

# **Vision from TE/MSC and the SMACC project**

## **Superconducting & Warm Magnets LHC & injectors (20 min)**

J.Ph. TOCK (TE-MSC-CMI)

With a contribution of

J. BAUCHE & A. NEWBOROUGH (TE-MSC-MNC)



**TE-MPE**  
LS1 Review  
2-3 June 2015

# Outline

- TE-MS-C-MNC feedback on MPE work (J Bauche/A Newborough)
  - SMACC (LHC)
    - General Scope – MPE involvement ↔ EIQA
    - Some specific points
      - Simplification of workflow
      - Working time
  - What worked well ?
  - ~~What went wrong ?~~ What could have been better ?
  - What is relevant in the LS2 perspective ?
  - Conclusions
- \* Some activities are not mentioned due to lack of time

The biggest room in the world, is the room for improvement.



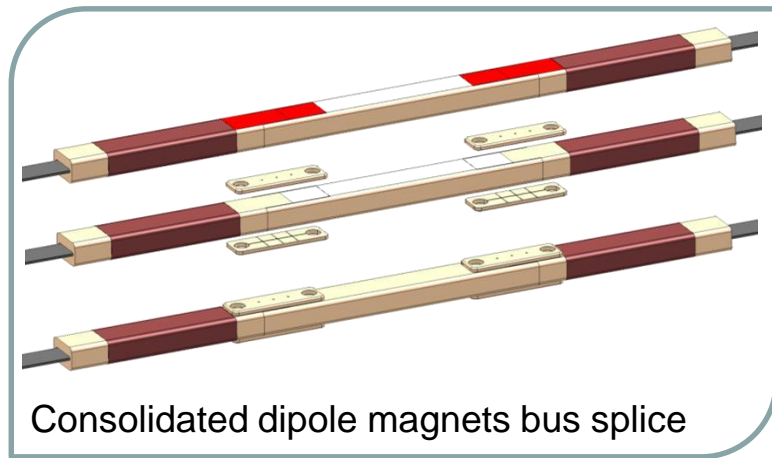
# TE/MS/MNC feedback on MPE work (valid in the general context, not only for LS1) [1/2]

- What was your group's contribution to MPE work? and the other way round?
  - Injectors: as users, MNC provides feedback on the operation of the interlock system to MPE.
  - See examples of mutual contribution between MPE and MNC below
- What was the impact of MPE work on your own activities?
  - The deployment of the WIC system is a major improvement w.r.t. the old systems very helpful for MNC interventions:
    - Better resolution of the faults monitoring, usually on individual magnets. This helps localising the problem in particular for magnets connected in series covering long distances (e.g. SPS) and preparing accordingly access to the equipment for intervention
    - Provides additional functionalities, like a post-mortem of the faults (magnet, interlock system itself, and power converters) and the remote accessibility, which is extremely helpful for performing a quick and efficient diagnostic
  - We fully support the deployment of the WIC in all machines!
- What were the interfaces (material, personnel...) with MPE work? Please define limits of responsibilities.
  - Limit of responsibilities is physical: the interlock box installed on the magnets.
    - MNC defines, procures and installs the protection devices (thermo-switches, flow-switches)
    - In most cases MPE supplies the interlock boxes to MNC; MNC installs the boxes on the magnets, connects the protection devices, and performs the tests of the system (triggering of thermo-switches/flow-switches, continuity test, 500 V insulation test). Where permitting the installation of the interlock box can be made by MPE for example when there is an intermediate interface between the sensors and the interlock box (e.g. in PSB).
    - MPE takes care of any element of the interlock system which is after the interlock box, i.e. cabling, PLCs, etc.

# TE/MS/MNC feedback on MPE work (valid in the general context, not only for LS1) [2/2]

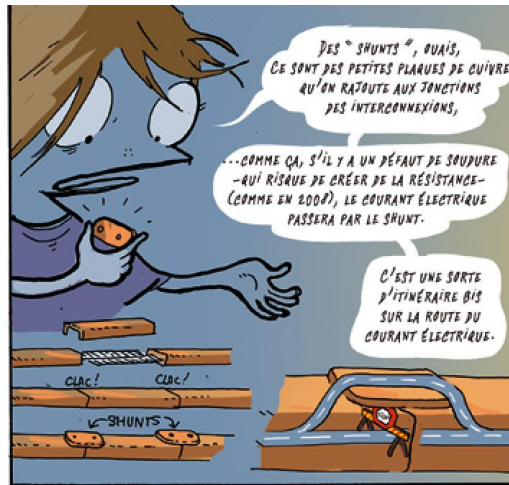
- What worked well?
  - Excellent collaboration between MPE and MSC/MNC teams! MPE has always been open to MNC feedback, and is always willing to improve the efficiency of the interlock system. Examples:
    - Following a long intervention in the SPS in 2012 on the ring-line sextupole interlocks (both MNC and MPE), MPE has immediately prepared a crash consolidation program to deploy the WIC system which they got approved and have implemented during LS1, in addition to their already planned work
    - In HIE-ISOLDE, following a demand from MNC, MPE added a functionality to the WIC: global locking of the converters to the presence of cooling water in the distribution circuit (EN/CV did not want to provide a “pumps running” signal)
- What went wrong?
  - In the case of the PSB the long time between initiating the upgrade (2008) and the installation of the WIC system (LS1) lead to some issues with communication and planning.
  - Again PSB, as ECR’s were not completed by many groups (incl. MPE) there were a few integration conflicts for the new interlock boxes which meant work had to be performed twice.
- What can be changed? What can be improved? What can be kept for LS2?
  - All of the injectors and experimental areas would benefit from the WIC. For the North and East Experimental Areas, this should be part of the consolidation projects.

