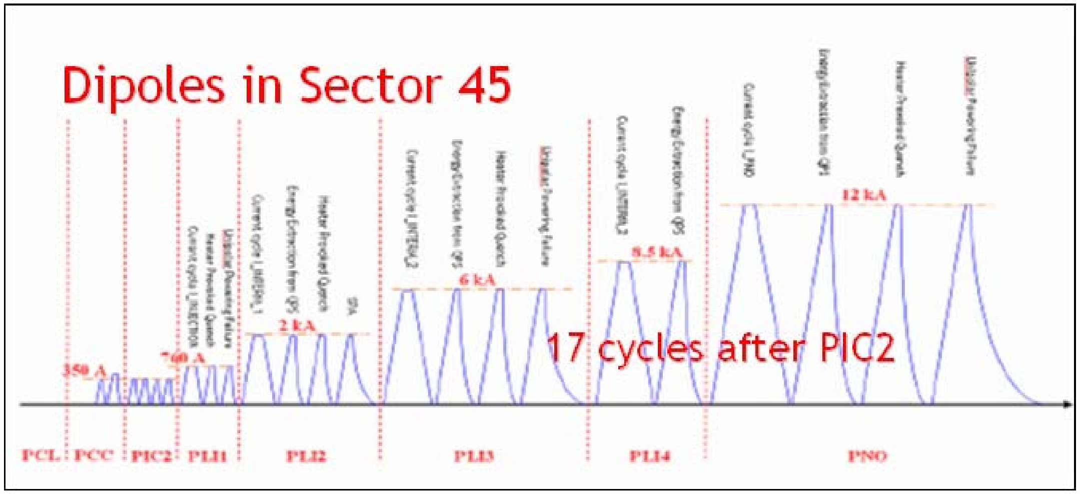


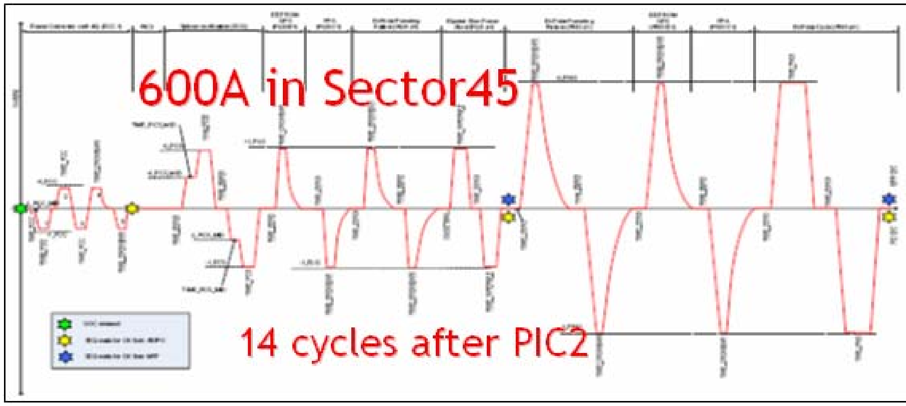
Approved and reproducible test sequences
Assistance to operators
Automatic recording of test results

Procedures : What are we doing better?

Optimisation of test procedures

- Automated sequences first tested in Sector45
- Sequences optimised for subsequent sectors





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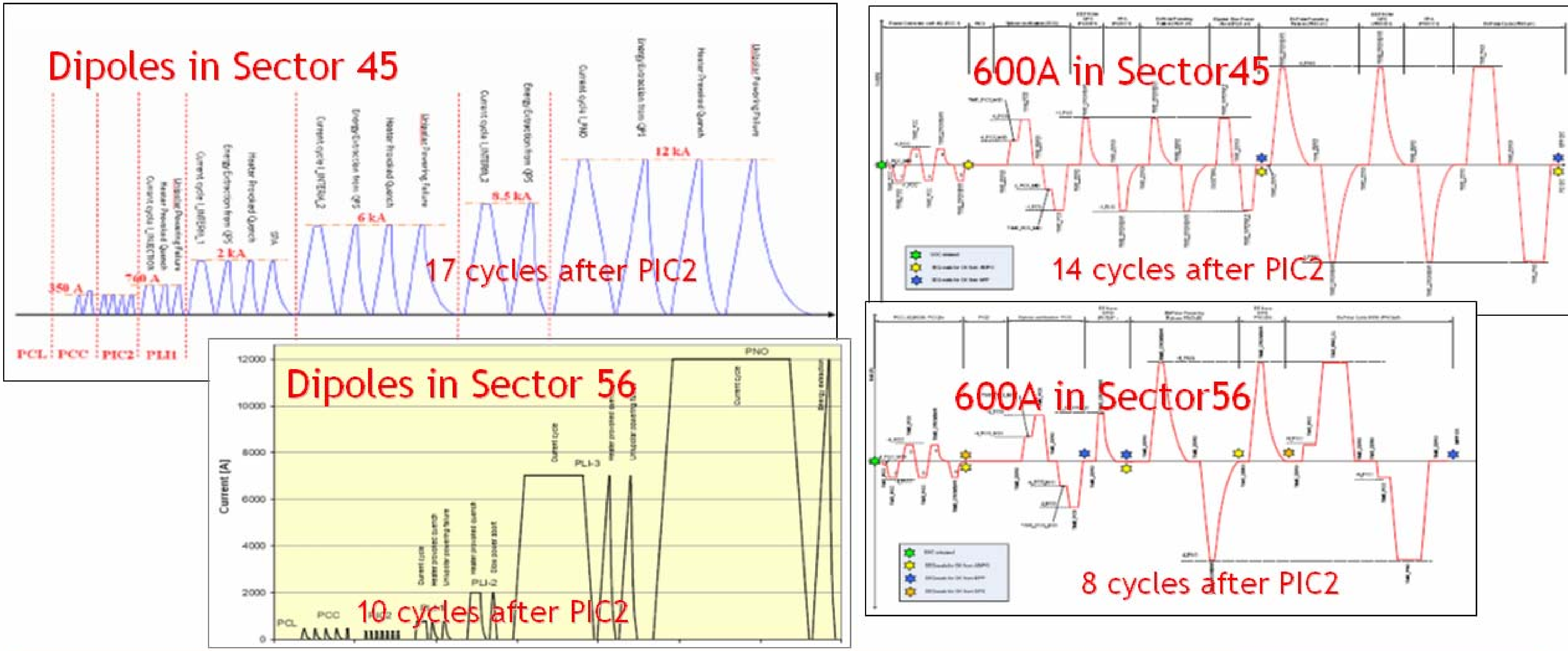


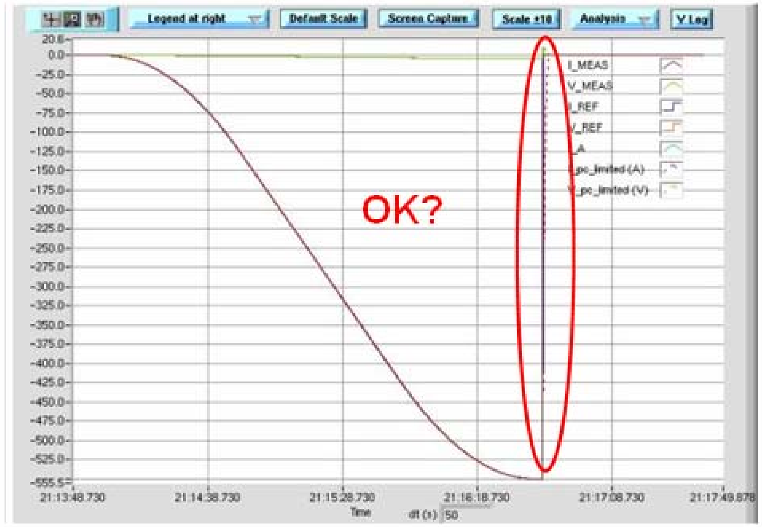
computer assisted analysis

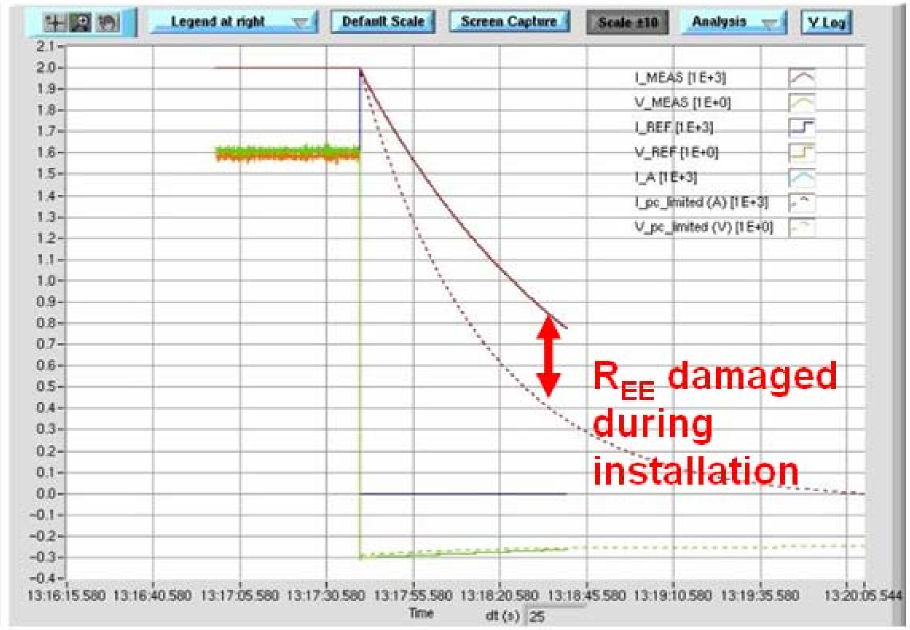
Group	Object	Property	Value	Comment
FGC_PNO2				
	Module_ID			
		System	FGC	
		Class	51_self	
		Device	RPLA.18L6.RCBH17.L6B1	
		Date	20080414	
		Time	180843	
	Circuit			
		Type	60A	
		Ltot	6.02	
		Rtot	0.0465	
		Rtom	0.0465	
PNO2_POS				
	I_MEAS			
		Shape	Flat+	
		I_RmpUp	0.50	
		I_Top	55.00	
		I_RmpDn	-0.50	
	U_LEAD_POS			
		Post_Ofs	-1.70E-3	|x| <3.50E-3
		Flat_Max	0.03449	0.02< |x| <0.08
	U_LEAD_NEG			
		Post_Ofs	-1.54E-3	|x| <3.50E-3
		Flat_Max	0.03731	0.02< |x| <0.08
	V_MEAS			
		Flat_Total	2.51	
		Flat_Cable	2.56	
		Flat_Magnet	-0.04545	|x| <0.15
		Post_Ofs	0.00745	|x| <0.05
	MAGNET_Calc			
		Linit	5.74209	5.5< |x| <6.5
		Resistance	2.36E-3	x <3.50E-3
	R_LEAD_POS			
		Flat_Avr	0.60E-3	0.45E-3< x <1.35E-3
		Flat_Slp	0.08E-6	|x| <1.80E-6

Analysis : What are we doing better?

- Increasing automation of test tools
- During a discharge analysis, a simulation of the circuit allows a rapid assessment of the result

RQT13.L8B2





RQF.A45

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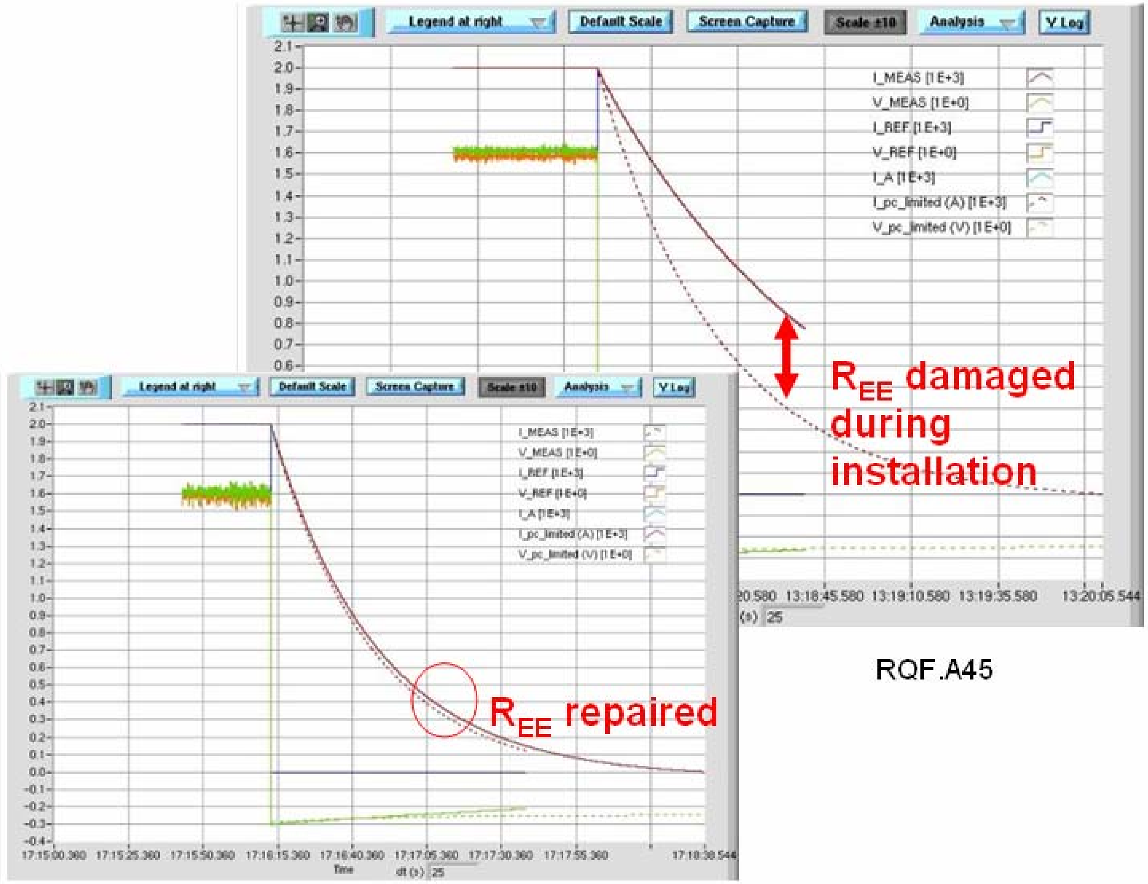

RQF.A45

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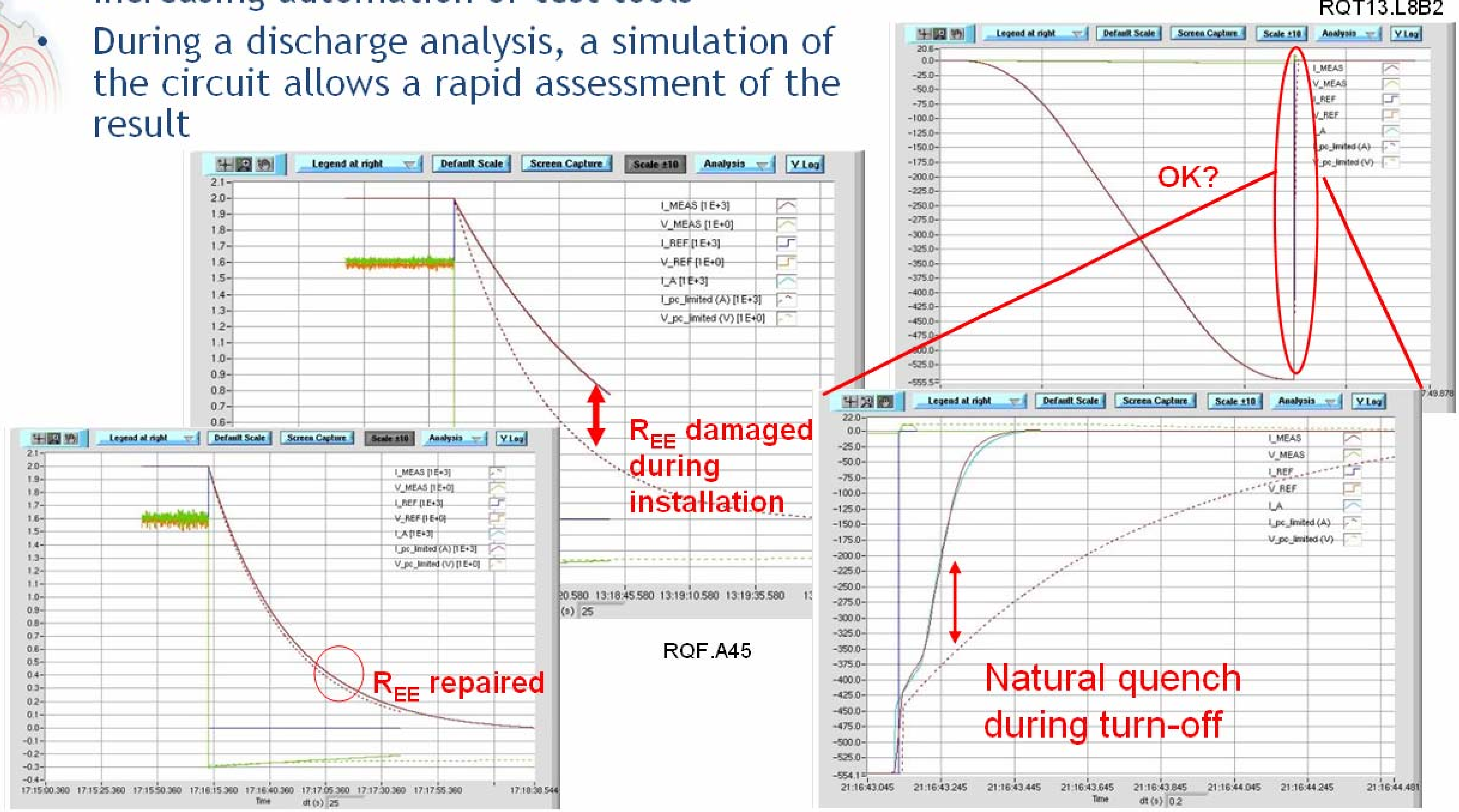