# Design of the consolidated splices



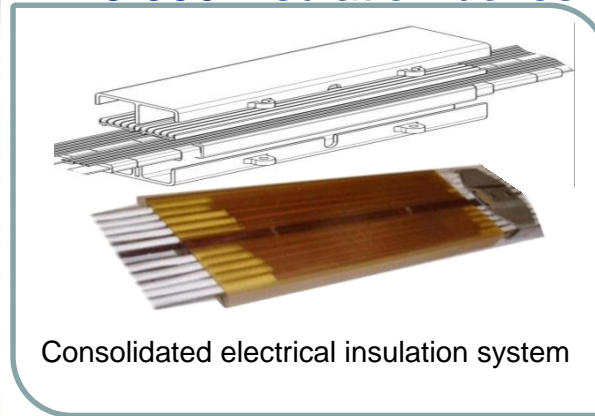
Consolidated dipole magnets bus splice

27 000 shunts



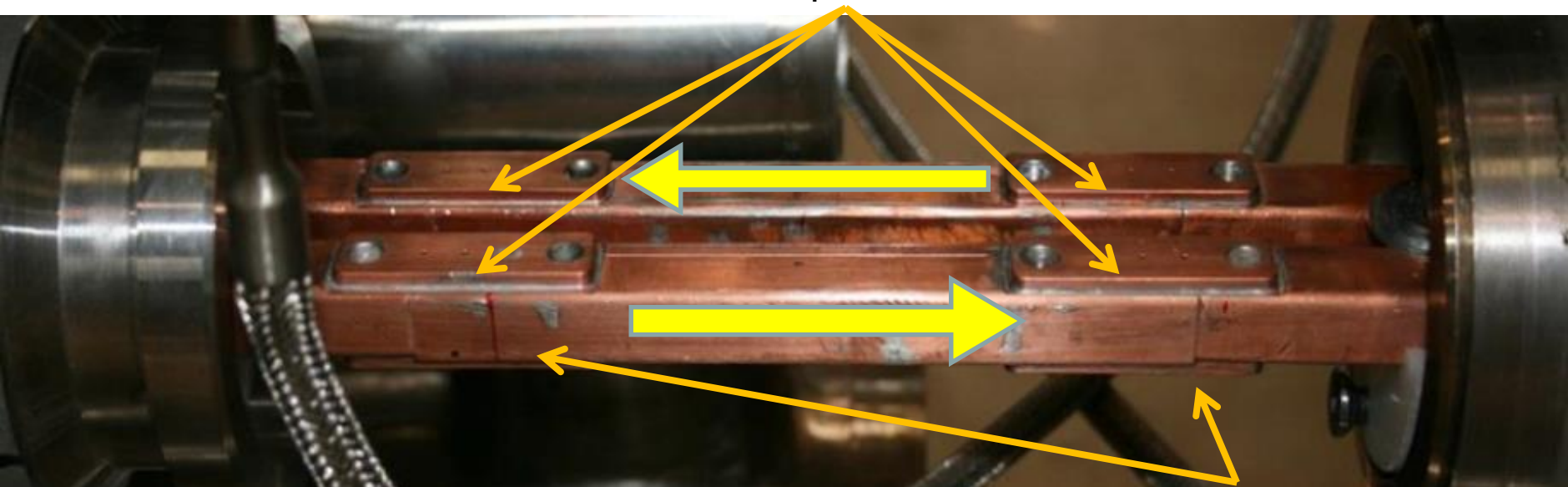
4 top shunts

5 000 insulation boxes



Consolidated electrical insulation system

Lison Bernet, <http://lhcf-france.fr>



4 bottom shunts (2 not visible)

# The main 2013-14 LHC consolidations

1695 Openings and final reclosures of the interconnections

Complete reconstruction of 3000 of these splices

Consolidation of the 10170 13kA splices, installing 27 000 shunts

Installation of 5000 consolidated electrical insulation systems

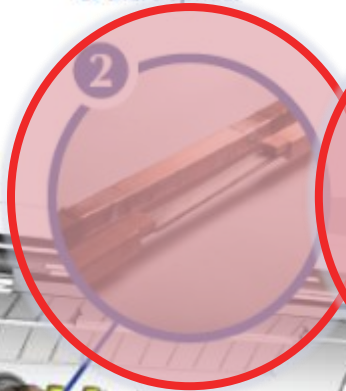
300 000 electrical resistance measurements

10170 orbital welding of stainless steel lines

1



2



3



4



5



6



7



8



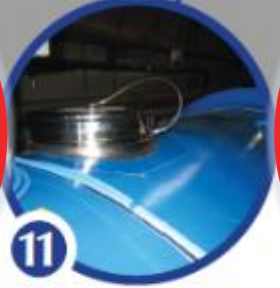
9



10



11



12



18 000 electrical Quality Assurance tests

10170 leak tightness tests

3 quadrupole magnets to be replaced

15 dipole magnets to be replaced

Installation of 612 pressure relief devices to bring the total to 1344

Consolidation of the 13 kA circuits in the 16 main electrical feed-boxes

# SMACC J.Ph. Tock (# 280)

## Superconducting Magnets And Circuits Consolidation

Open/Close IC [DN200]

A Musso (A Chrul) #36

- Opening/ Closure of IC  
Partial and complete  
W bellows & ther. shields
- Installation of DN200

TIG welding [EN-MME]

S Atieh (D Rey) #18 (+5)

- Orbital & manual

DFBA [TE-CRG]

A Perin (O Pirotte) #13

- Splices and BB

Main arc splices cons.

F Savary (H Prin) #93

- Sleeves cutting
- BB surfacing
- Shunt installation
- Insulation
- Splice de- & resoldering [25%]
- Quadrupole diodes connection
- Experts

Special interventions "SIT"

N Bourcey (G Maury) #18

- Cryomagnets exchange
- Connect. Cryostat cons.
- PIMs
- Specific issues
- Heavy NCs

Quality Assurance

R Ostojic #43

- Electrical QC: #20: C.Scheuerlein (P.Thone)
- Welding QC: # 6 : JM Dalin
- ICIT: : #11 : C Garion/D Bodart  
[Beam vacuum & Open/Close QC]
- QA manager support: #2
- Audits: #3

ELQA [TE-MPE]

K Dahlerup  
(G D'Angelo) #28

- Continuity
- HV test

Leak Test [TE-VSC]

P Cruikshank  
(C Garion) #19

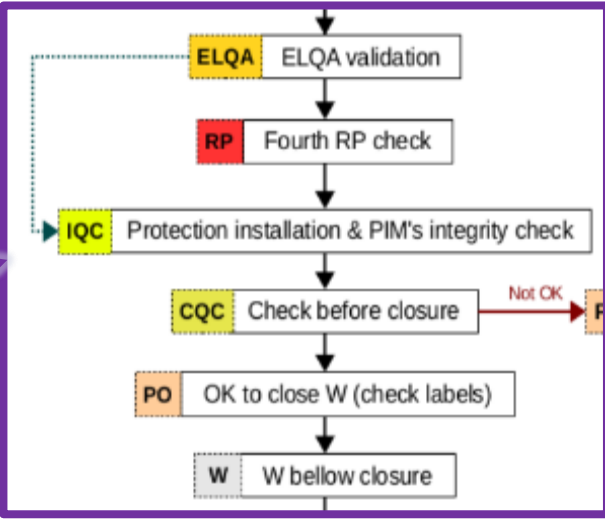
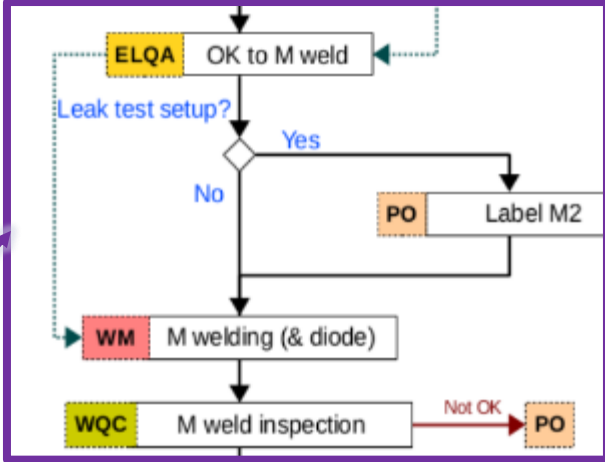
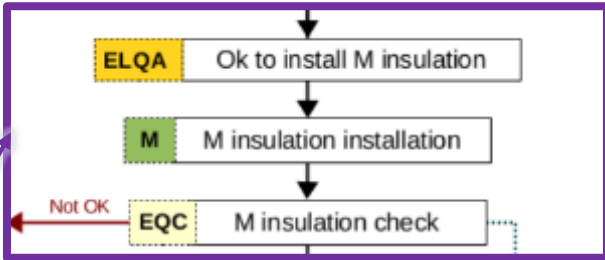
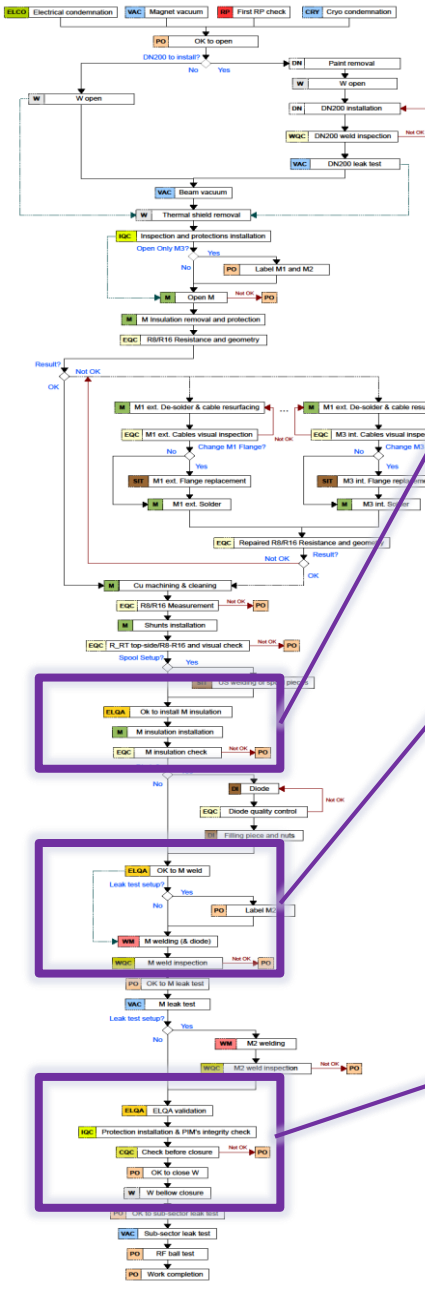
- Beam lines
- Cryogenics lines
- Insulation vacuum

SMACC CSI (Coordination, Support, Infrastructure) M Pojer (R Giachino) #11

- Radiation protection
- Safety, Access
- General logistics
- Pressure test
- Link to visits, media
- Coordination with  
Survey, BLM, Instrumentation, Transport, planning, QPS, cryogenics, VSC, MPE, CRG.
- Test teams on a chain of IC
- Reporting tools
- Administrative support (Budget, human resources, scientific secretary)

# What worked well ?

# SMACC workflow



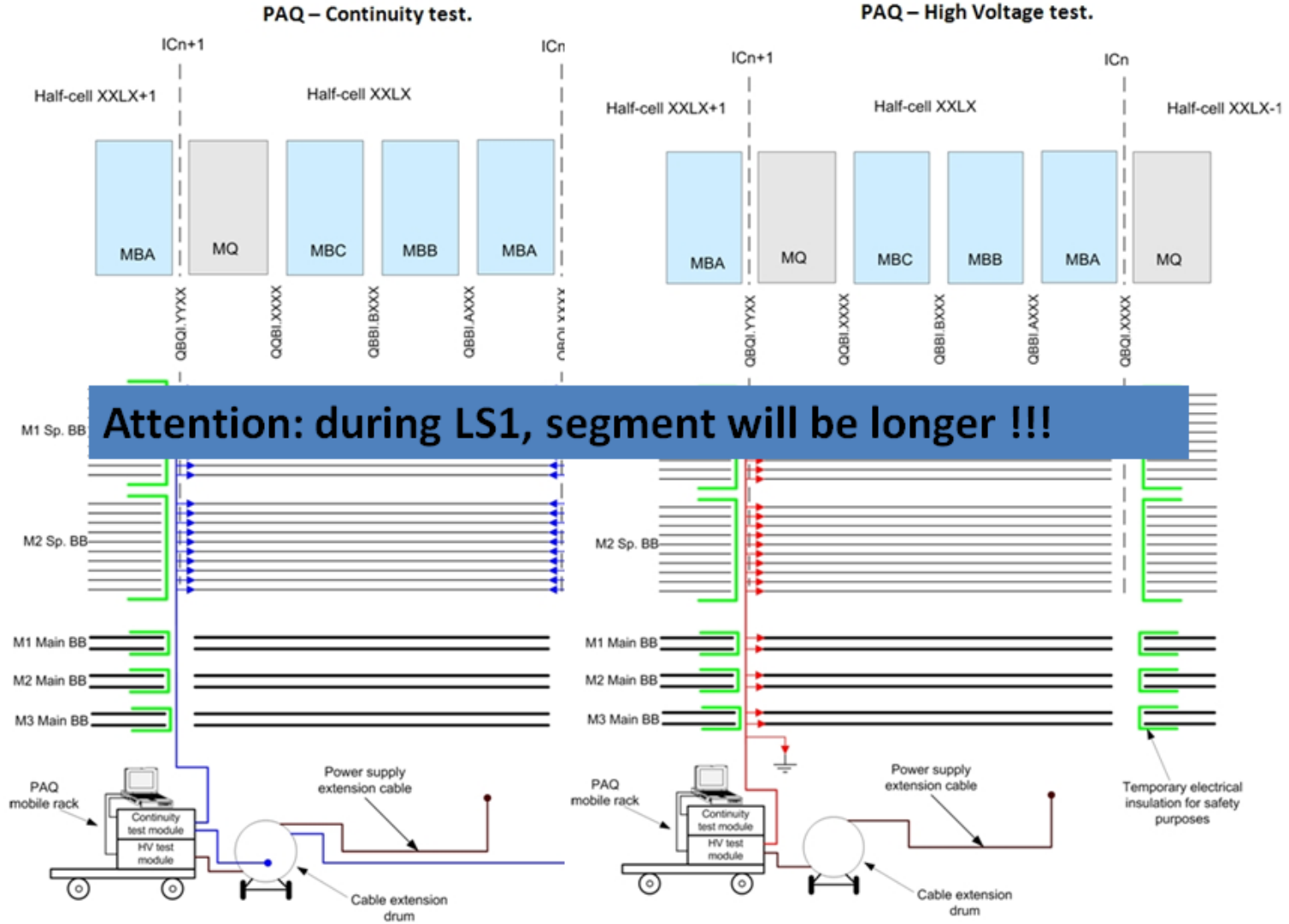
- 3 systematic hold points for EIQA
- Ad-hoc stops could be implemented in case of NC
- Tests performed regularly daily → (bi)weekly
- At the end of the test, only a global signature in WISh for the whole sector
  - If test is OK, all “pending” steps become OK

Week	Day	Task	Task	Task	Task
Week 4	20.Jan	Mon		S81 LSI-PAQ	
	21.Jan	Tue		S12 LSI-PAQ; Team#1	S23 LSI-PAQ
	22.Jan	Wed	S78 LSI-PAQ	S81 LSI-PAQ	
	23.Jan	Thu		S12 LSI-PAQ; Team#1	S23 LSI-PAQ
	24.Jan	Fri			
	25.Jan	Sat			
Week 5	27.Jan	Mon		S81 LSI-PAQ	S84 LSI-PAQ?
	28.Jan	Tue		S12 LSI-PAQ; Team#1	S23 LSI-PAQ
	29.Jan	Wed			
	30.Jan	Thu		S12 LSI-PAQ; Team#1	S23 LSI-PAQ
	31.Jan	Fri			
	1.Feb	Sat			
Week 6	3.Feb	Mon		S81 LSI-PAQ	S84 LSI-PAQ?



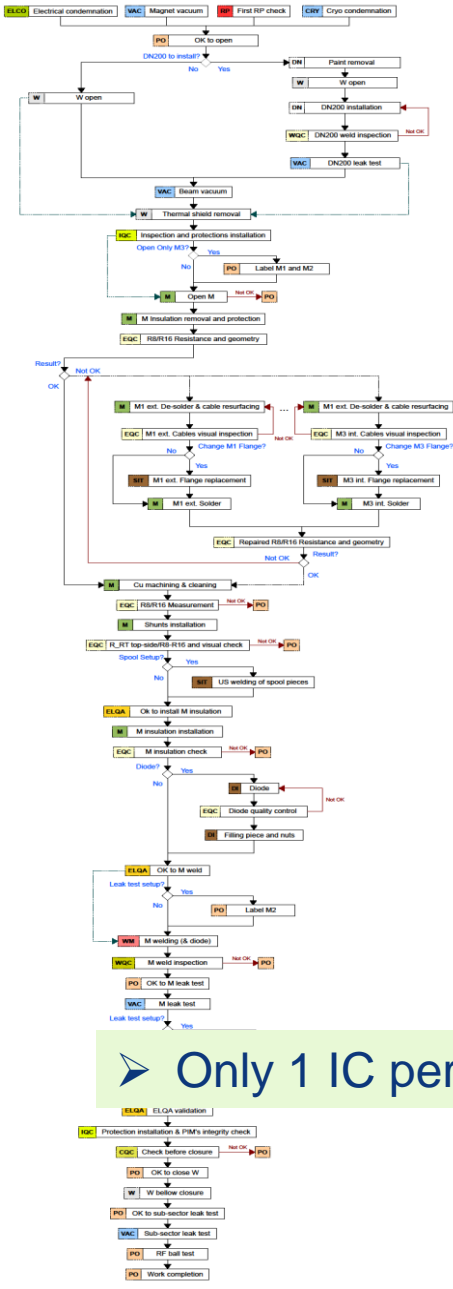
# What worked well ?