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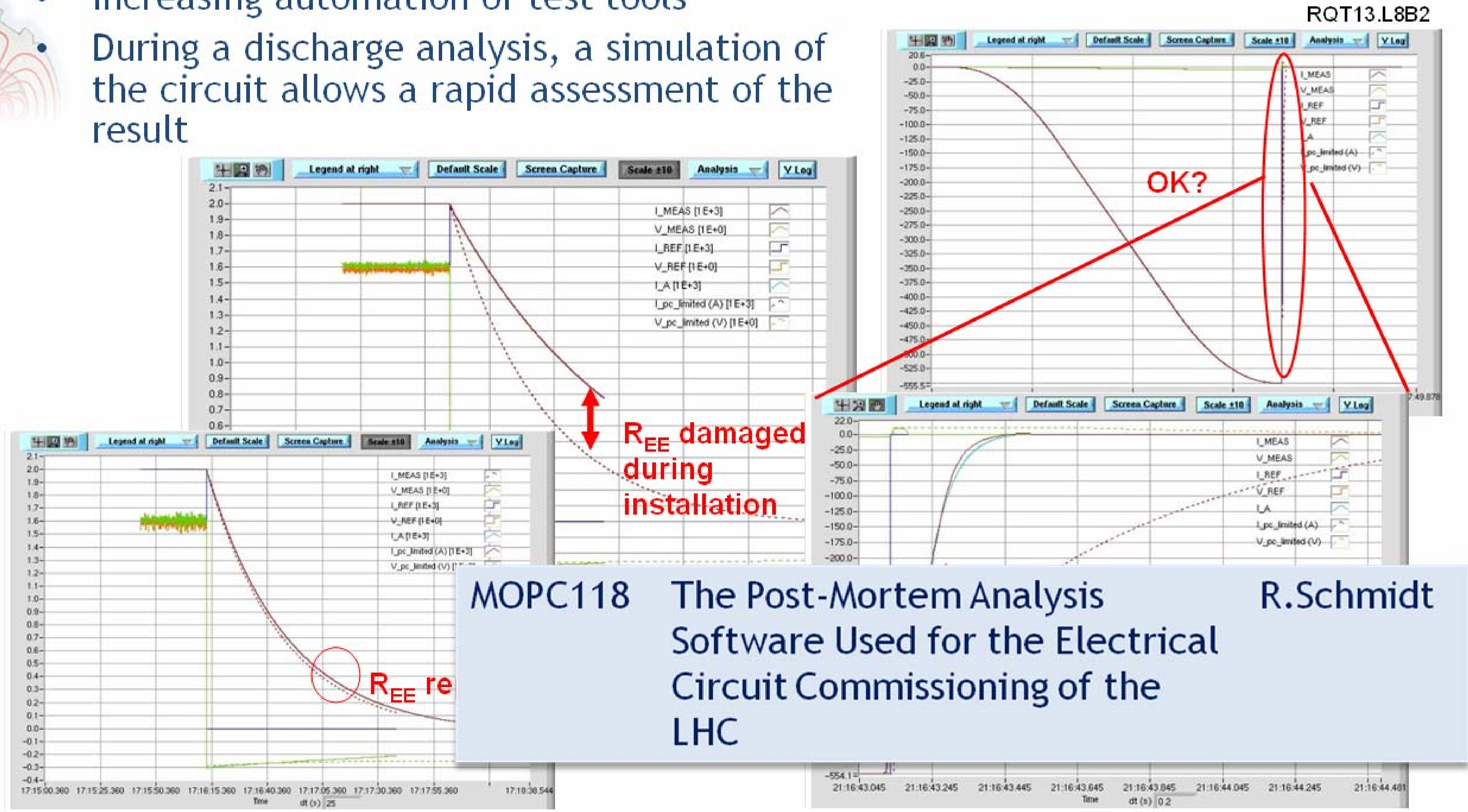
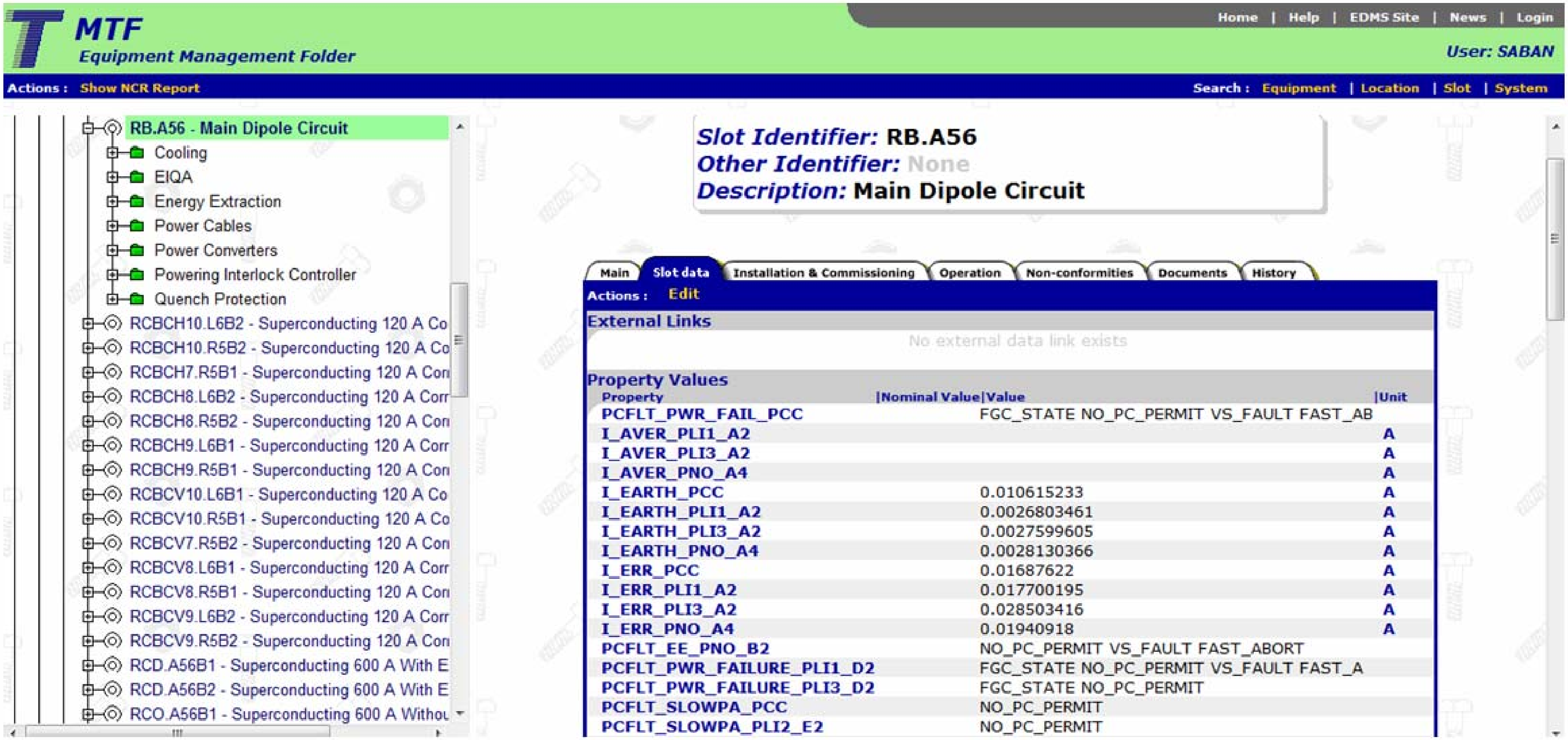
- Increasing automation of test tools
- During a discharge analysis, a simulation of the circuit allows a rapid assessment of the result



MOPC118 The Post-Mortem Analysis Software Used for the Electrical Circuit Commissioning of the LHC R.Schmidt

quality control



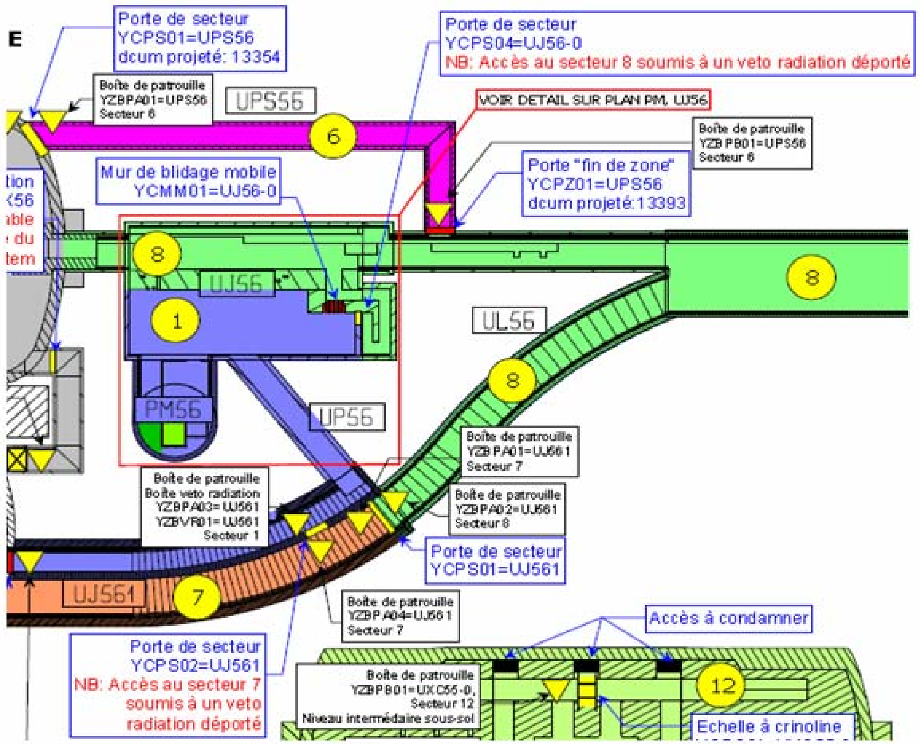
Automated recording but also manual data entry
Provides data for analyis tools
Ensures perennity of data

real-time follow up of tests

RQ4.R5	PNO.c4	14 / 15 (93%)	PNO.c4	Y	–	PCL	PCC.4	PIC2	PLI1.c3	PLI2.f3	PLI2.e3	PNO.c3	PNO.c4	PIC2 GPM										
RQ5.L6	PNO.c4	14 / 15 (93%)	PNO.c4	Y	–	PCL	PCC.4	PIC2	PLI1.c3	PLI2.f3	PLI2.e3	PNO.c3	PNO.c4	PIC2 GPM										
RQ5.R5	PNO.c4	14 / 15 (93%)	PNO.c4	Y	–	PCL	PCC.4	PIC2	PLI1.c3	PLI2.f3	PLI2.e3	PNO.c3	PNO.c4	PIC2 GPM										
RQ6.R5	PNO.c4	14 / 15 (93%)	PNO.c4	Y	–	PCL	PCC.4	PIC2	PLI1.c3	PLI2.f3	PLI2.e3	PNO.c3	PNO.c4	PIC2 GPM										
RQ7.R5	PNO.c4	14 / 15 (93%)	PNO.c4	Y	–	PCL	PCC.4	PIC2	PLI1.c3	PLI2.f3	PLI2.e3	PNO.c3	PNO.c4	PIC2 GPM										
RQ8.L6	PNO.c4	14 / 15 (93%)	PNO.c4	Y	–	PCL	PCC.4	PIC2	PLI1.c3	PLI2.f3	PLI2.e3	PNO.c3	PNO.c4	PIC2 GPM										
RQ8.R5	PNO.c4	14 / 15 (93%)	PNO.c4	Y	–	PCL	PCC.4	PIC2	PLI1.c3	PLI2.f3	PLI2.e3	PNO.c3	PNO.c4	PIC2 GPM										
RQ9.L6	PNO.c4	14 / 15 (93%)	PNO.c4	Y	–	PCL	PCC.4	PIC2	PLI1.c3	PLI2.f3	PLI2.e3	PNO.c3	PNO.c4	PIC2 GPM										
RQ9.R5	PNO.c4	14 / 15 (93%)	PNO.c4	Y	–	PCL	PCC.4	PIC2	PLI1.c3	PLI2.f3	PLI2.e3	PNO.c3	PNO.c4	PIC2 GPM										
RQX.R5	PNO.d11	21 / 33 (63%)	PNO.d11	Y	–	PCC.T1	PCC.T2	PCC.T3	PCC.T4	PIC2	PLI1.a4	PLI1.d4	PNO.a5	PNO.d4	PLI1.d5	PLI2.e4	PLI3.d6	PLI1.d7	PLI2.e5	PLI3.d8	PLI1.d9	PLI2.e6	PLI3.d10	PL
RB.A56	PNO.b2	21 / 22 (95%)	PNO.b2	N	–	PCL	PCC.2	PIC2	PLI1.a2	PLI1.f1	PLI1.d2	PLI2.f1	PLI2.e2	PLI3.a2	PLI3.f1	PLI3.d2	PNO.a4	PNO.b2	PIC2 GPM					
RQD.A56	PNO.b3	17 / 19 (89%)	PNO.b3	Y	–	PCL	PCC.3	PIC2	PLI1.f5	PLI1.d2	PLI2.f1	PLI2.e2	PLI3.f1	PNO.b3	PNO.d2	PIC2 GPM								
RQF.A56	PNO.b3	17 / 19 (89%)	PNO.b3	Y	–	PCL	PCC.3	PIC2	PLI1.f5	PLI1.d2	PLI2.f1	PLI2.e2	PLI3.f1	PNO.b3	PNO.d2	PIC2 GPM								

access control

Access control is activated as soon as the cool down of a sector starts



access control

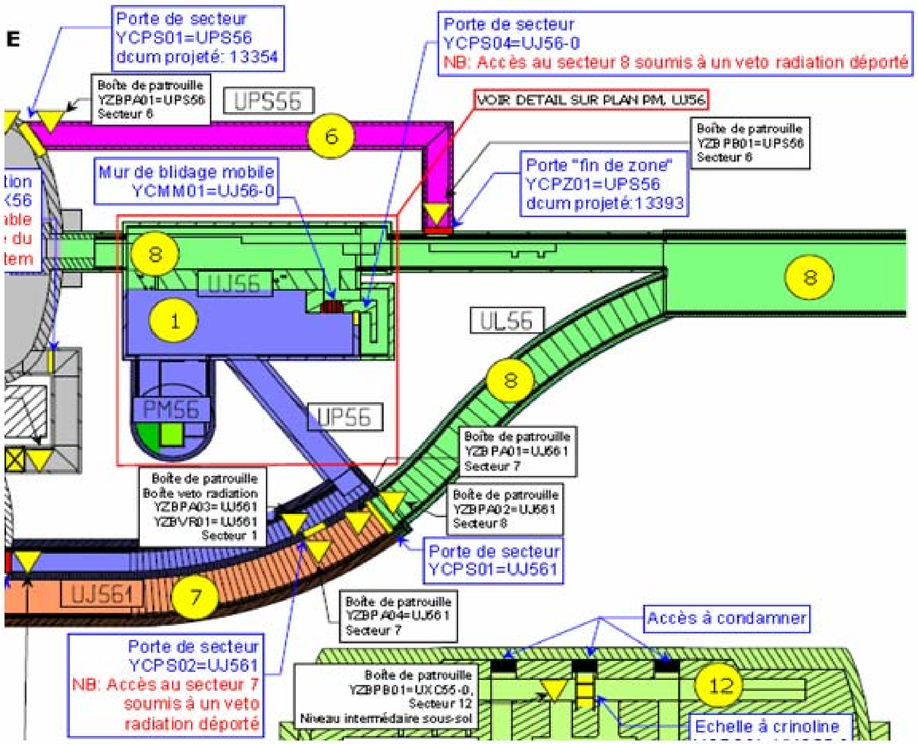
Access control is activated as soon as the cool down of a sector starts

Rule 1

During the powering tests and in particular above 1 kA no one must be in the tunnel.

Rule 2

No tampering with equipment already commissioned.



TUPC129 The LHC Access System: from Design to Operation T.Pettersson

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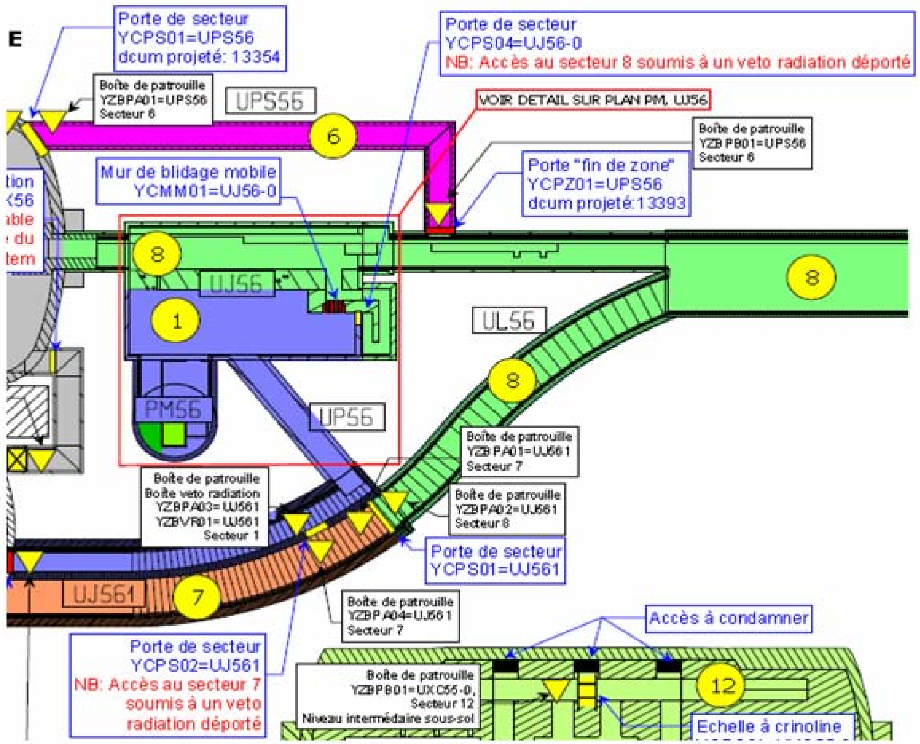
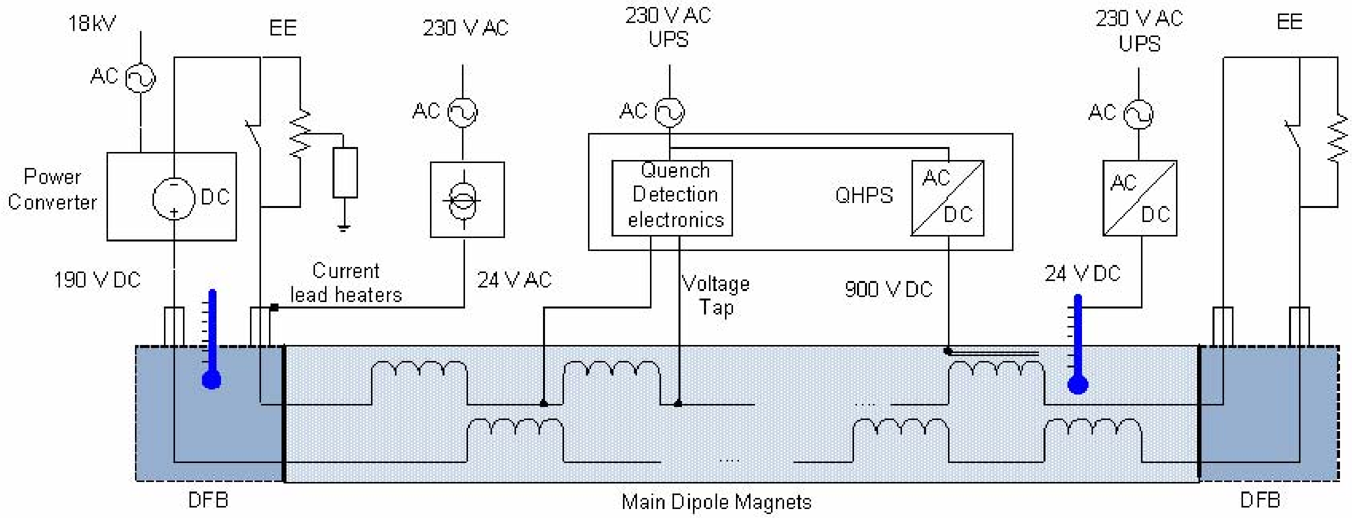
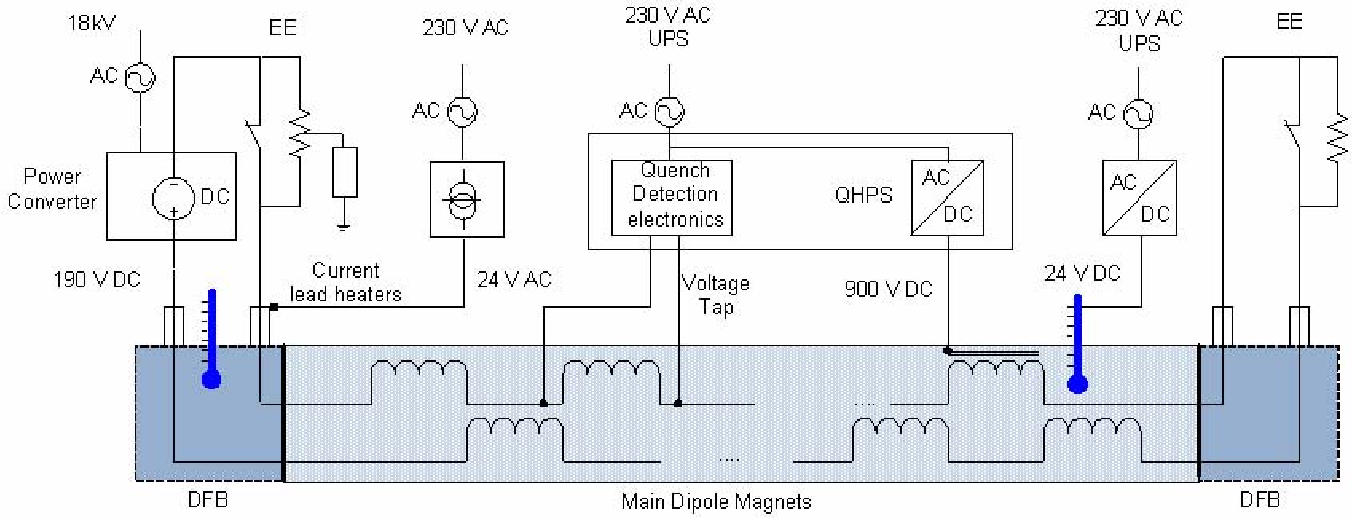