# Workflow Simplification



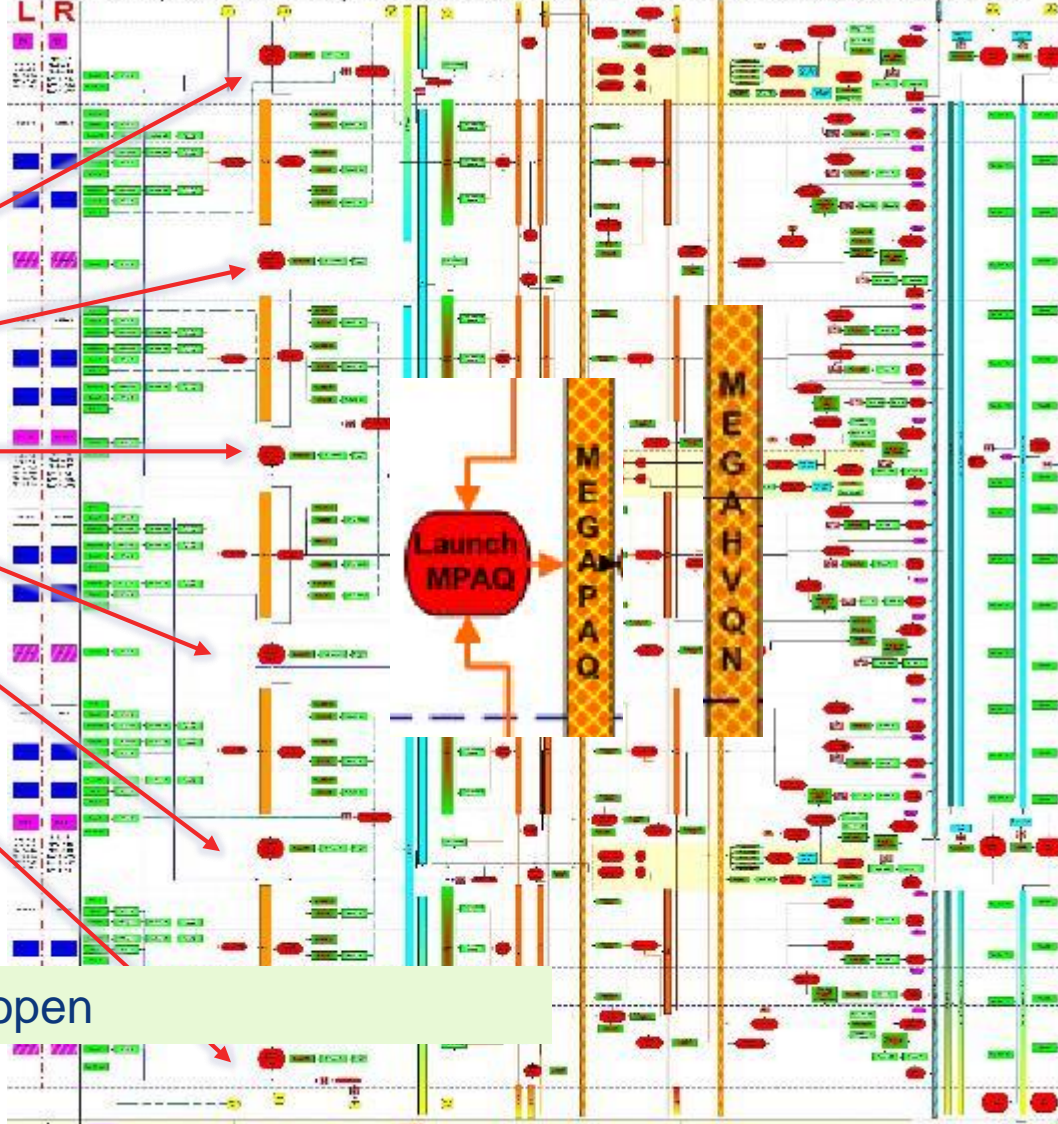
# What worked well ?

# Workflow Linearization



IC to be left open for PAQ

**MASTER INTERCONNECTION FLOW DIAGRAM**  
for ABC (Q11R to Q11L) sectors from 3-4 Q25L4 till 7-8 Q25L8 via 4-5, 5-6, 6-7



➤ Only 1 IC per sector to be left open

<b>LEGEND</b>	M1 INT. DE-SOLDER & CABLE RESURFACING	COOPERATIVE	TESTS PROGRAMS	ABLE TO PROCEED
	M3 INT. DE-SOLDER & CABLE RESURFACING	M WELD	ELECTRICAL TEST	TESTS PROGRAMS
M1 INT. FLANGE REPLACEMENT	M INSULATION INSTALLATION	COOPERATIVE	TESTS PROGRAMS	ABLE TO PROCEED
M3 INT. FLANGE REPLACEMENT	M INSULATION CHECK	COOPERATIVE	TESTS PROGRAMS	ABLE TO PROCEED
M1 INT. SOLDER	DIODE QUALITY CONTROL	COOPERATIVE	TESTS PROGRAMS	ABLE TO PROCEED
M3 INT. SOLDER	DIODE QUALITY CONTROL	COOPERATIVE	TESTS PROGRAMS	ABLE TO PROCEED
M1 INT. SOLDER	DIODE QUALITY CONTROL	COOPERATIVE	TESTS PROGRAMS	ABLE TO PROCEED
M3 INT. SOLDER	DIODE QUALITY CONTROL	COOPERATIVE	TESTS PROGRAMS	ABLE TO PROCEED
M1 INT. SOLDER	DIODE QUALITY CONTROL	COOPERATIVE	TESTS PROGRAMS	ABLE TO PROCEED
M3 INT. SOLDER	DIODE QUALITY CONTROL	COOPERATIVE	TESTS PROGRAMS	ABLE TO PROCEED

# What could have been better?

*Many many issues...*

**From:** Giorgio D'Angelo  
**Sent:** 01 June 2013 12:40  
**To:** elqa-LS1-PAQ (People informed about LS1 PAQ problem)  
**Subject:** FW: PAQ in 5 - 6

Chers tous,

Encore des soucis ds le secteur 56 !!! Regardez les photos...

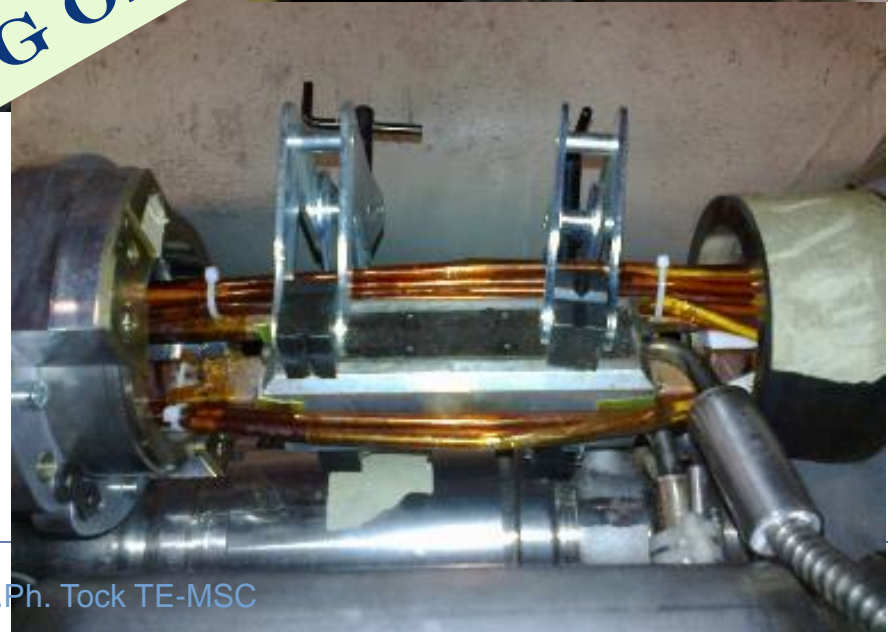
Finalemnt, après avoir retiré les pièces (papier et caoutchouc) en contact entre les interconnexions QEQL.11R5 et QBQL.14R5 et QBQL.18R5, les tests sont bons !!

Merci d'

Giorgio D'Angelo ELQA team



**THANKS TO FLEXIBILITY AND UNDERSTANDING OF THE ELQA TEAM**



J.Ph. Tock TE-MS

# What could have been better?

Dear all,

Here what was found in S78 last Friday !!!

The cut spools in QBBI.26L8 were announced on Friday pm, the field team did not have the info but discovered it.

For the machine still attached, it must be avoided the days were we perform LS1-PAQ test.

Many thanks

Giorgio



**THIS WAS THE OPTIMUM WAY TO WORK FOR SMACC**

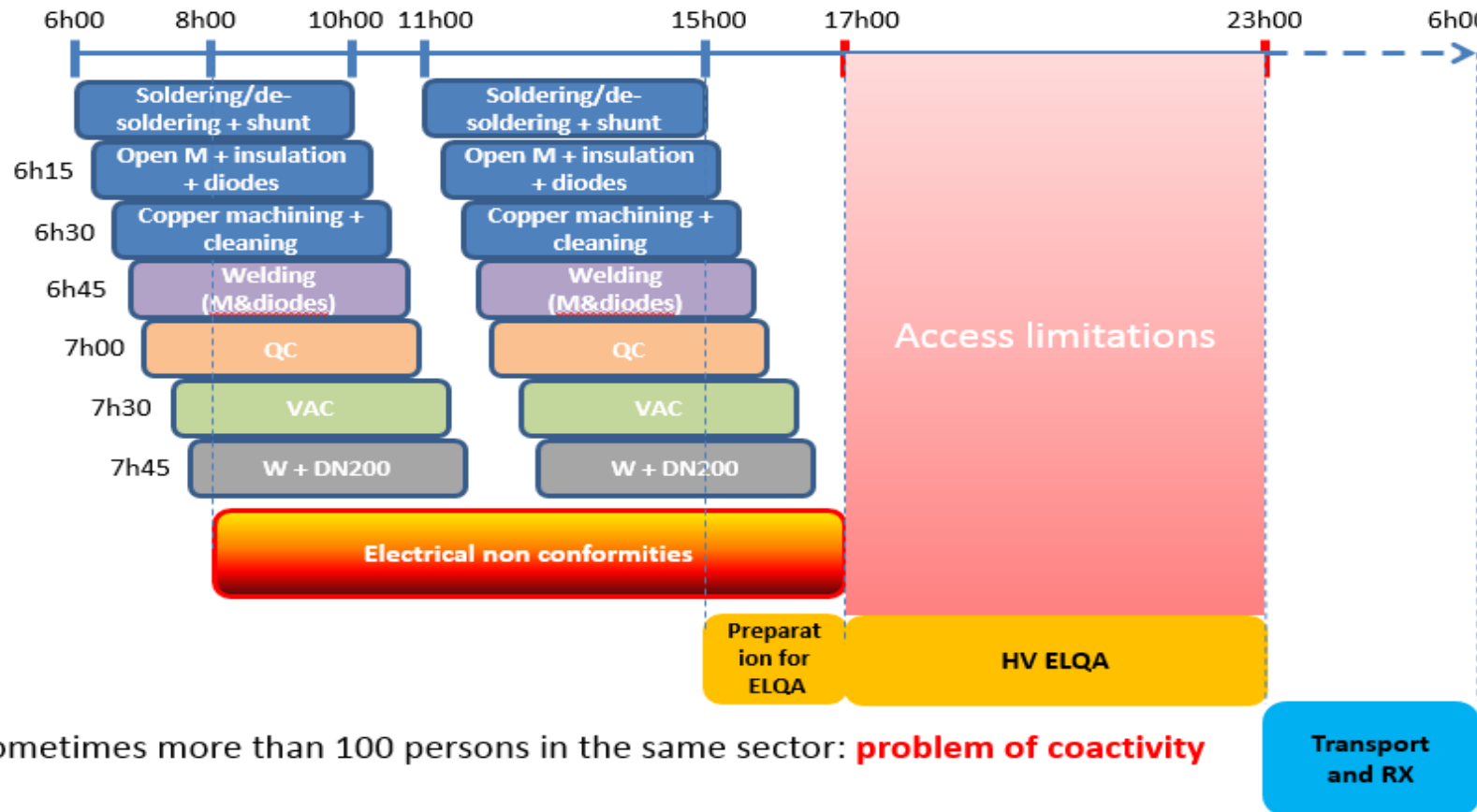


**“PAQ test is complete for today and ok.** The high leakage problem M3 external bus bar is gone for the reason which remains unknown.”

- 😊 Improved when frequency of EIQA test was reduced
- 😊 Improved with awareness, training of splices team
- 😊 Improved thanks to interventions of worksite managers
- ☹️ **But this led to some times not treated issues, likely not critical**

# What worked well ?

# Staggered working times



Sometimes more than 100 persons in the same sector: **problem of coactivity**

## Decided to have staggered working times

😊 Safety considerations

😊 Reduced co-activity

😞 The smallest team had to work during unsociable hours

My view:  
OK for standard activities, less for ad-hoc ones

# What worked well ?

## Safety measures to cope with this way of working

De- & Re condemnation of DFBA for each measurement and inform people



**CONTINUOUS IMPROVEMENT IN THE COURSE OF THE PROJECT THANKS TO CSI**



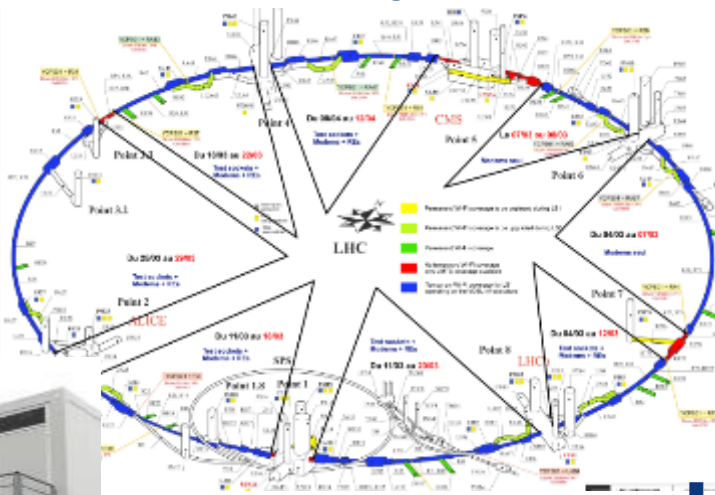
Could such a tool be developed to help solving the "Yellow Papers" issue ?