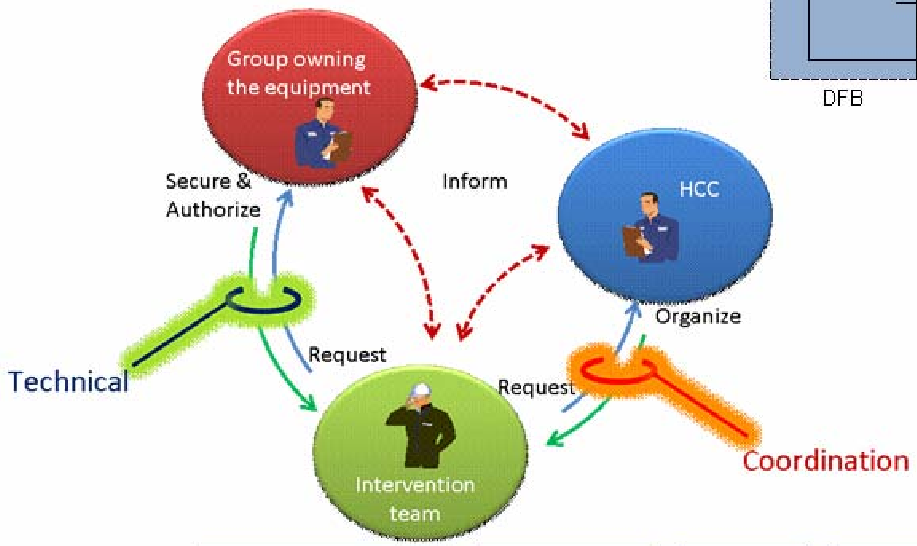
Access becomes restricted immediately after each sector reaches 80 K

electrical safety



electrical safety

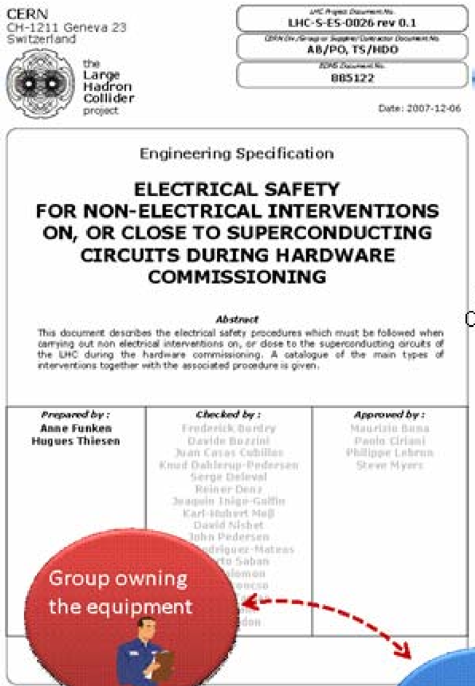




- All the circuits of a DFB are locked and grounded when any work is foreseen on that DFB
- Access to the tunnel is not authorized when current above 1 kA is present in any of the circuits of a sector

DFBXH				DFBMB			DFBMI		DFBMJ		DFBAP				ARC		DFBAA		DFBLA		DFBXA		
D1	QX	600A	120A	Q4	D2	120A	Q5	120A	Q6	120A	Spool	LineN	Main	6kA	120A	60A	6kA	LineN	120A	6kA	QX	600A	120A
1	3	7	5	1	1	6	1	2	1	2	6	19	3	4	16	94	4	14	10	4	3	7	5
XR8				MR8.Q4			MR8.Q5		A81.Q6		A81								LL1		XL1		

electrical safety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Switzerland

the Large Hadron Collider project

LHC Project Document No.
LHC-S-ES-0026 rev 0.1

CERN Div./Group or Supplier/Contractor Document No.
AB/PO, TS/HDO

EDMS Document No.
885122

Date: 2007-12-06

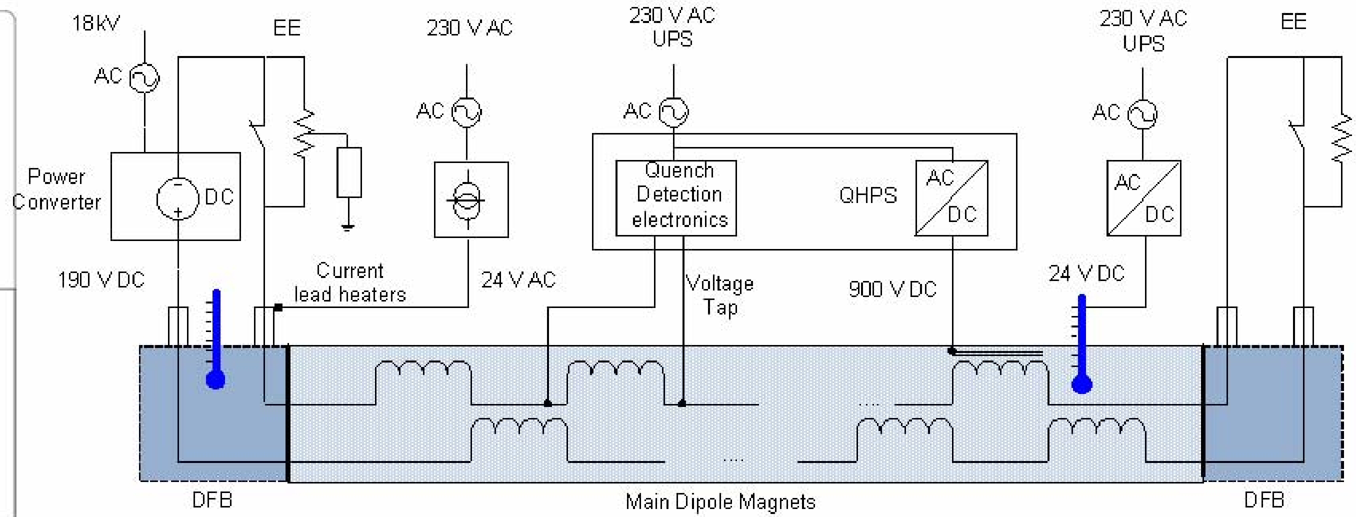
Engineering Specification

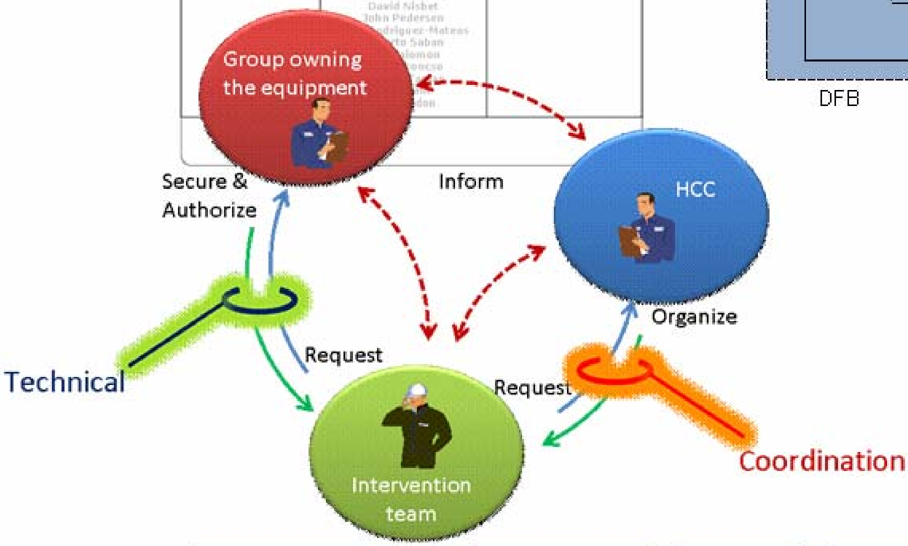
ELECTRICAL SAFETY FOR NON-ELECTRICAL INTERVENTIONS ON, OR CLOSE TO SUPERCONDUCTING CIRCUITS DURING HARDWARE COMMISSIONING

Abstract

This document describes the electrical safety procedures which must be followed when carrying out non electrical interventions on, or close to the superconducting circuits of the LHC during the hardware commissioning. A catalogue of the main types of interventions together with the associated procedure is given.

Prepared by :	*Checked by :*	*Approved by :*
Anne Funken Hugues Thiesen	Frederick Bordry Davide Bozzini Juan Casas Cubillos Knud Dahlerup-Petersen Serge Deleval Reiner Denz Joaquin Inigo-Golfin Karl-Hubert Meß David Nisbet John Pedersen	Maurizio Bona Paolo Ciriani Philippe Lebrun Steve Myers





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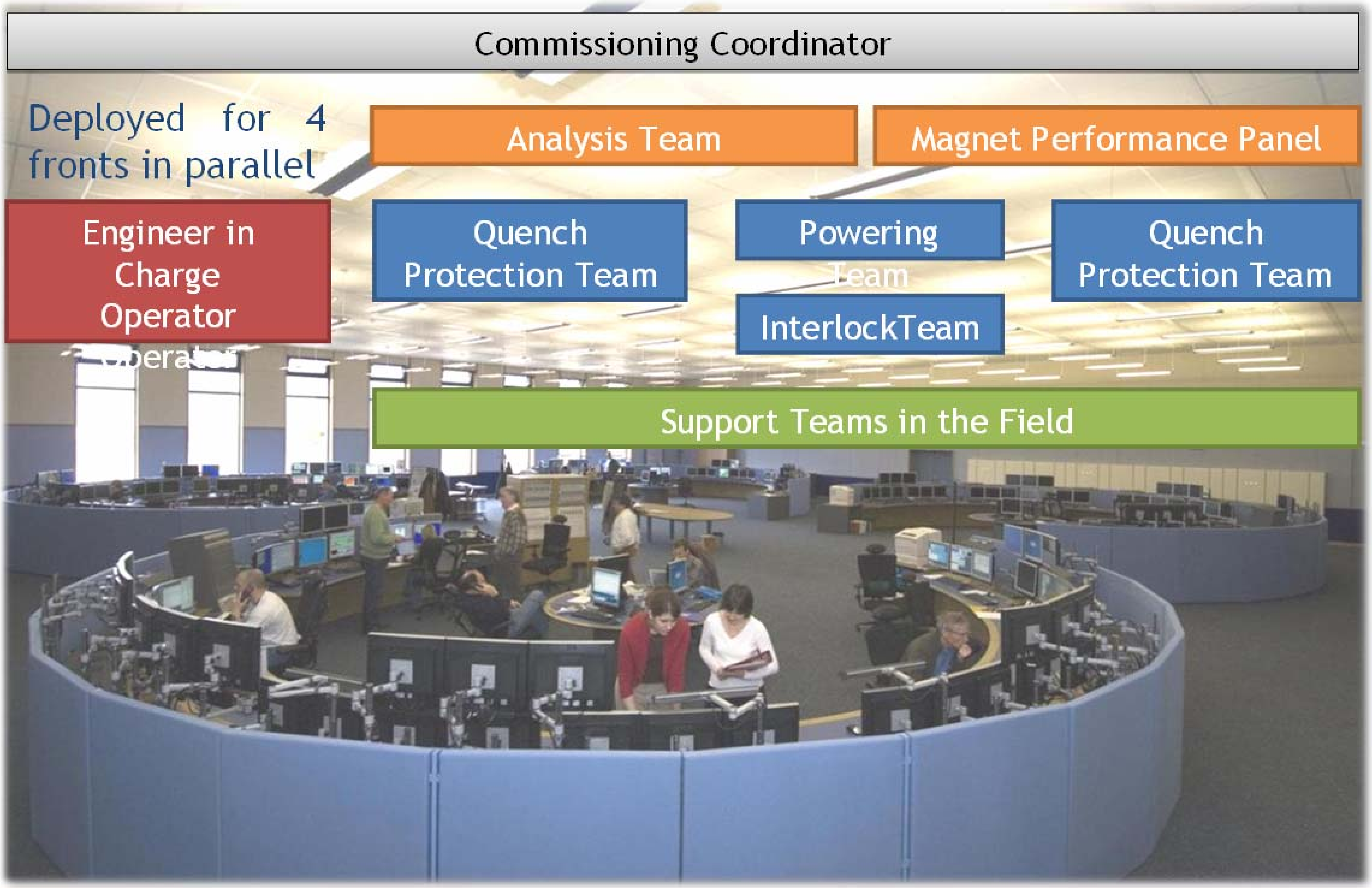
1	3	7	5	1	1	6	1	2	1	2	6	19	3	4	16	94	4	14	10	4	3	7	5
XR8				MR8.Q4			MR8.Q5		A81.Q6		A81								LL1		XL1		

the organization

the organization



additonal resources: the project associate programme

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the
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project

LHC Project Document No.
LHC-PM-MR-0002 rev 1.3

CERN Div./Group or Supplier/Contractor Document No.
AB-CO/AB-OP/AB-PO/AT-ACR/AT-MEL/TS-HDO

EDMS Document No.
503580

Date: 2005-05-19

Management Report

RESOURCES FOR THE INDIVIDUAL SYSTEM TESTS AND THE HARDWARE COMMISSIONING OF THE LHC

PART 1: THE COMMISSIONING OF THE SUPERCONDUCTING MAGNET CIRCUITS AND THE ASSOCIATED TECHNICAL SYSTEMS

Abstract

It is expected that the hardware commissioning will be dominated by the commissioning of the very complex powering system for superconducting magnets and its associated infrastructure. Time and investment for additional personnel will be mainly spent for this activity.

This document presents **the resources identified for a commissioning scenario restricted by a number of assumptions**: in particular, the parallel commissioning of two sectors around an even point **-not more and not less-** and the staggered commissioning of an additional set of two sectors where the cool down follows the powering tests of the first set (see page 4).

However from the data presented in this document, it is possible to derive the resources needed for a different scenario when some of the restrictions are lifted or relaxed.

The present version of the document reports the resources required when **the staggered commissioning of two sets of two adjacent sectors where only the powering tests do not overlap** is carried-out (13 months schedule).

Prepared by :	*Checked by :*	*Approved by :*
Simon Baird **Frederick Bordry** **Bertrand Frammery** **Karl-Hubert Meß** **Roberto Saban** **Laurent Tavian** **Esther Barbero-Soto** **Juan Casas-Cubillos** **Paulo Gomes** **Félix Rodríguez-Mateos** **Bruno Puccio** **Robin Lauckner** **Rüdiger Schmidt** **Luigi Serio** **Hugues Thiesen** **Markus Zerlauth**	**Paolo Ciriani** **Philippe Lebrun** **Steve Myers** **Paul Proudlock**	**Lyn Evans**

additonal resources: the project associate programme

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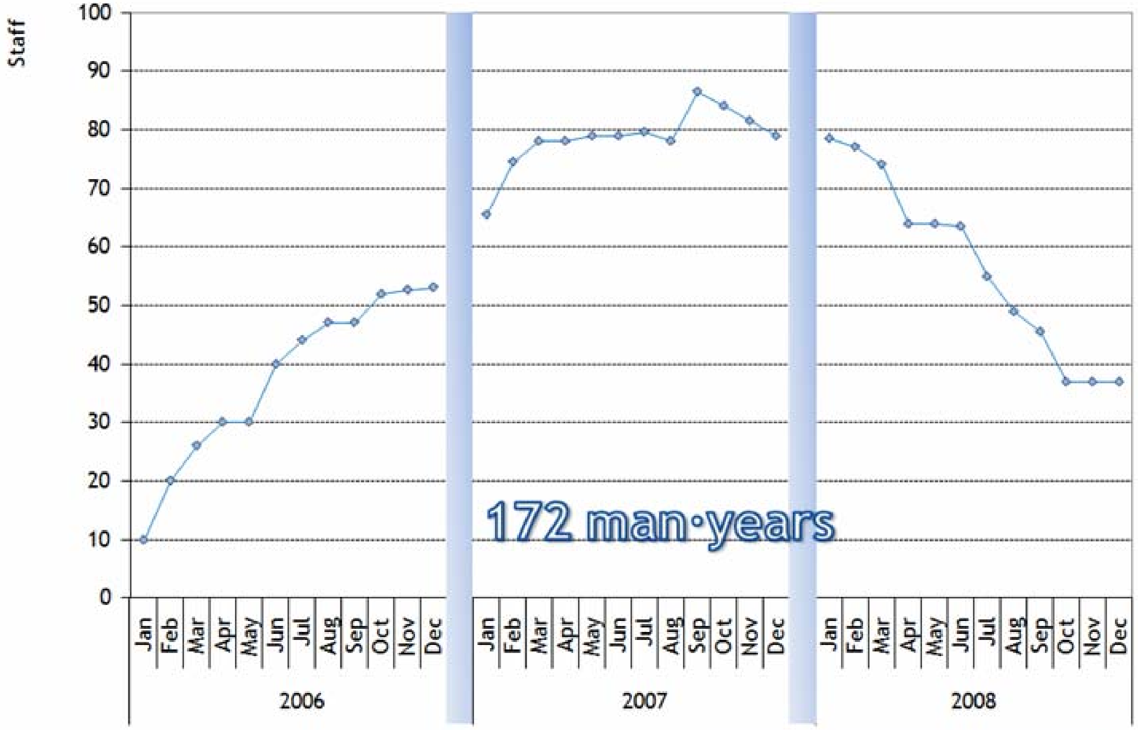
Greece
France
India
Italy
Pakistan
Poland
Russia
Spain
USA

CERN staff, fellows and colleagues deployed by national institutes integrated in a single team

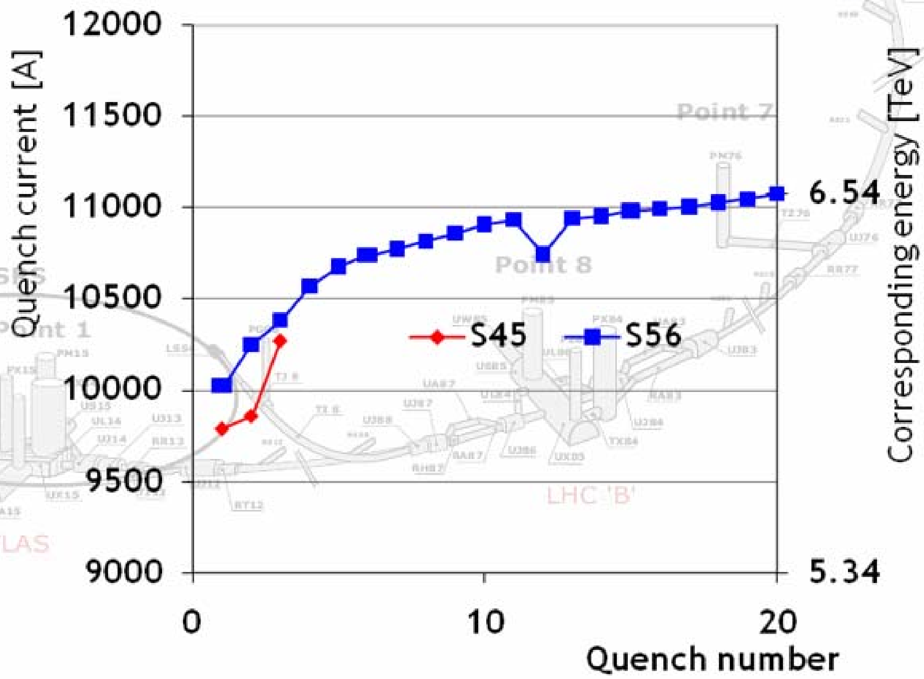


the strategy

The mandate of the Hardware Commissioning Team to nominal current for operation at 7 TeV

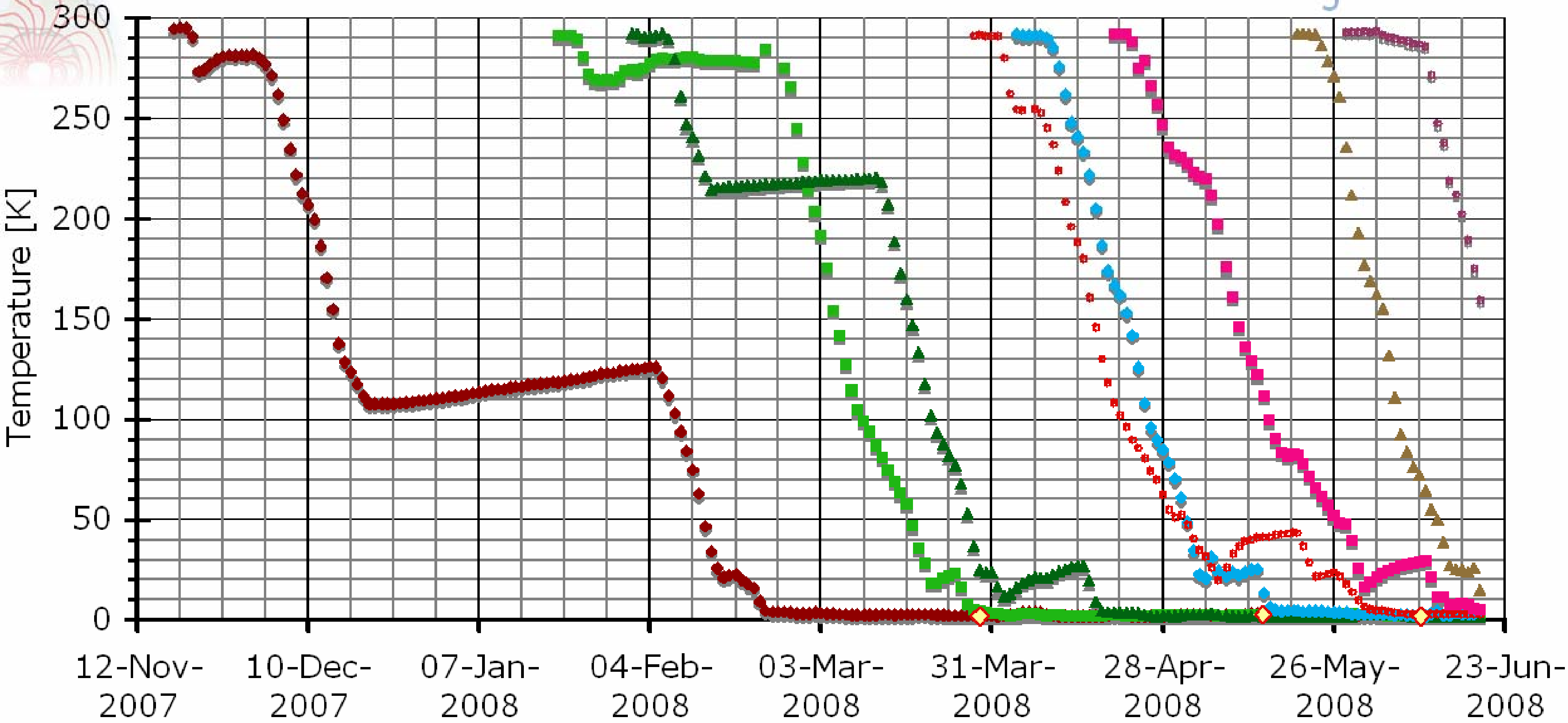
After the confirmation in two sectors that a current level (8500 A) corresponding to 5 TeV could be reached without any training quench in the dipole circuit, this was adopted as the baseline for the other sectors.

It was however decided to continue with the training quenches in Sector 56 to confirm the number of quenches needed to train a full sector to 7 TeV.



cool down

4 sectors below 2 K
almost
5



Cooling sectors + Cryo tuning + Powering activities

WEPD040	Outcome of the Commissioning of the Readout and Actuation Channels for the Cryogenics of the LHC	Gonzalo Fernandez Penacoba

cool down

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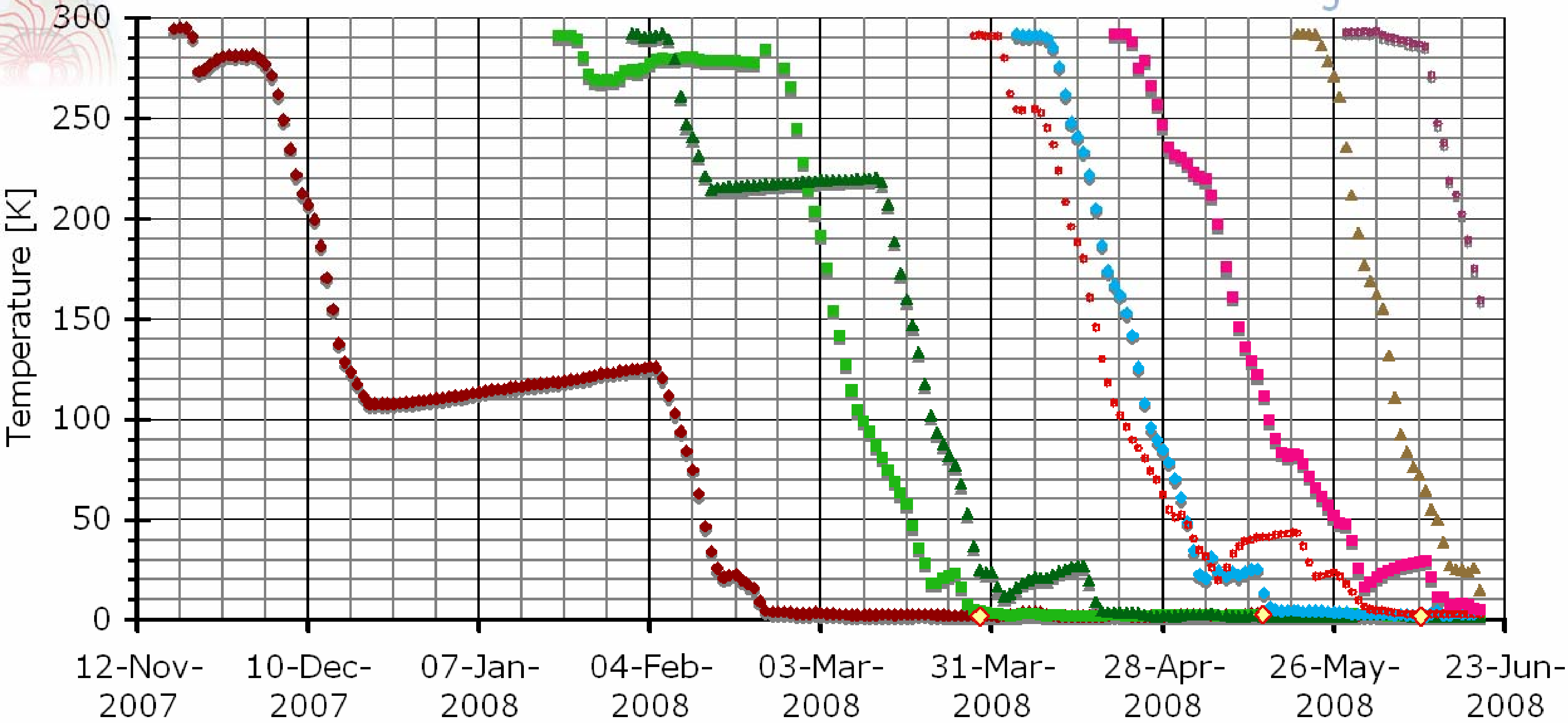
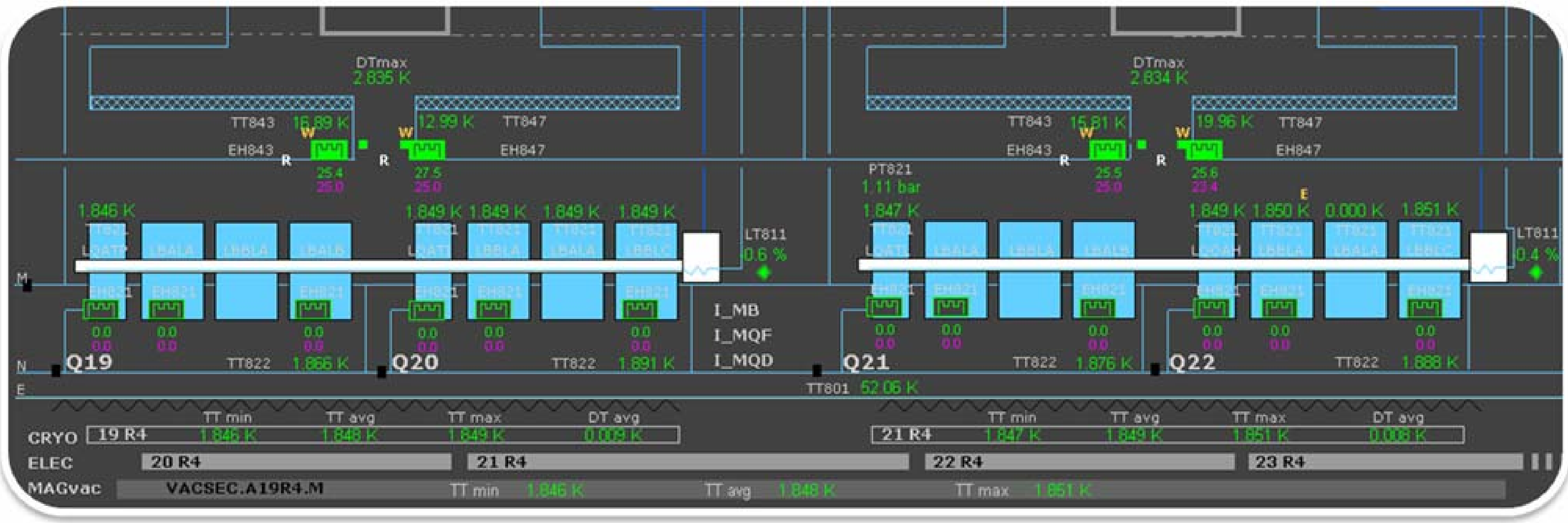


Cooling sectors + Cryo tuning + Powering activities

a training quench and it's propagation

- Natural quench in A22R4 at 9859 A
- 4 magnets quenched (3 propagation quenches)

Magnet	Cryogenic cell	Local time	Δt quench [s]	I quench [kA]	E [MJ]
A22R4	21R4	16:50:34.947		**9.859**	4.957
B22R4	21R4	16:51:24.679	49.732	6.011	1.843
C22R4	21R4	16:52:07.532	92.589	3.829	0.748
C21R4	19R4	16:52:41.798	126.855	2.644	0.357
					Total 7.905



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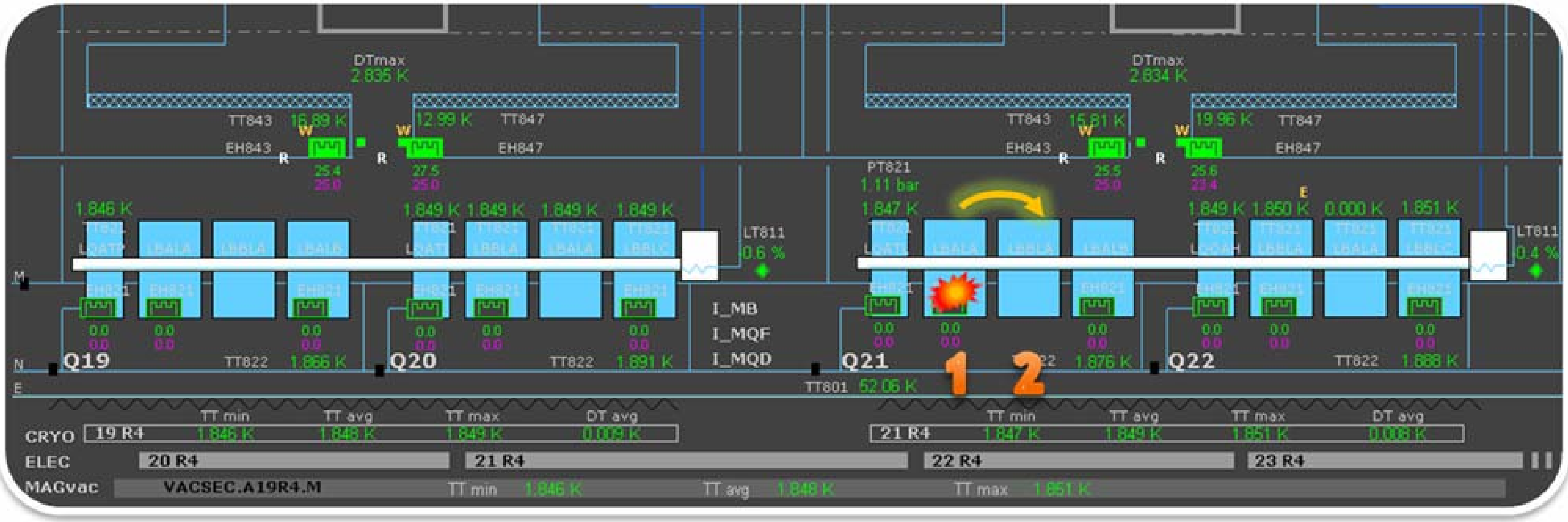

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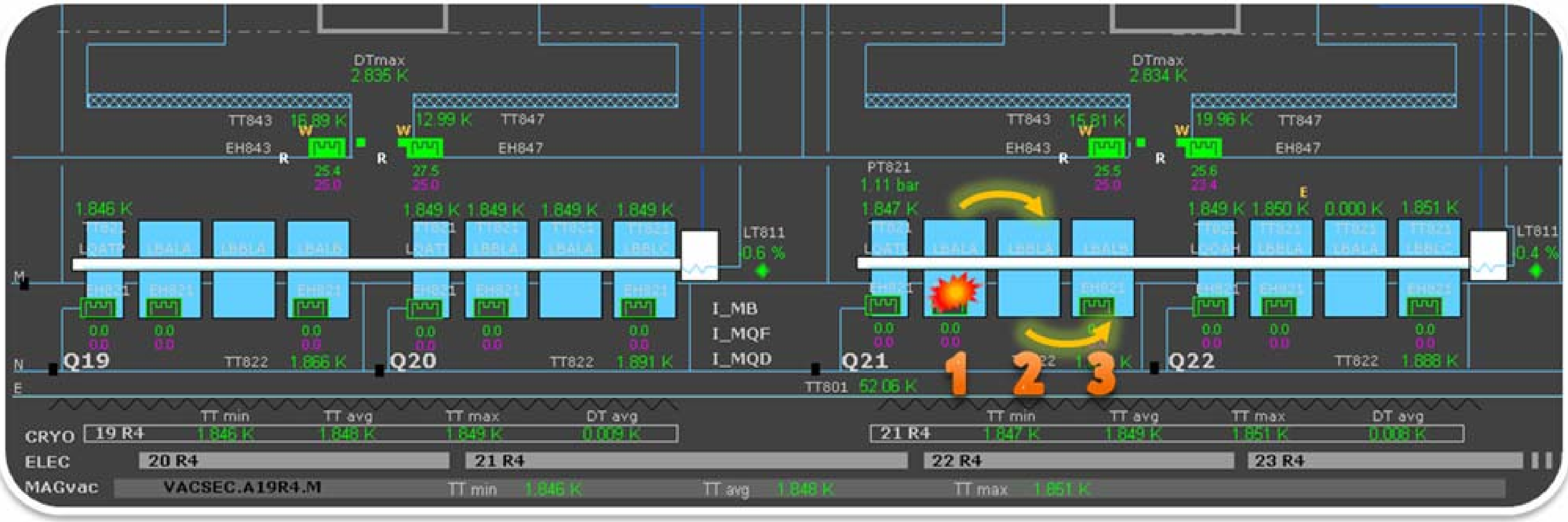