# What worked well ?

# CSI support / Logistics



## WiFi coverage



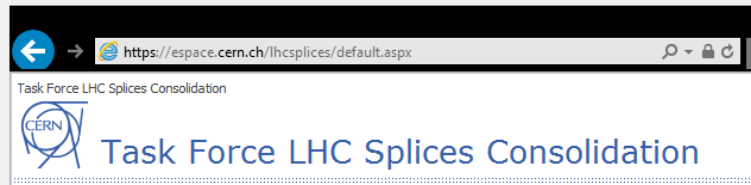
- To be thought and prepared well in advance,
- To go in details
- To be included in the budget
- Include some margin

WiFi need was “officially” for WISh.  
It took months to be implemented  
Act now to improve the situation for TS, (E)YETS,LSX,...

# What worked well ?

# Preparation well ahead

- Started in 2009
- Participation to the LHC splices TF (1<sup>st</sup> meeting 12.11.2009)



## Members

Antonio Perin

Arjan Verweij

Cedric Garion

Christian Scheuerlein

Delio Duarte Ramos

Francesco Bertinelli

Frederic Savary

Gerard Willering

Herman ten Kate

Jean-Philippe Tock, Chairman

Nuria Catalan Lasheras

Paolo Fessia

Serge Mathot

Stefano Sgobba

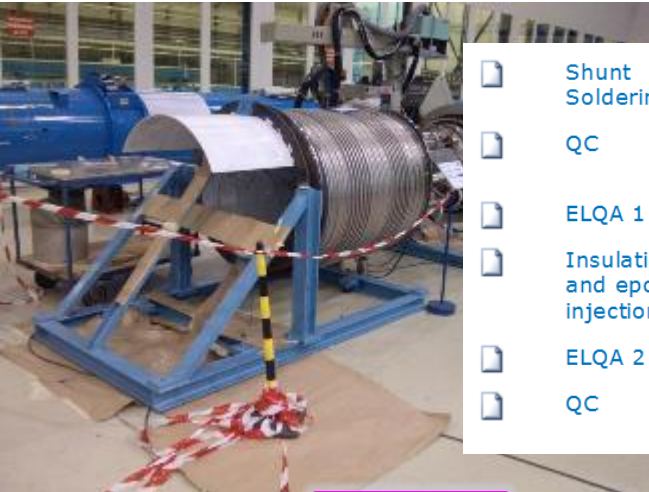
MPE in the task force since the beginning,  
☹ not in the SMACC EIQA team

- ❖ Long lifecycles of CERN processes (i.e. collaboration agreements)
- ❖ Identification of key individual persons
- ❖ Ratio of experienced staff (including collaborators)
- ❖ Integration in the team
- ❖ Allowed training



# What worked well ?

# Training on mock-us



- Shunt Soldering
- QC
- ELQA 1
- Insulation V4 and epoxy injection
- ELQA 2
- QC

- M. Pozzobon (X. Favre) ; M. Duret; S. Triquet
- C. Scheuerlein; C. Scheuerlein
- G. D'Angelo; G. D'Angelo;
- J.M.Demolis (Ch. Charvet); M. Duret; S. Triquet
- G. D'Angelo; G. D'Angelo;
- C. Scheuerlein; C. Scheuerlein

MT-1: Mockup test 1, bldg. 180 October 4th 2012

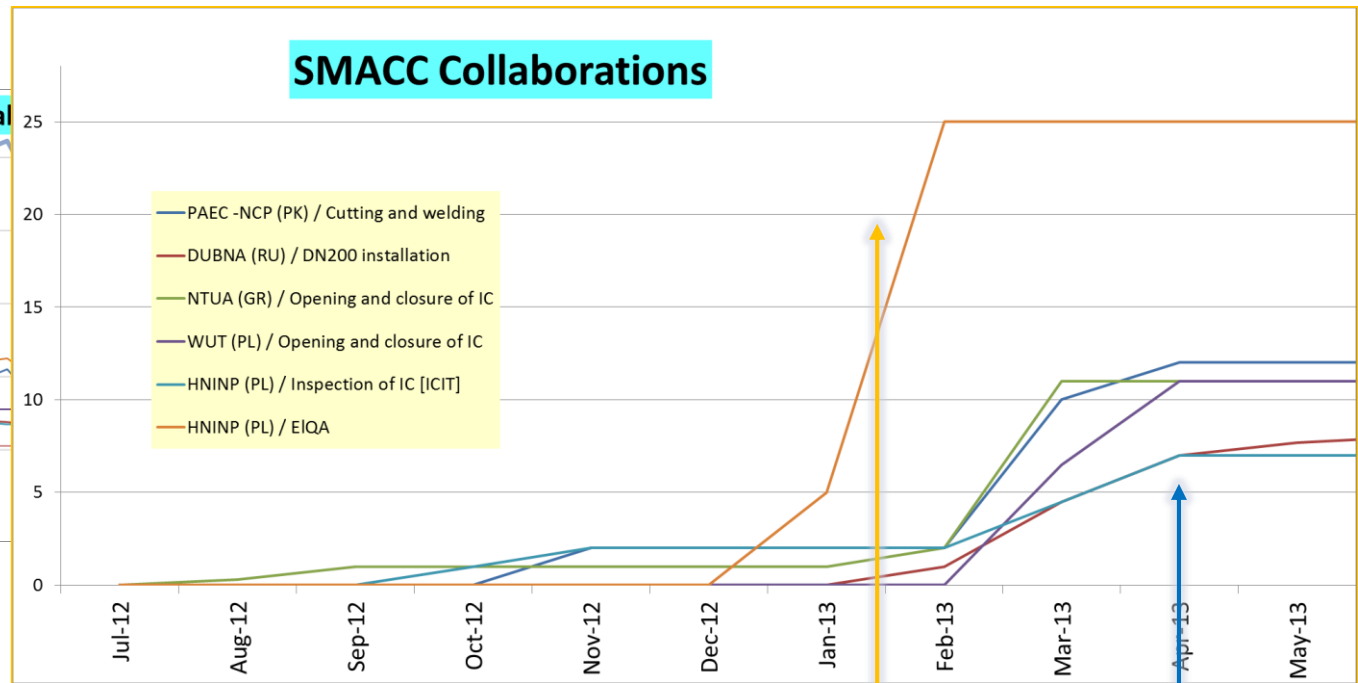
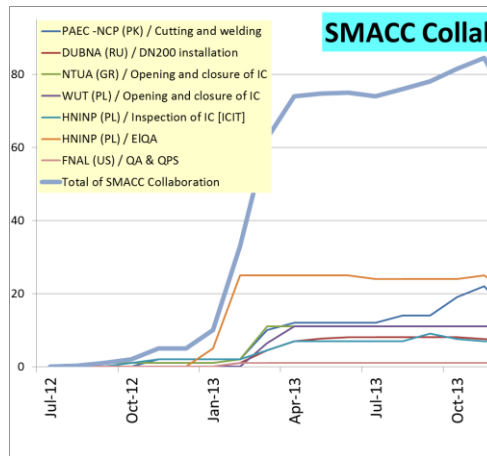
Interconnection name: QBBI.8R1  
<https://cern.ch/MT-1/>