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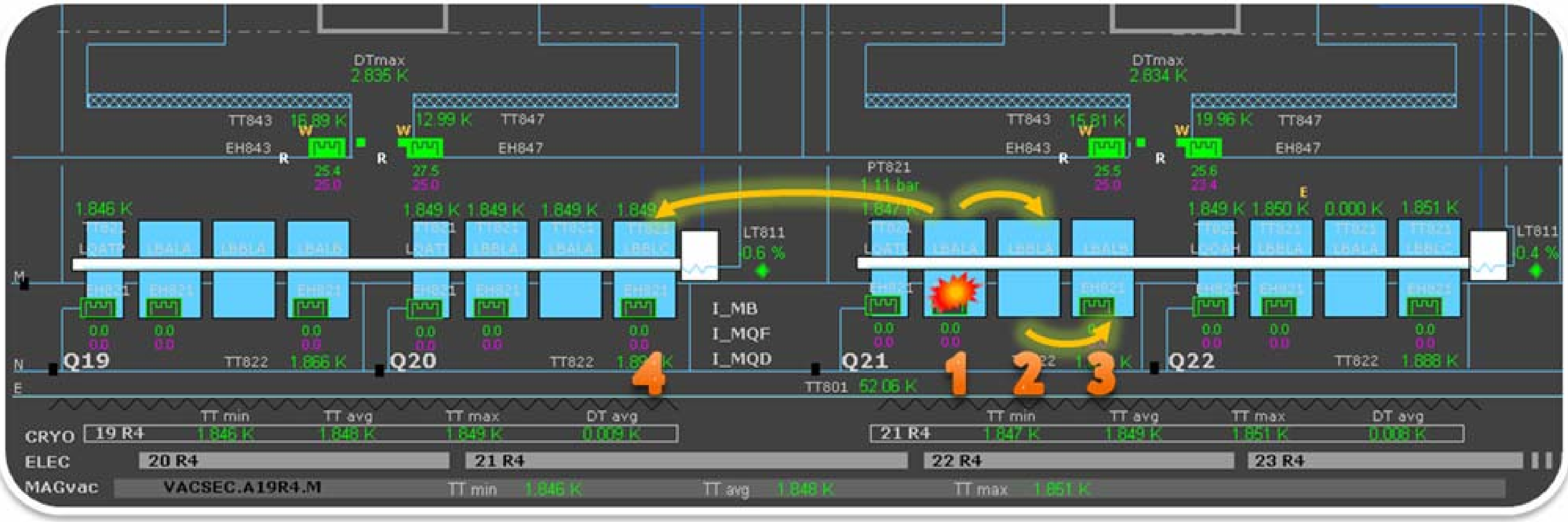
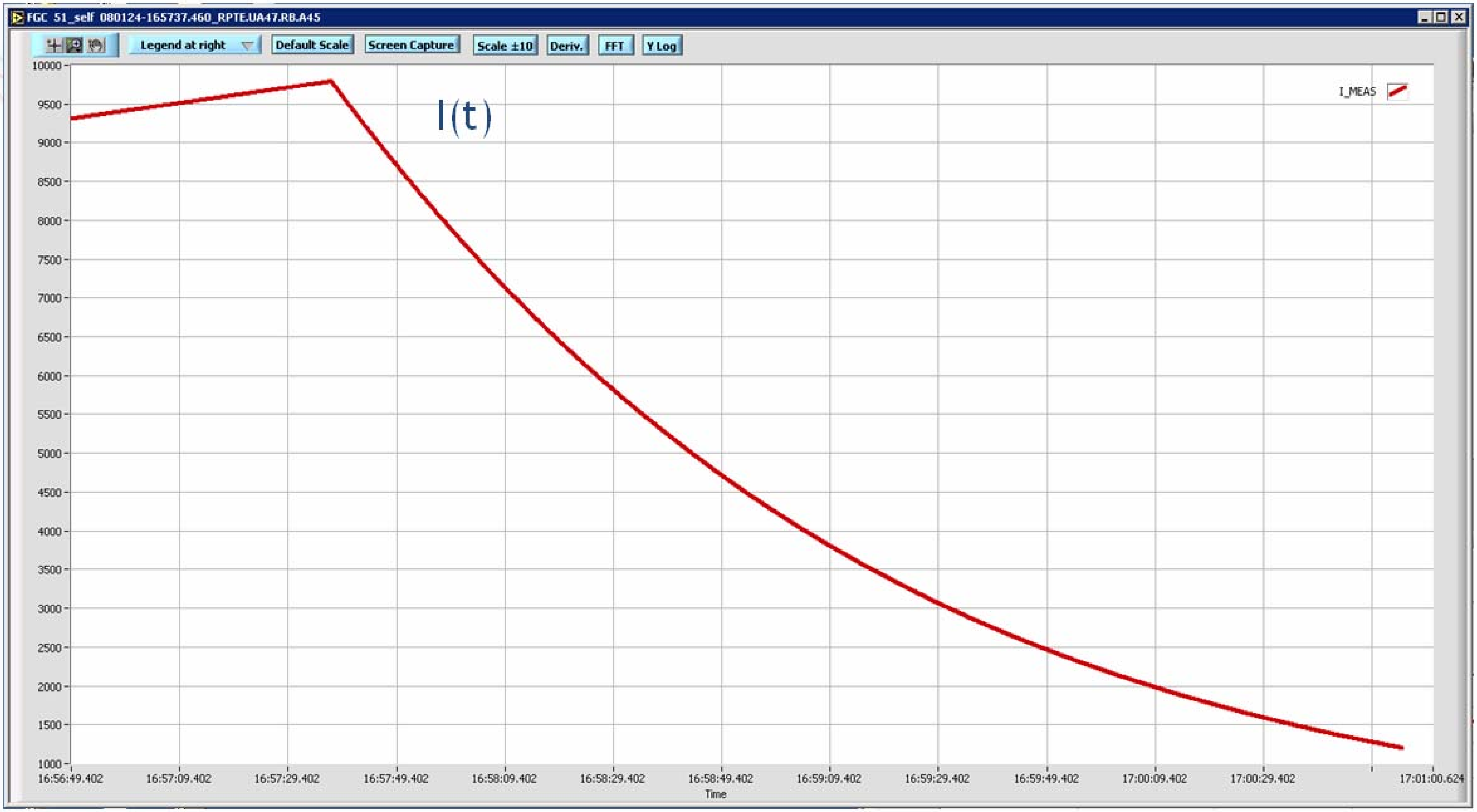


training quench characteristics



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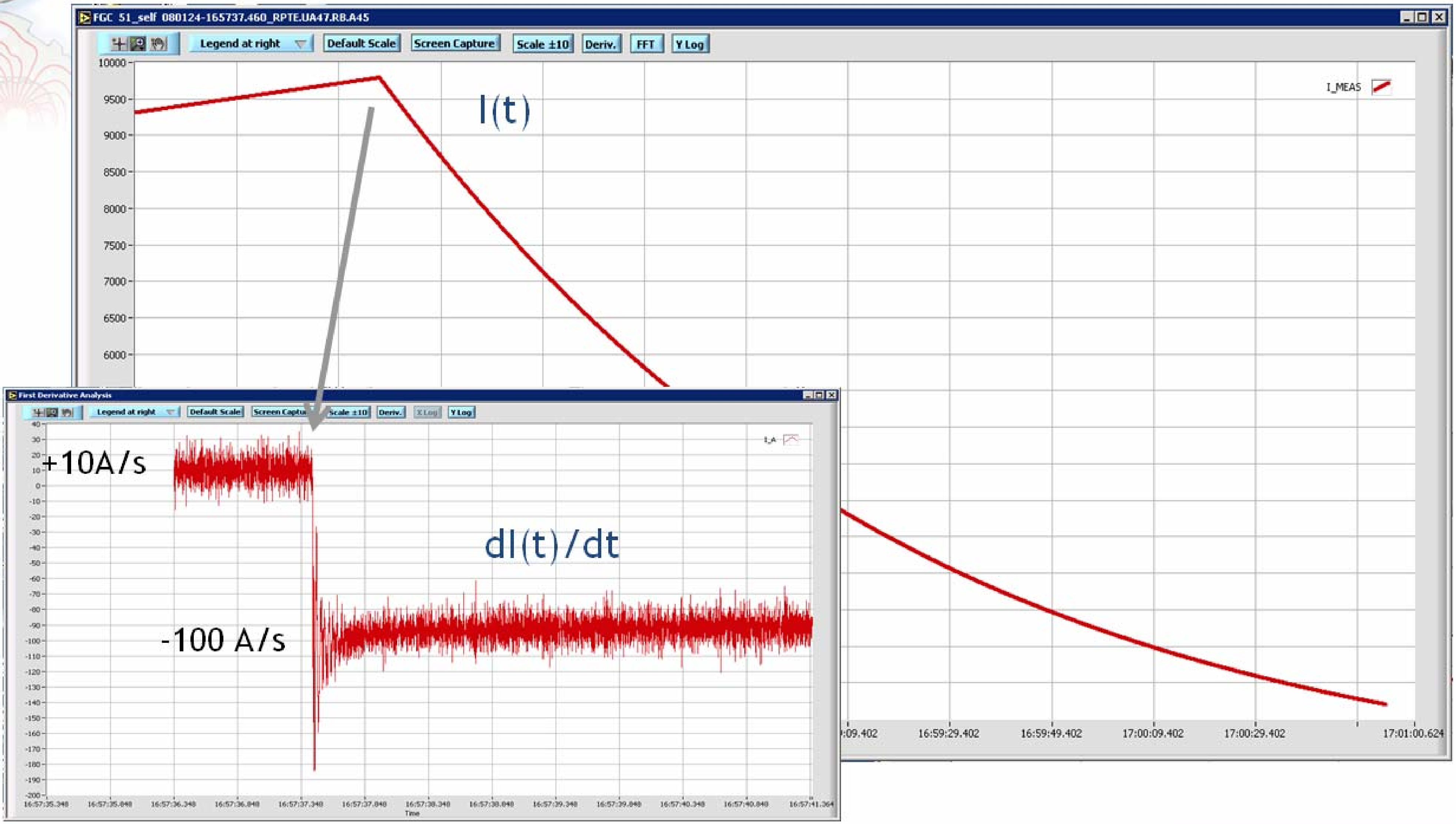

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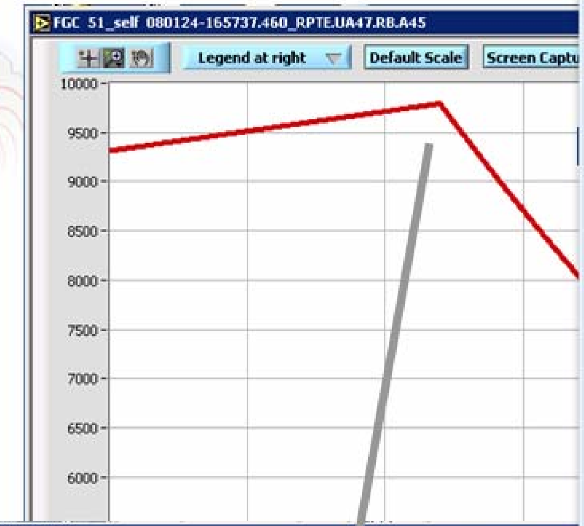
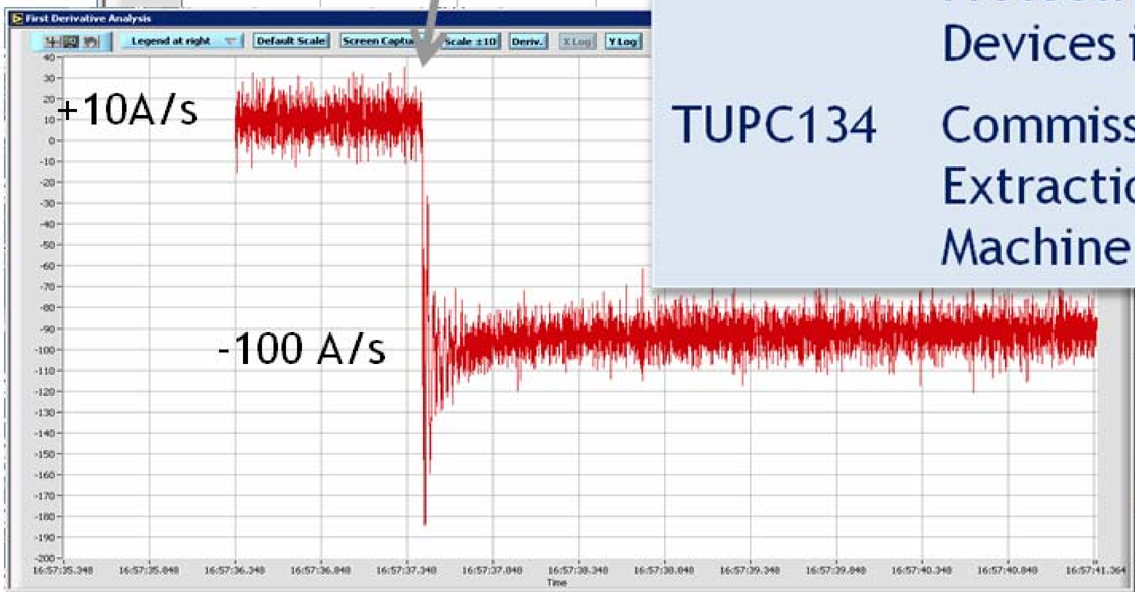
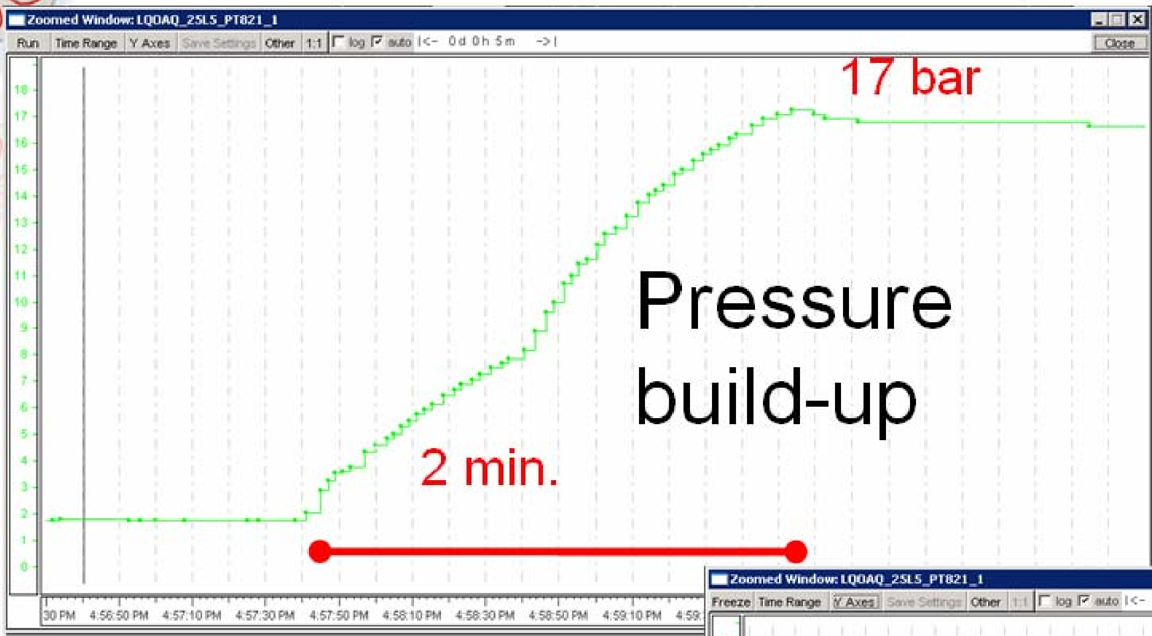
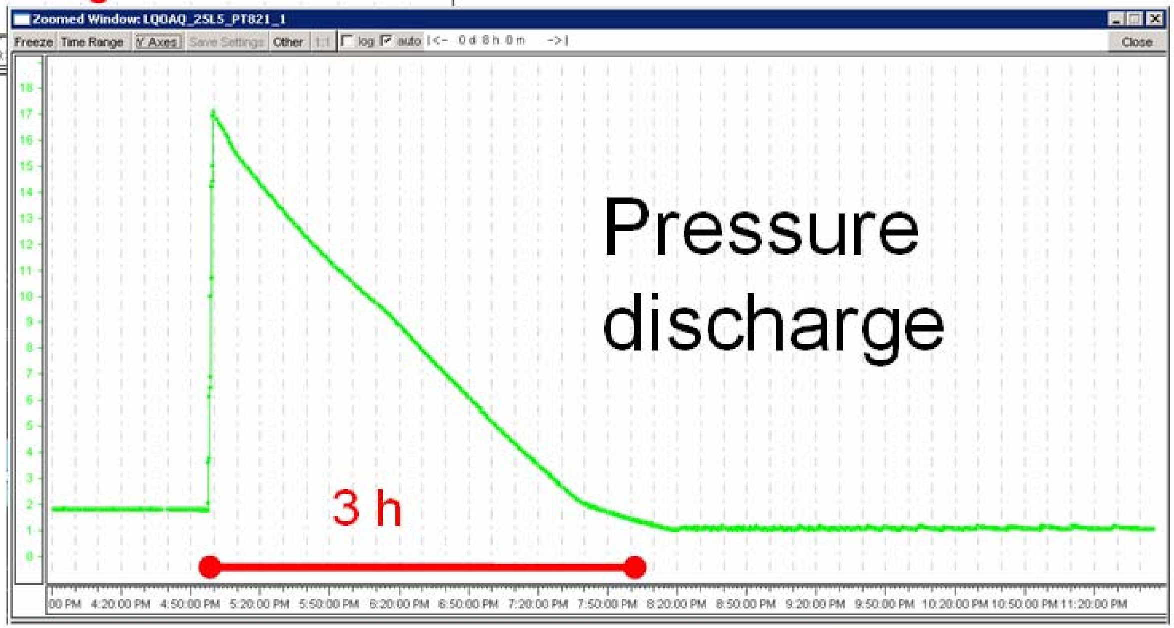


WEPD007	Detection and Location of Electrical Insulation Faults on the LHC Superconducting Circuits during the Hardware Commissioning	D.Bozzini
WEPD018	Commissioning of the LHC Current Leads	K-H.Meß
WEPD010	Electronic Systems for the Protection of Superconducting Devices in the LHC	R.Denz
TUPC134	Commissioning of the Energy Extraction Facilities of the LHC Machine	K-H.Meß

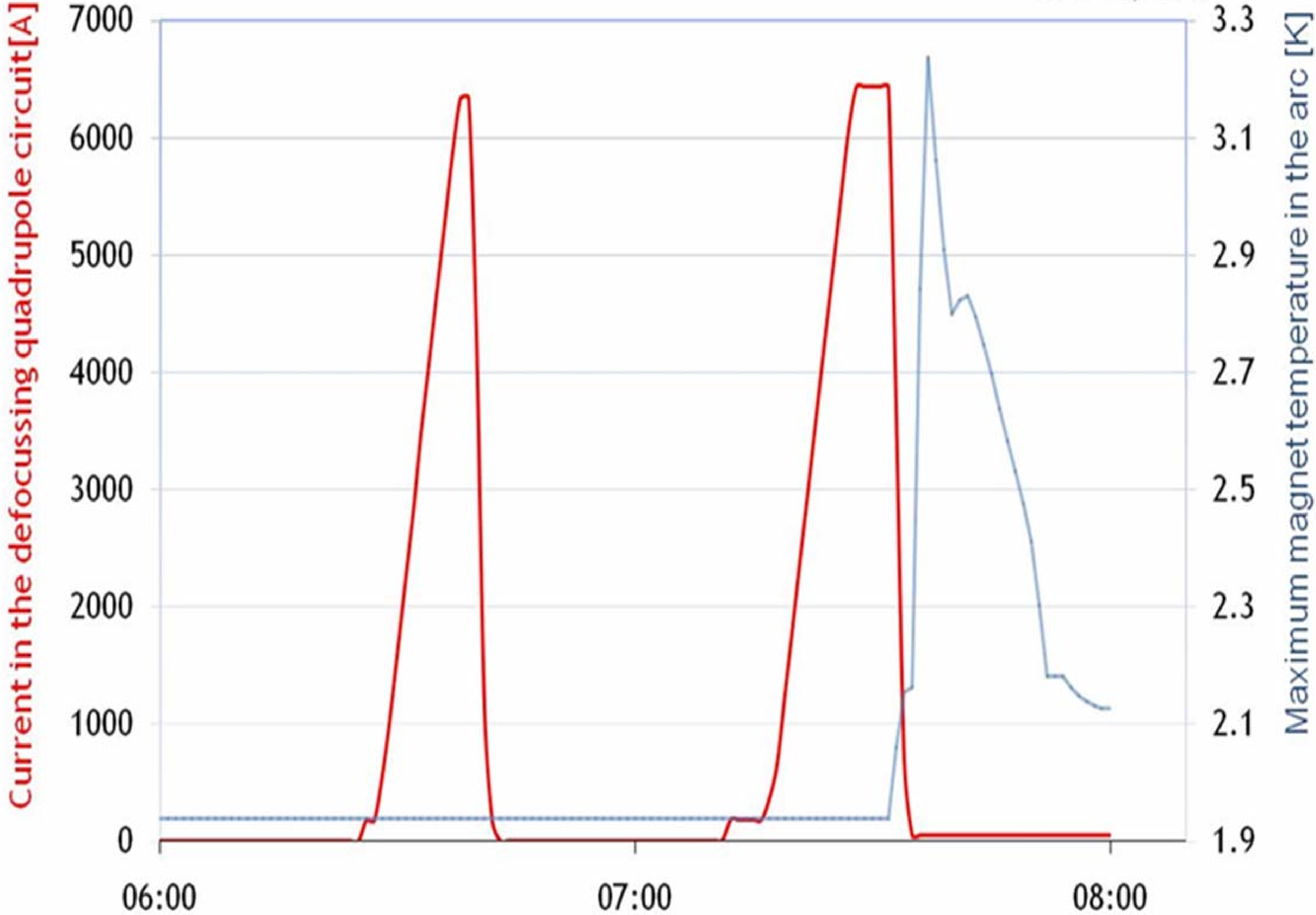


hydraulic aspects





RQD Circuit discharge in the energy extraction system and Quench from 6.5 kA
June 21, 2007



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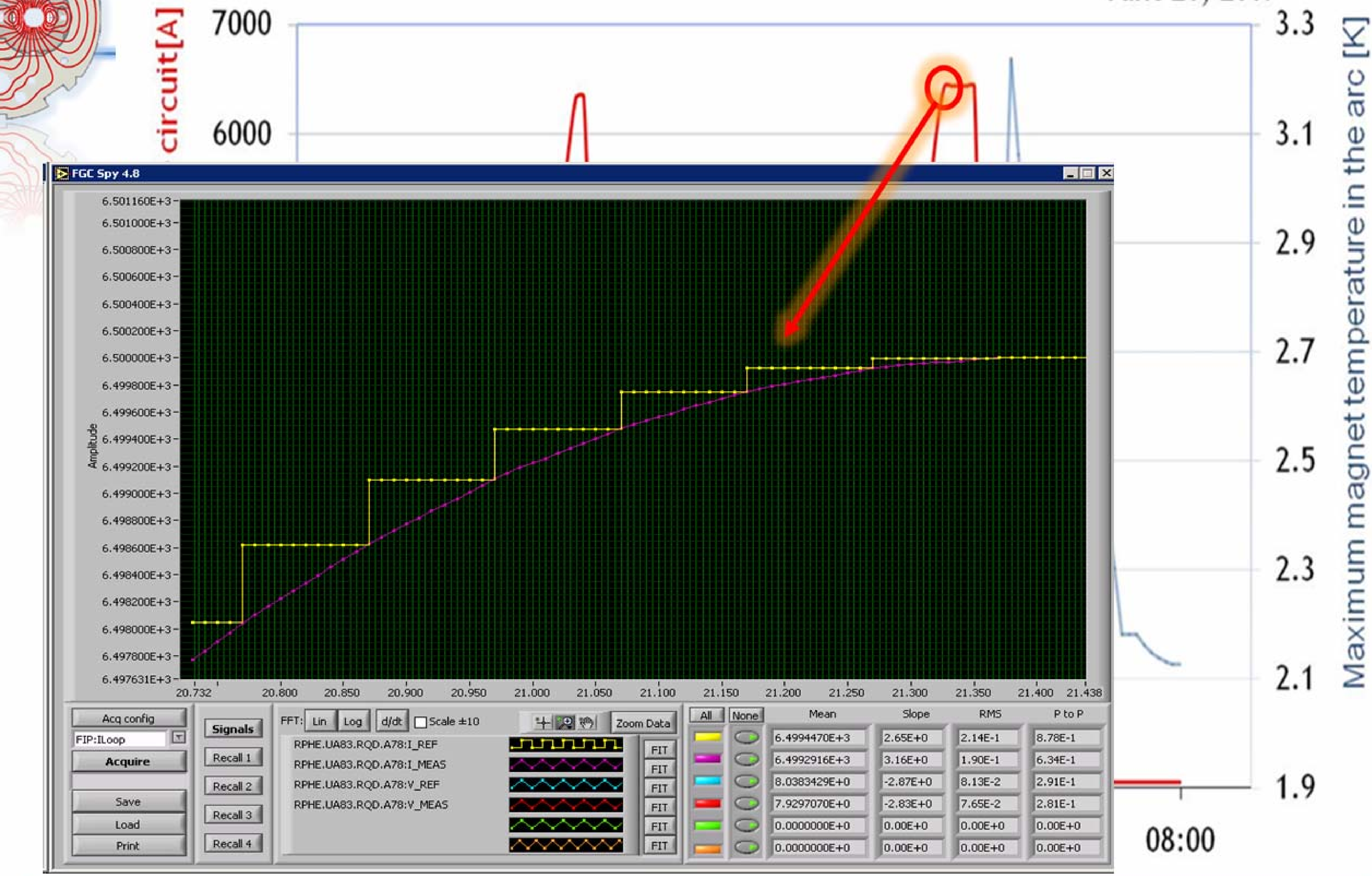
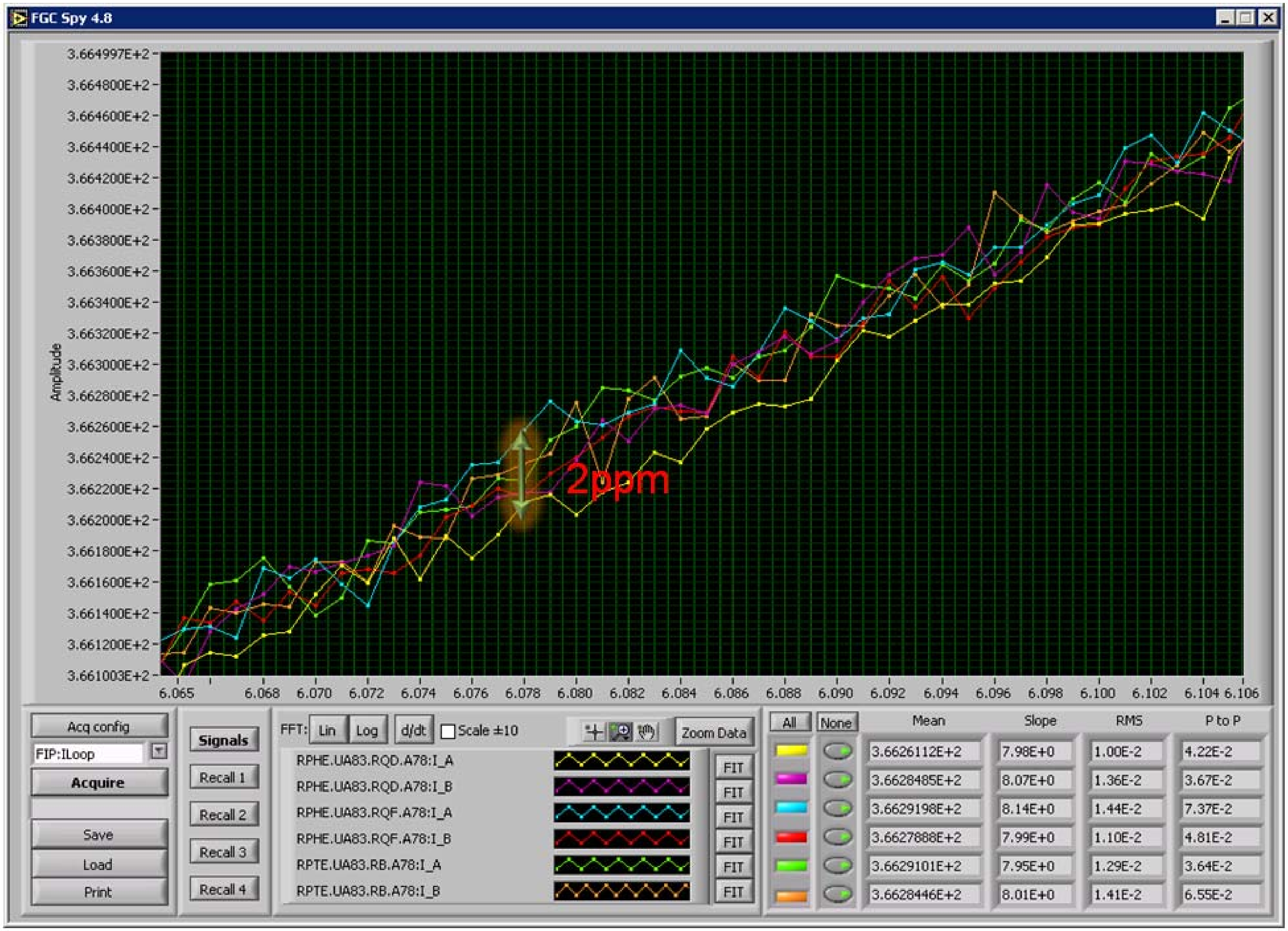
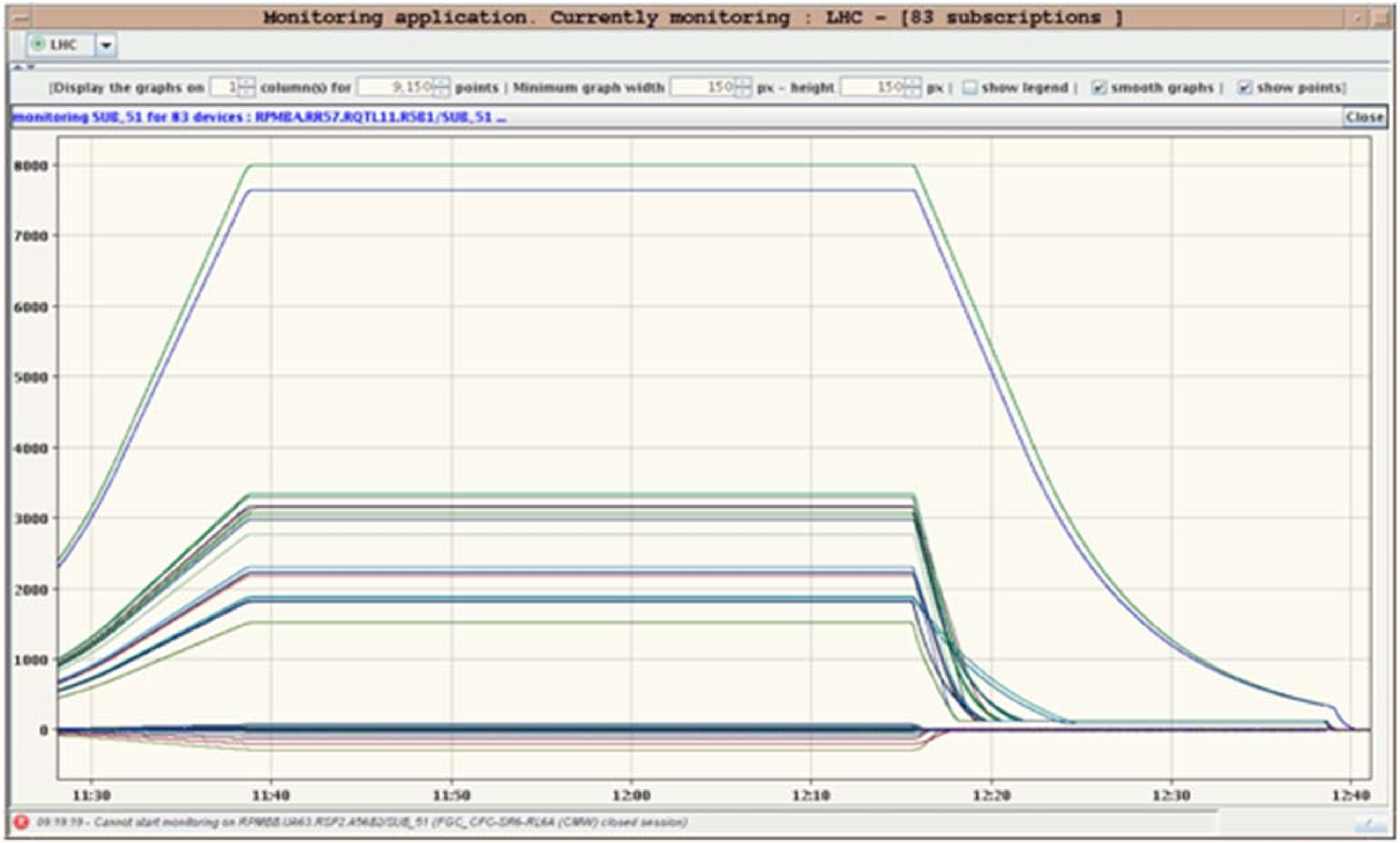


Tracking between main circuits

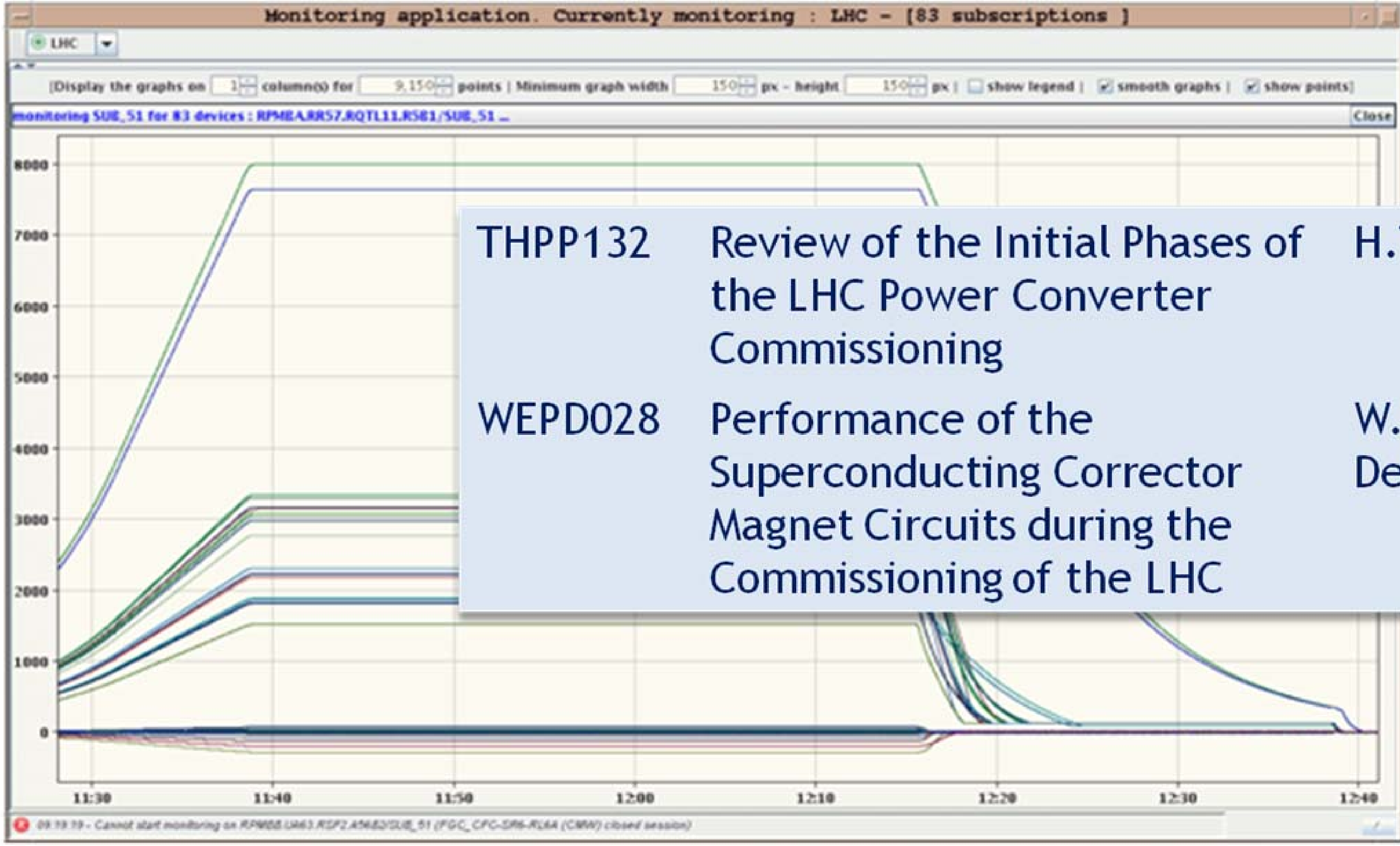


powering groups of circuits



the simultaneous powering of the arc and the two matching sections (LR5 and ML6) up to nominal current: 165 circuits (176 power converters) powered together up to 5 TeV equivalent current