Task	Start	Due Date	Time started	Time finished	Duration	Resource Names	Assigned to	OK	Comments - WGI - Procedures - Tests
opening M below	08/13/002	08/14/002				A. Bostani	A. Bostani		
full layer insulation						A. Bostani	A. Bostani		
opening thermal screen						A. Bostani	A. Bostani		
QC inspection, rubber + steel foil						M. Rombaux	M. Duret, S. Triquet		
reinsertion plugs						M. Rombaux	M. Duret, S. Triquet		
welding M line						J. M. Rabier + M. Duret	M. Duret, S. Triquet		
percentaging the insulation						J.M.Demolis (Ch. Charvet)	M. Duret, S. Triquet		
QC before doubletapping process						C. Scheuerlein	C. Scheuerlein		
doubletapping & soldering						S. Kozin + M. Bouchonnet	M. Duret, S. Triquet		
QC						C. Scheuerlein	C. Scheuerlein		
soldering Superconductor						S. Kozin + M. Bouchonnet	M. Duret, S. Triquet		
soldering M pin + wedge						S. Kozin + M. Bouchonnet	M. Duret, S. Triquet		
QC						C. Scheuerlein	C. Scheuerlein		
backfilling of the M surface						M. Duret	M. Duret, S. Triquet		
four inspection M line						M. Pozzobon	M. Duret, S. Triquet		
four soldering						M. Pozzobon (Ch. Charvet)	M. Duret, S. Triquet		
QC						C. Scheuerlein	C. Scheuerlein		
step 1						G. D'Angelo	G. D'Angelo		
inspection 04 and epoxy injection						J.M.Demolis (Ch. Charvet)	M. Duret, S. Triquet		
step 2						G. D'Angelo	G. D'Angelo		
QC						C. Scheuerlein	C. Scheuerlein		
reinsertion plugs removal						M. Rombaux	M. Duret, S. Triquet		
being M line						S. Kozin	M. Duret, S. Triquet		
four inspection M line						J. M. Rabier	M. Duret, S. Triquet		
link test						A. Bostani	P. Chaboussat		
QC removal, rubber + steel foil						M. Rombaux	C. Scheuerlein		
removal screen						A. Bostani	A. Bostani		
full layer insulation						A. Bostani	A. Bostani		

- As realistic as possible
- To explain the work
  - To practice it
  - To assess the exact time required
  - To «select» people
  - To integrate
  - To know each other

# What worked well ? What could have been better?



Start of EIQA work

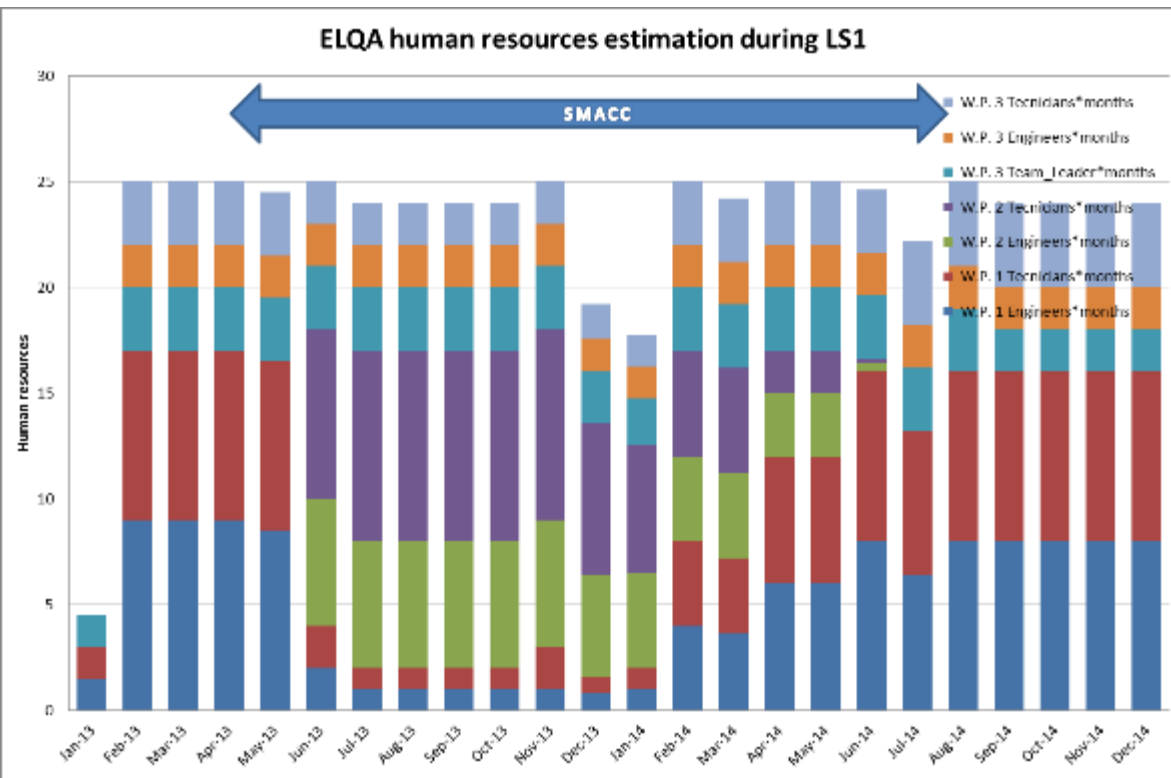
Opening of first IC

From the LS1 day...”

- Early integration of newcomers allows:
  - ✓ the team leader to solve many practical issues
  - ✓ For an appropriate training
  - ✓ For a good integration within the project.
  - ✓ To select people

It's worth the investment  
Do not neglect the preparation time”

# What could have been better?



- Had to be extended by 3 months,
- More margin could have been foreseen since the beginning
- Also a less abrupt decrease is likely more realistic.  
(Days-off at the end of the contract)

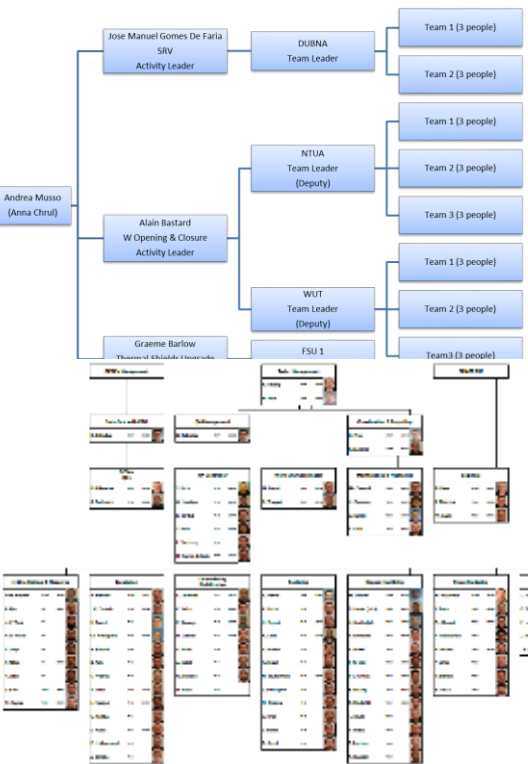
# $\alpha$ $\omega$ team gave support, i.e. yellow racks



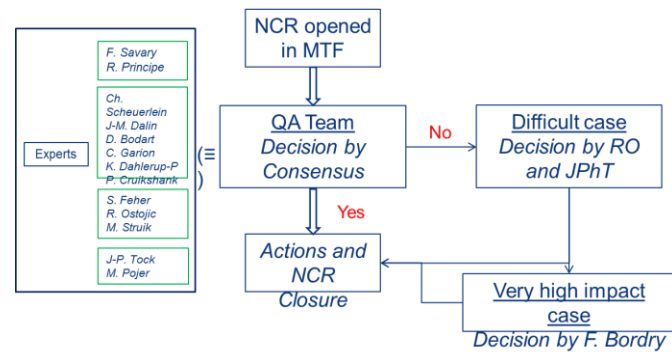
# What worked well ?