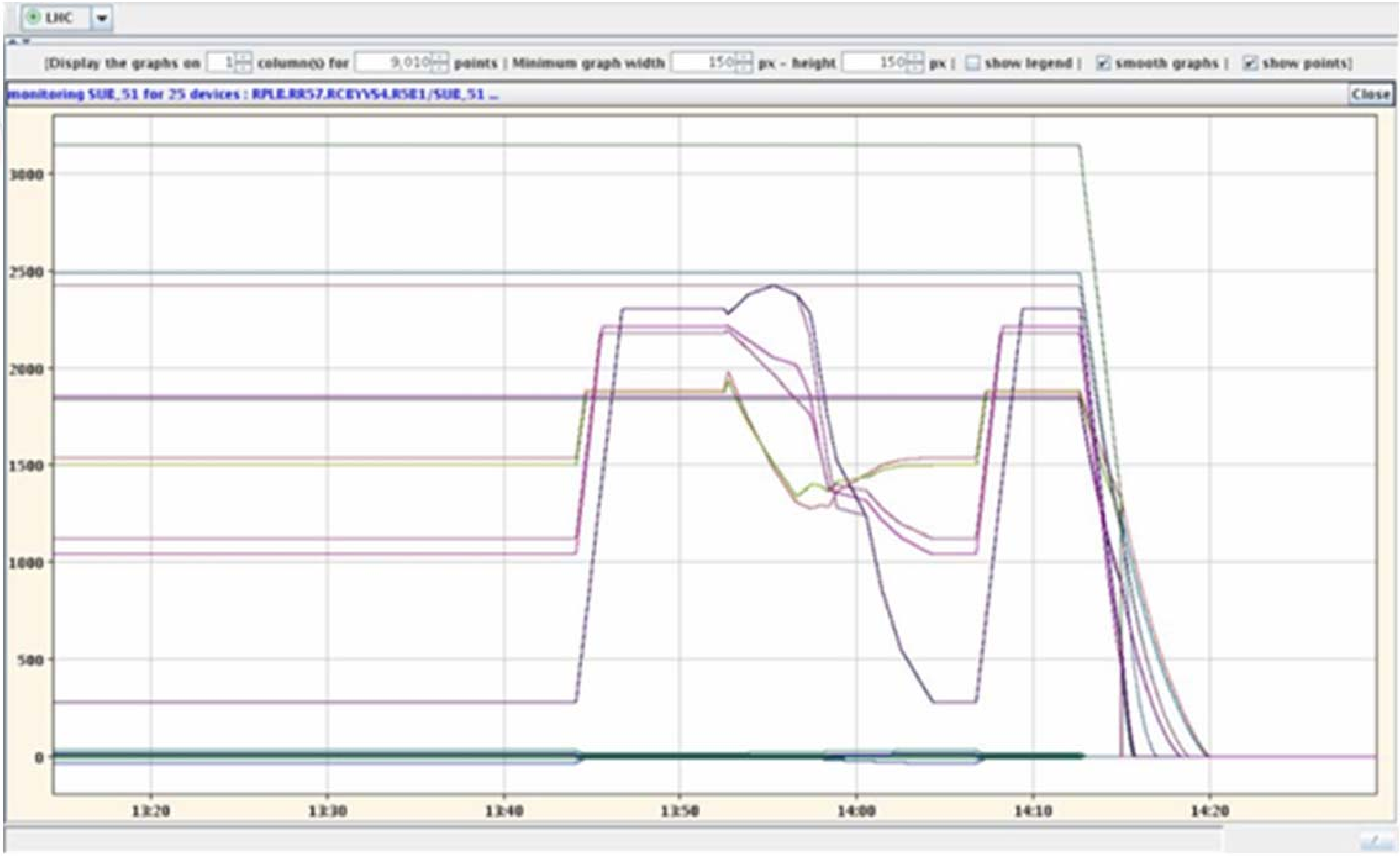
powering groups of circuits



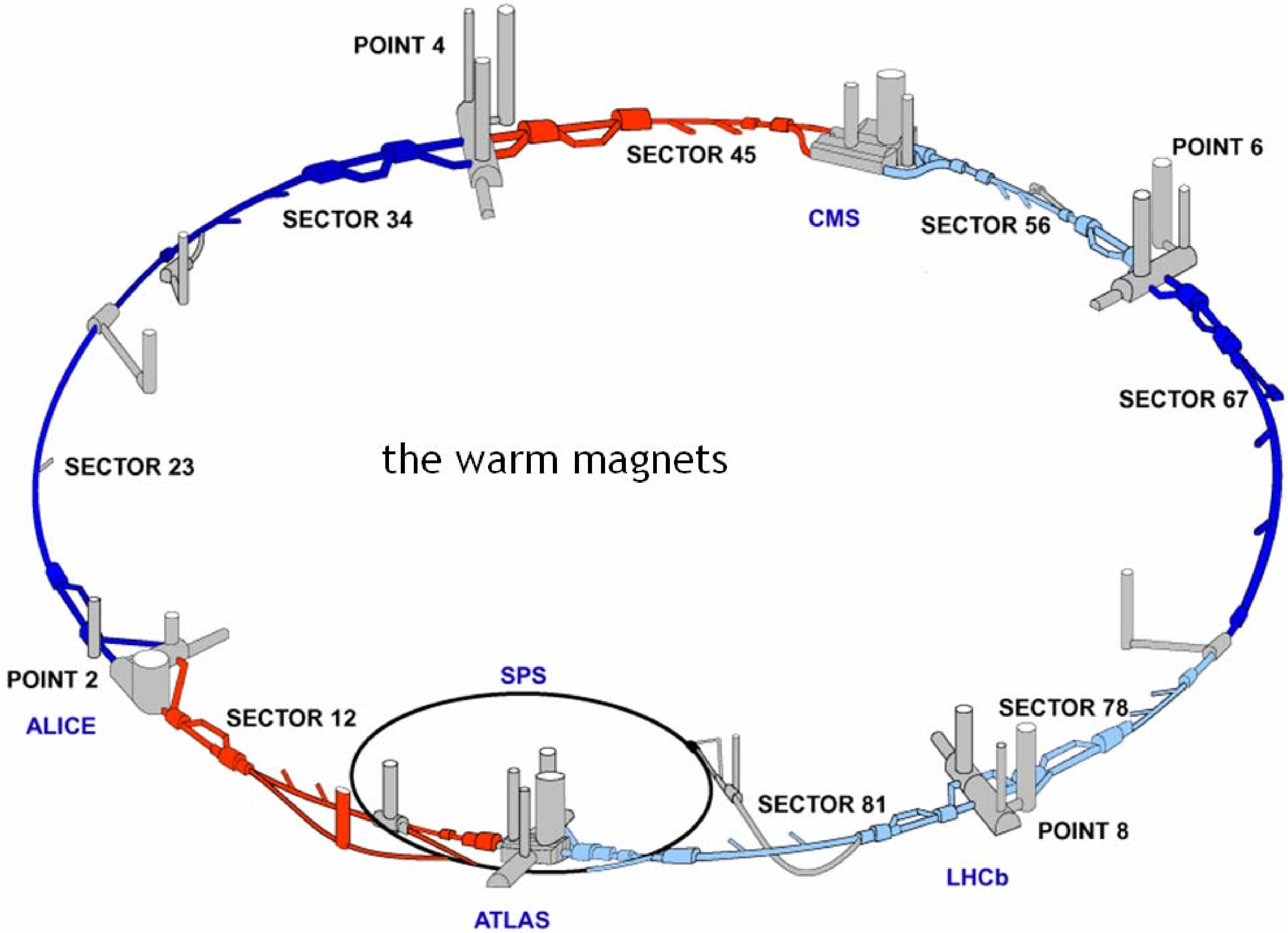
THPP132	Review of the Initial Phases of the LHC Power Converter Commissioning	H.Thiesen
WEPD028	Performance of the Superconducting Corrector Magnet Circuits during the Commissioning of the LHC	W.Venturini-Delsolaro

the simultaneous powering of the arc and the two matching sections (LR5 and ML6) up to nominal current: 165 circuits (176 power converters) powered together up to 5 TeV equivalent current

the squeeze


LHC
[Display the graphs on 1 column(s) for 9,010 points | Minimum graph width 150 px - height 150 px | show legend | smooth graphs | show points]
monitoring SUB_51 for 25 devices : RPLB.RR57.RCBYVS4.R5B1/SUB_51 ...
Close
3000
2500
2000
1500
1000
500
0
13:20
13:30
13:40
13:50
14:00
14:10
14:20

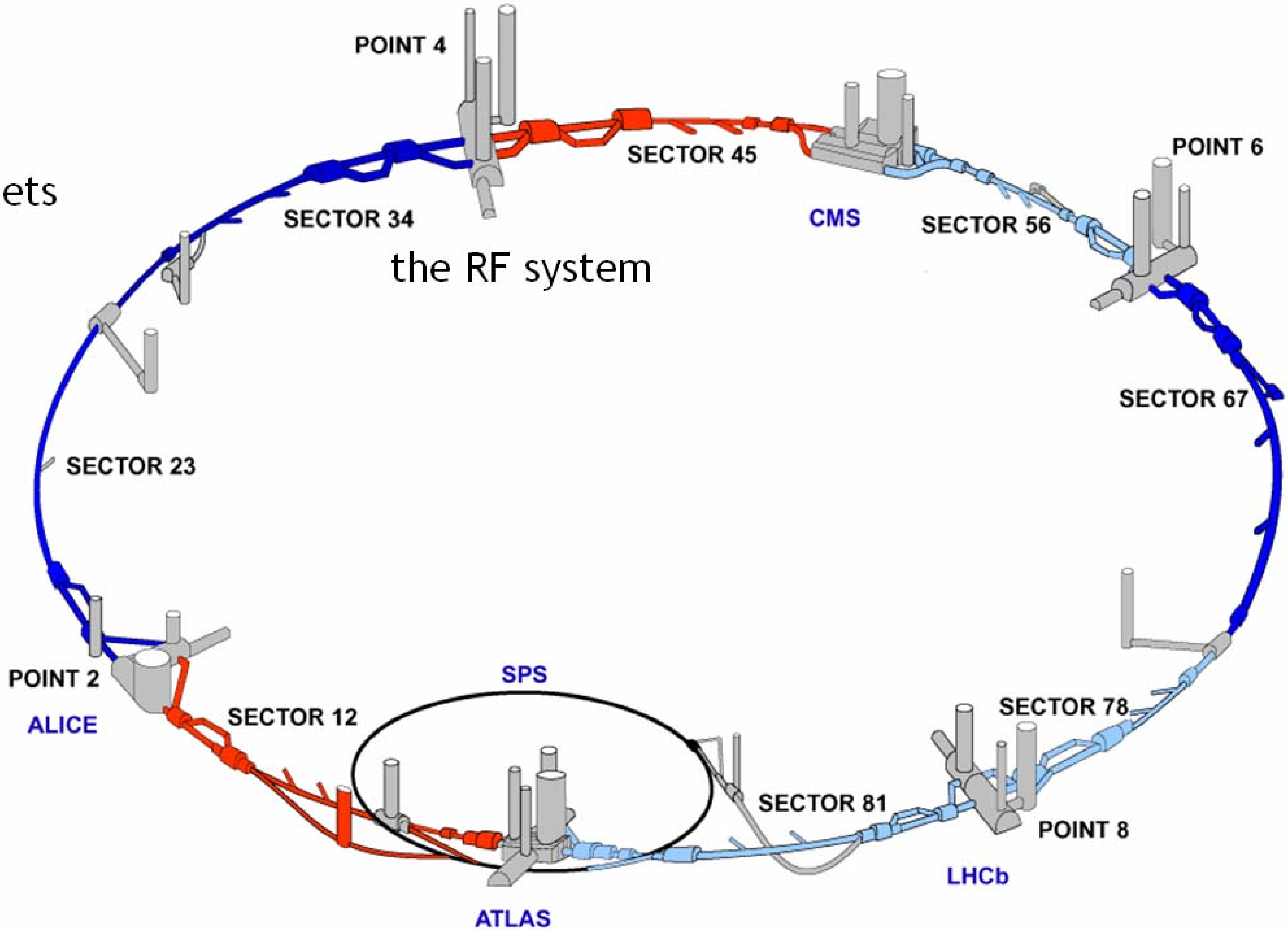
the superconducting circuits but also all the other systems



the superconducting circuits but also all the other systems

the warm magnets

the RF system



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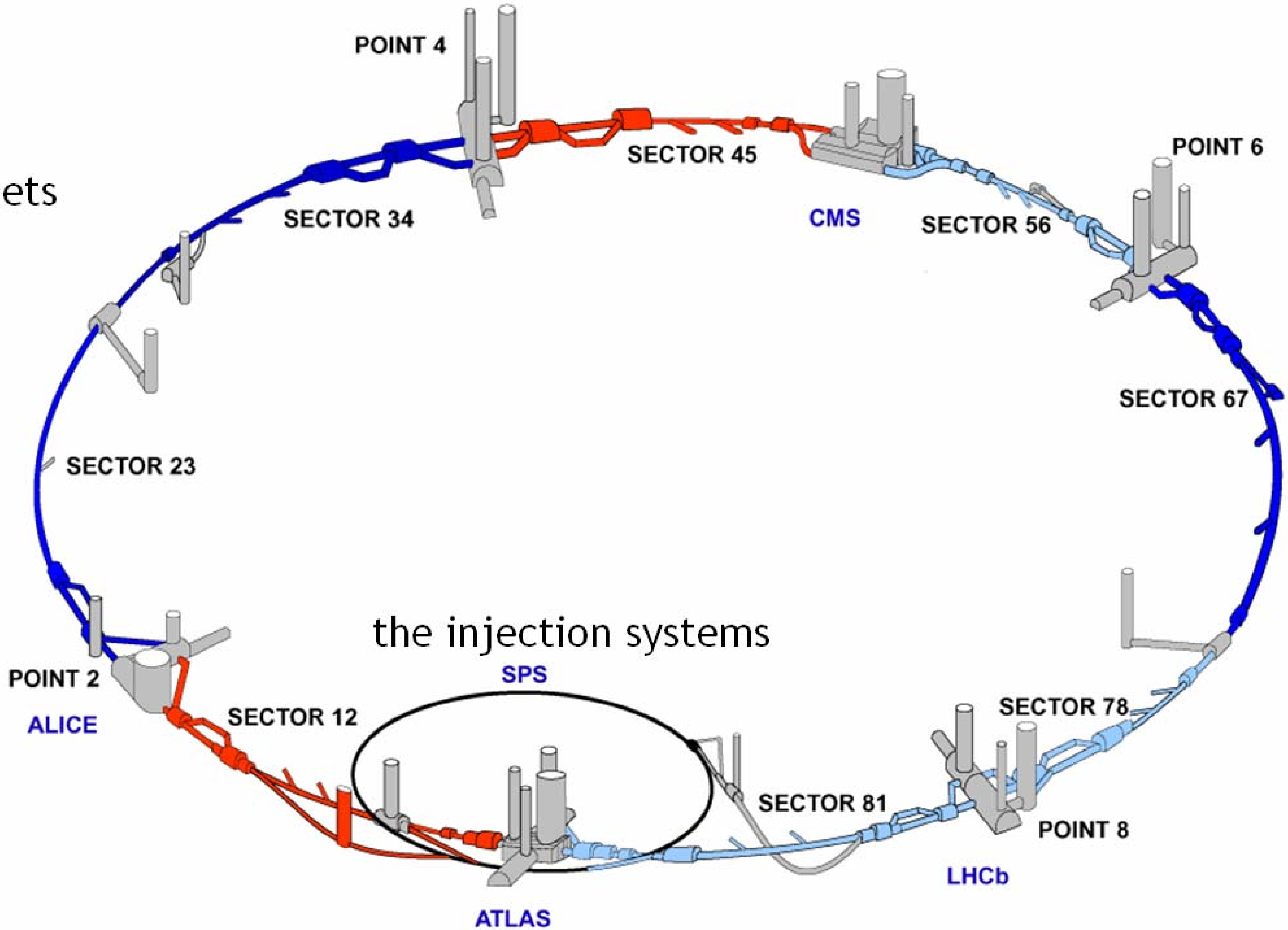


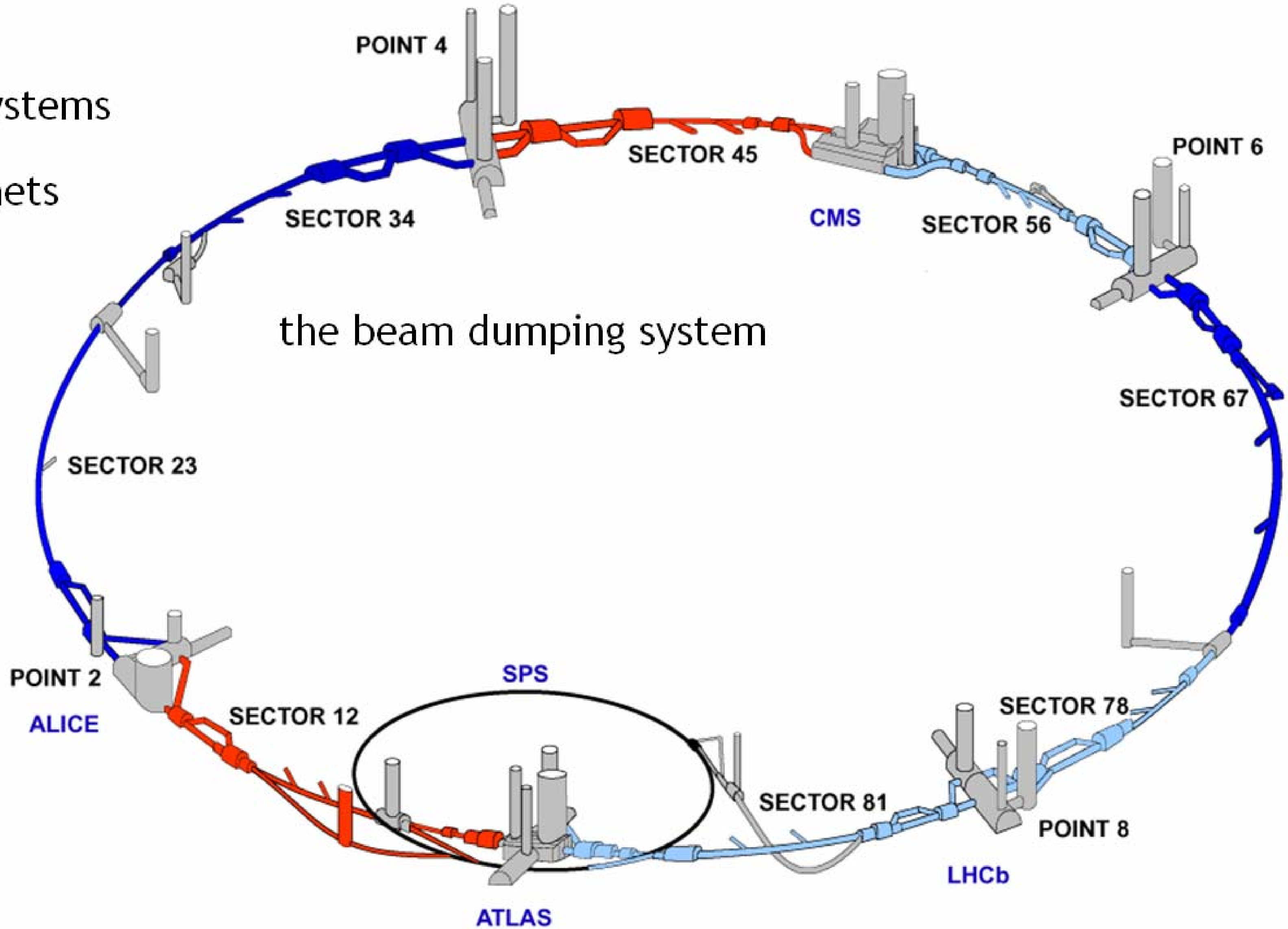
the superconducting circuits but also all the other systems

the injection systems

the warm magnets

the RF system

the beam dumping system



the superconducting circuits but also all the other systems

the beam dumping system

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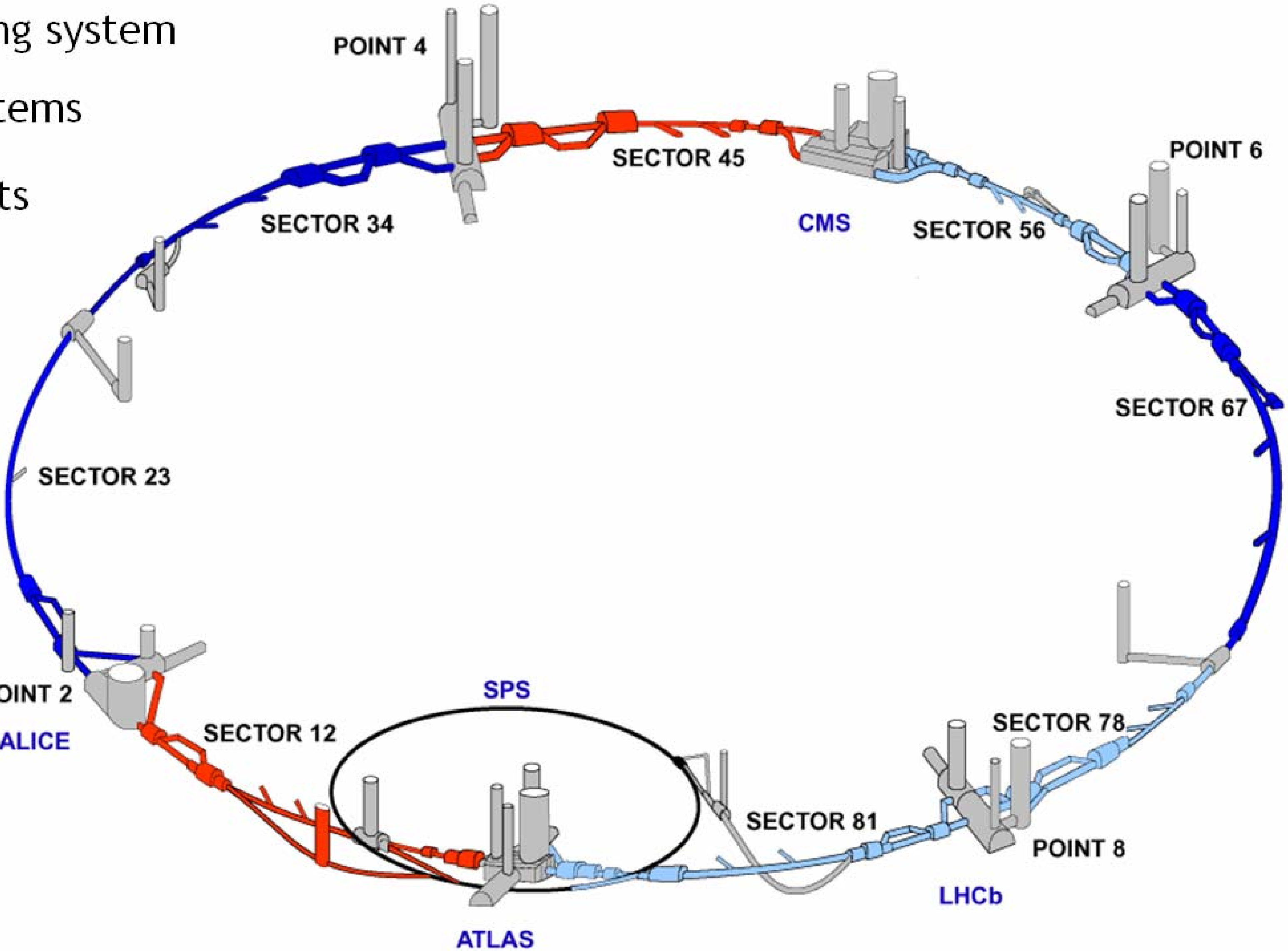
the warm magnets

the RF system

the collimators



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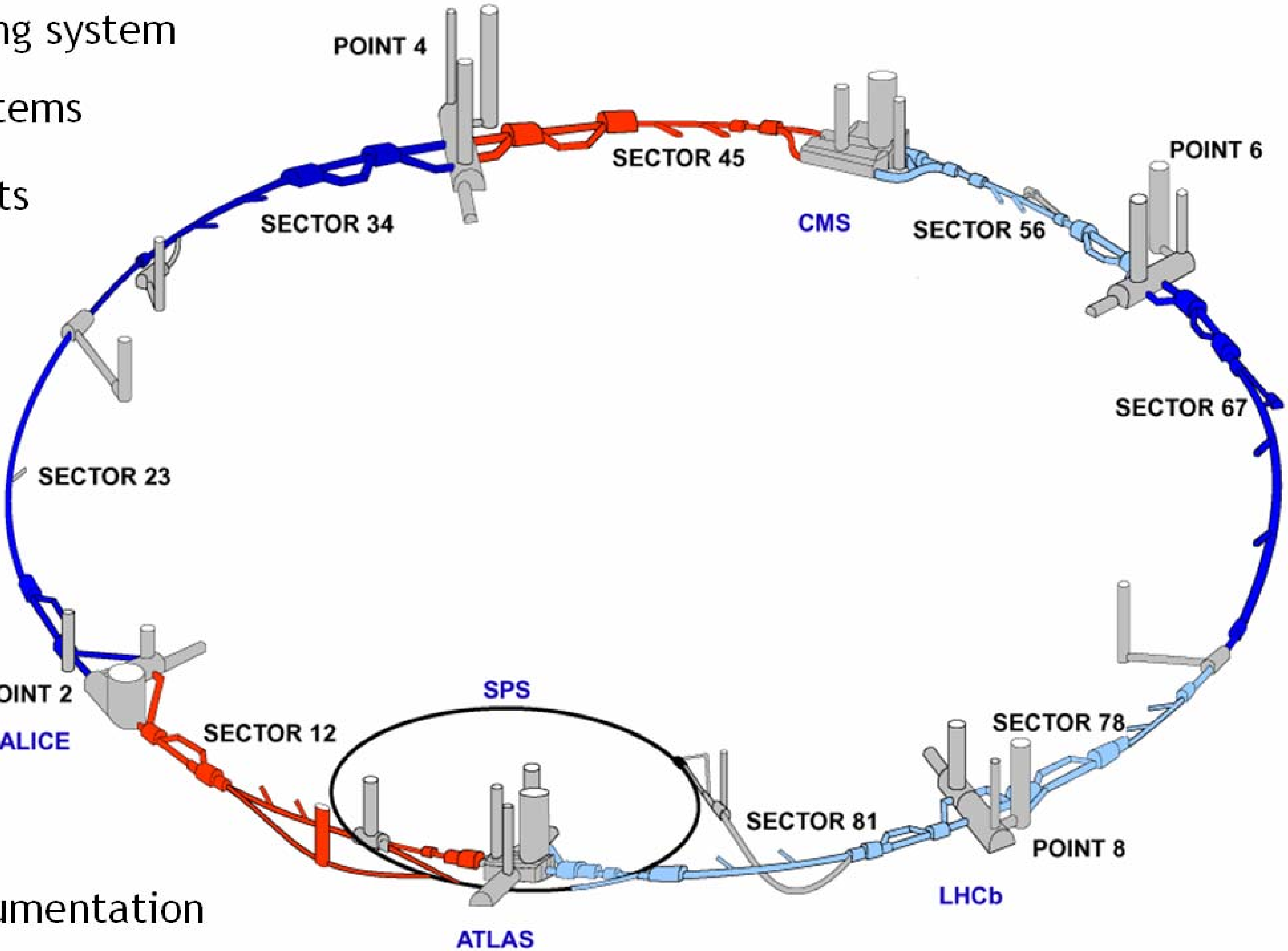


the collimators

the beam instrumentation

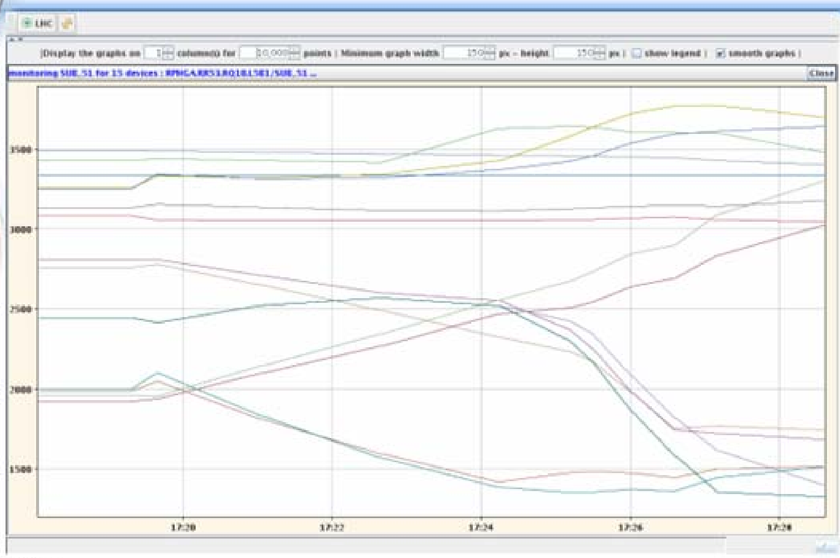
software for operation, controls and diagnostics

Using the final software foreseen for operation for the commissioning of the machine systems

1

- Sequencer
- Logging system
- Post mortem system
- On-line databases
- Industrial supervision systems

software for operation, controls and diagnostics



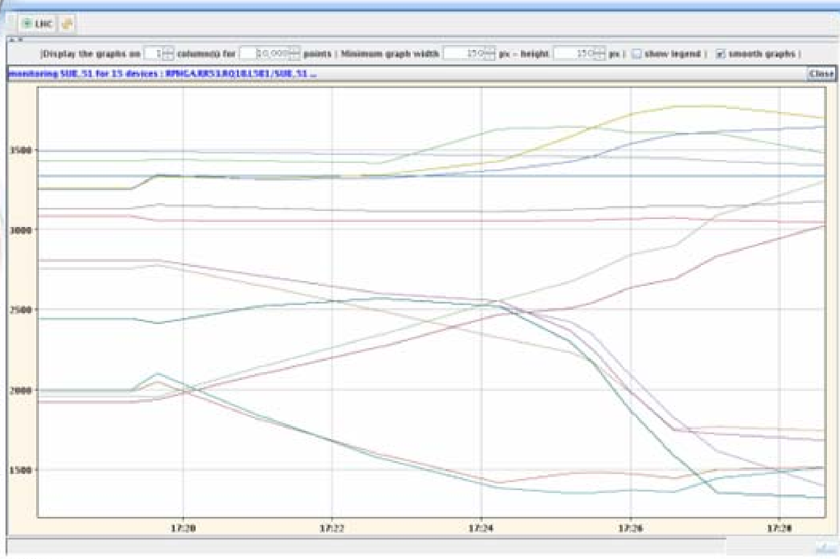
Using the final software foreseen for operation for the commissioning of the machine systems

1
- Sequencer
- Logging system
- Post mortem system
- On-line databases
- Industrial supervision systems

Dry runs

2
- Injection kickers system
- LHC Beam dumping system (kickers, energy tracking, diagnostics)
- Beam instrumentation (loss monitors, position monitors, current transformers, screens)
- Power converters in simulation mode
- Collimators
- Timing system
- Communication with experiments (handshakes, modes, fill number, beam based measurements, etc.)
- Post mortem data acquisition system
- Squeeze

software for operation, controls and diagnostics



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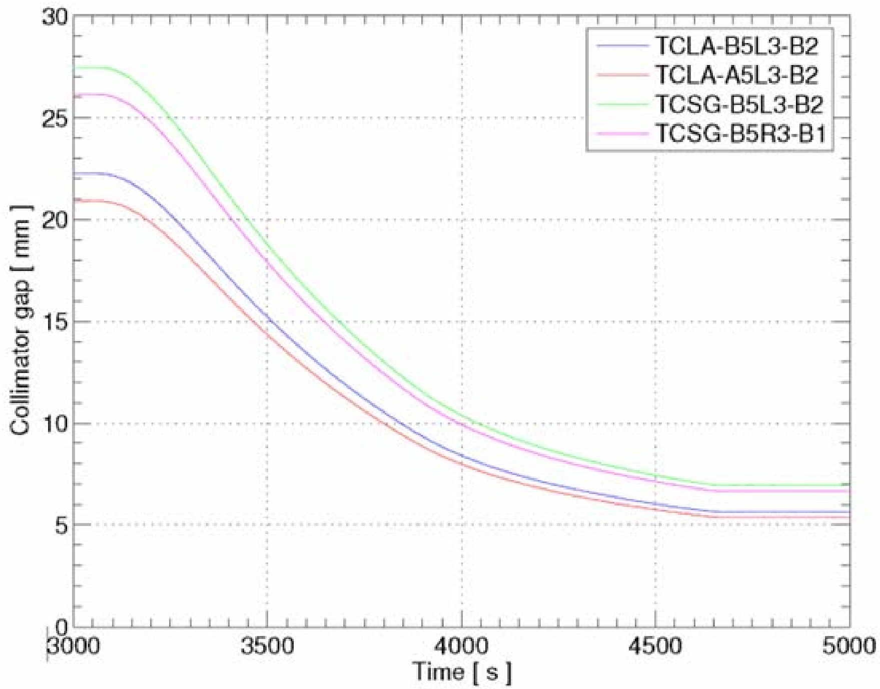
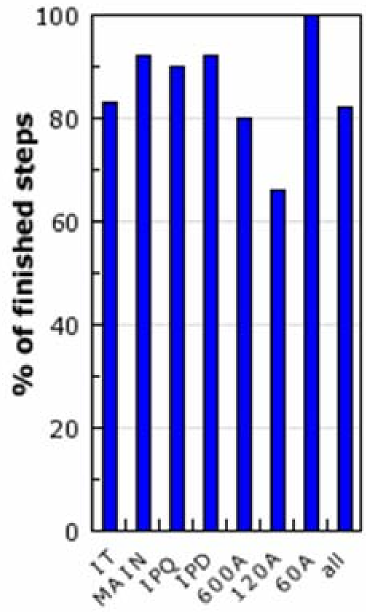


what slows us down

- Infrastructure system instabilities and late upgrades
  - Electrical distribution faults
  - Installation of Static Var Compensators
  - Water cooling (indirectly)
- Cryogenics
  - Impact of the infrastructure instabilities on the cryogenic system
  - Line Y interruptions
  - Manning of the cryogenics control room
- Other
  - Control system teething problems

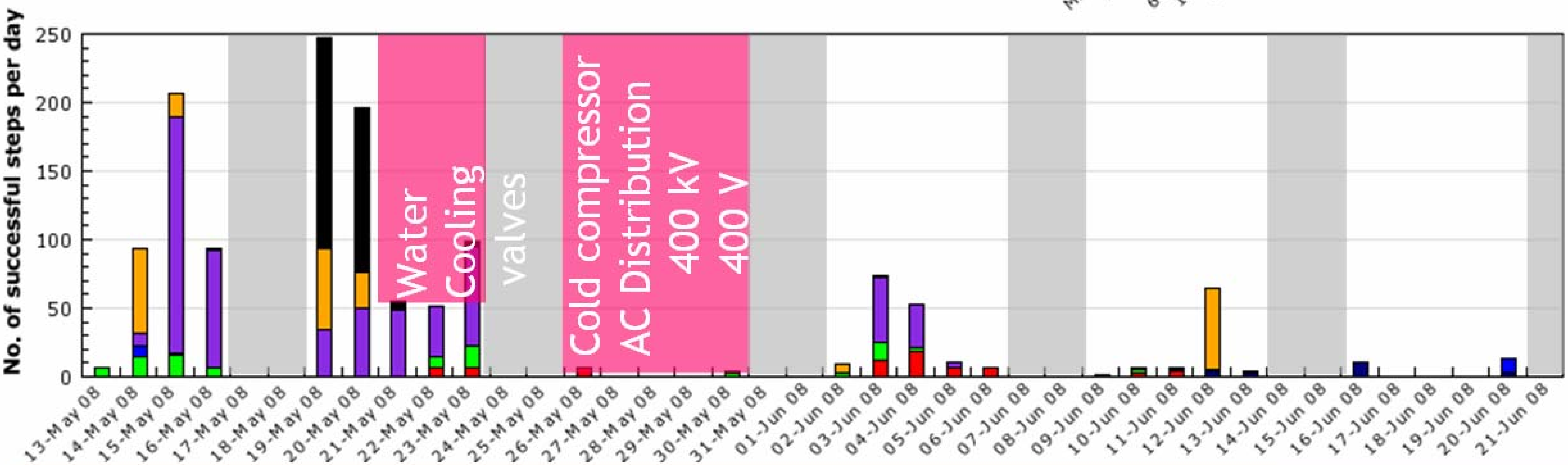
outlook



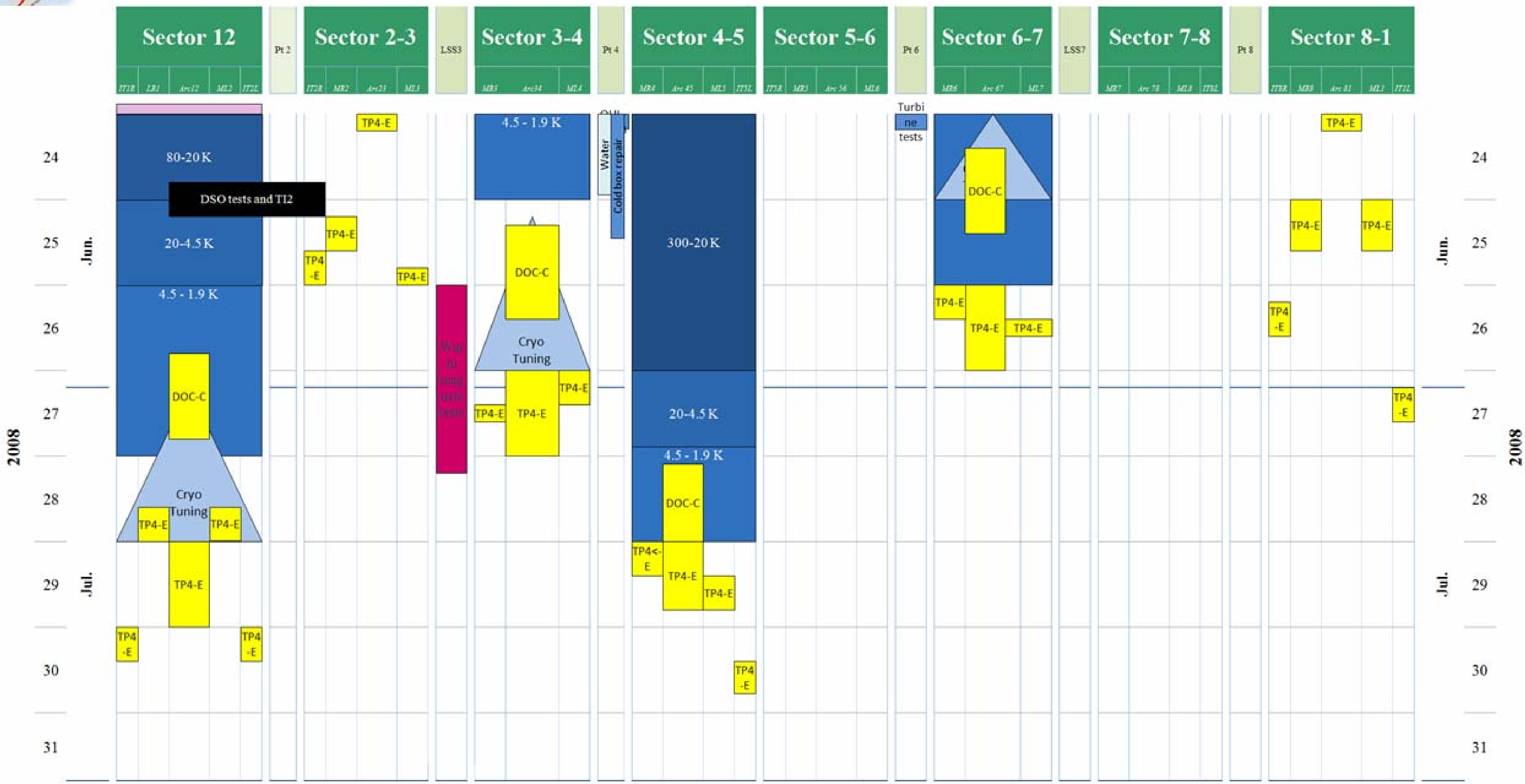
82% done

between 3 and 4 weeks per sector

(two shifts five days a week)



outlook



early August!

conclusions

- All the non-conformities discovered so far could either be fixed, or accepted-as-is, or cured with compensatory measures.
- The quality of the test procedures and the depth of the analysis which follow every test step have so far allowed a safe and thorough progress of the commissioning process.