# Communication & I/F definition

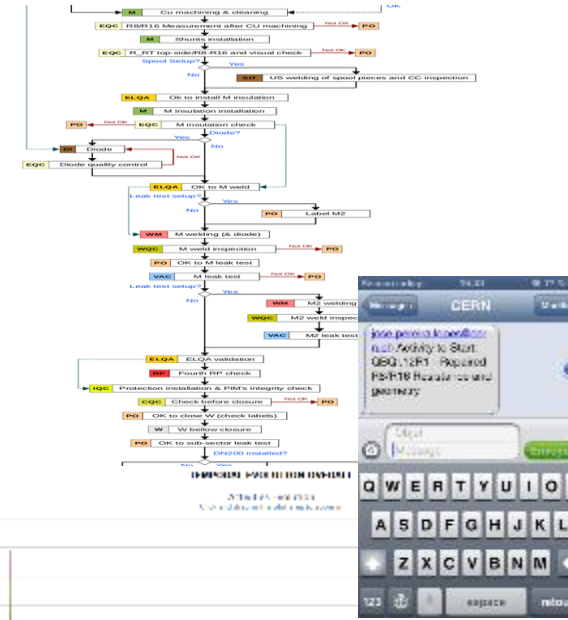
## ❖ Organization charts (with pictures)



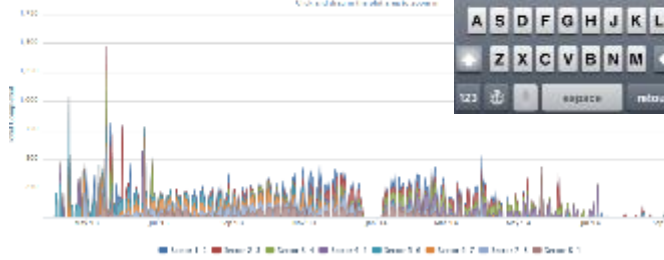
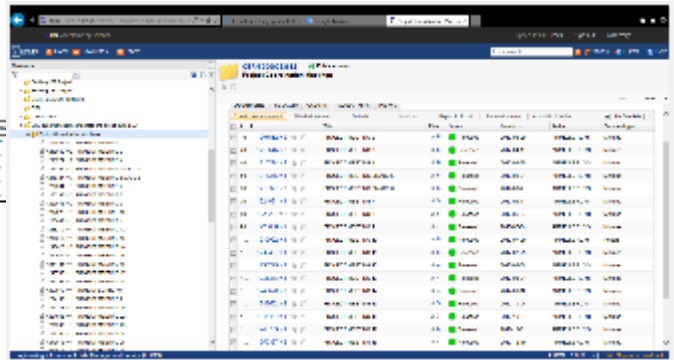
## ❖ Decision process



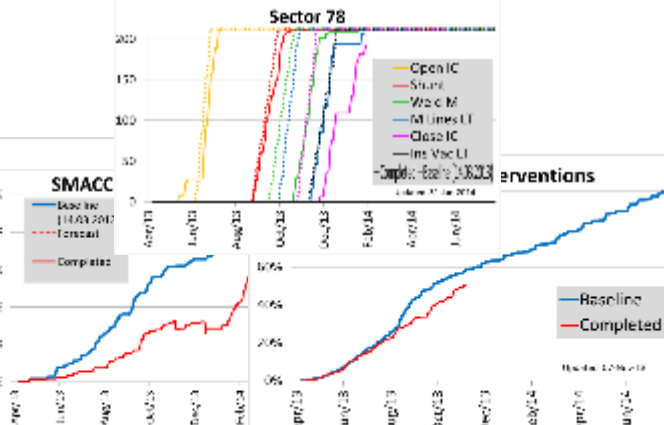
## ❖ WISh tool



## ❖ Coordination meetings



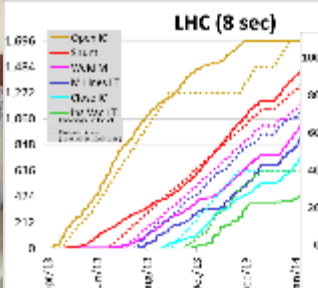
## ❖ Web dashboards



**SMACC J.Ph. Tock (#280)**

**Superconducting Magnets And Circuits Consolidation**

Open/Close IC (DN200) A.Musso (A.Chrul) #36	Main arc splices cons F.Savary (H.Phr) #93	Quality Assurance R.Ostojic #43
Opening/ Closure of IC Partial and complete W belows & ther shields Installation of DN200	Sleeves cutting BB surfacing Shunt installation Insulation Splice de- & resoldering (25%) Quadrupole diodes connection	Electrical QC: #20: C.Scheuerlein (P.Thonet) Welding QC: #6: JM Dalin ICIT: #11: C.Garion/D.Bodart QA manager support: #2 Audits: #3
TIG welding (EN MME) S.Alieh (D.Rev) #18 (+5)	Special interventions "SIT" N.Bourcy (G.Maury) #18	ELQA (TE-MPE) K.Dahlerup (G.D'Angelo) #28
DFBA (TE-CRG) A.Perrin (O.Protte) #13	Cryomagnets exchange Connect. Cryostat cons. PILS Specific issues Heavy NCS	Leak Test (TE-VSC) P.Cruikshank (C.Garion) #19
Splices and BB	SMACC CSI (Coordination, Support, Infrastructure) M.Pojer (R.Giachino) #11	Beam lines Cryogenics lines Insulation vacuum
Radiation protection Safety, Access General logistics Pressure tests Link to tests, media	Coordination with Survey, BLM, Instrumentation, Transport, planning, GPS, cryogenics, VSC, MPE, CRG. Test teams on a chain of IC Reporting tools Administrative support (budget, human resources, scientific secretary)	



# What worked well ?

## Independent QA team

### SMACC

#### Superconducting Magnets And Circuits Consolidation

##### Production

##### Quality Assurance (QA)

Main arc splices cons. "The train" (93)

General QA (43)

Open/Close IC (36)

TIG welding (18)

Electrical QA (28)

Special Interventions (18)

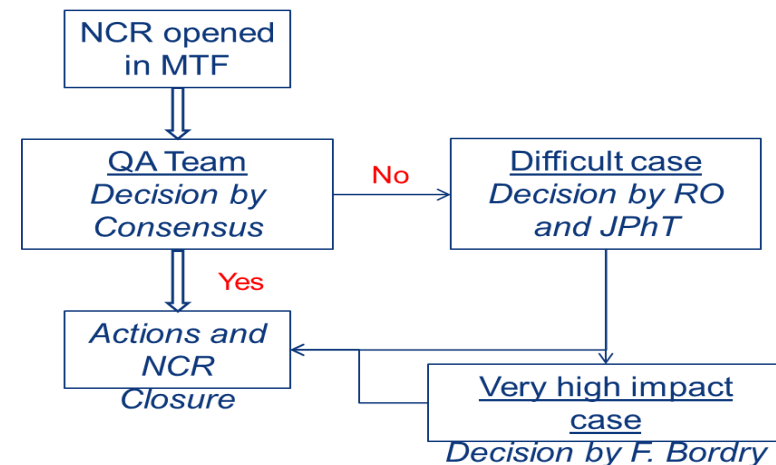
DFBA (13)

Leak Test (19)

Project Office (11)

- ❑ Decision process in case of NC defined beforehand
- ❑ NC management (Meeting up to 3 times per week)
  - Timely reaction
  - Wide information on the issues encountered
  - All involved teams represented
  - Escalated to the appropriate level

- ❑ 30% of staff for QA activities (1/3 for EIQA)
- ❑ As independent as possible (other group, department,...)



# What could have been better?

- Many (hopefully not all) key persons that were part of the EIQA team during installation and during the 2008-09 shutdown were not present any more during SMACC
- It took quite a long time to establish the new procedures

My view: because of the changes in the team and a heavy loading of the experts

> Ensure a sufficient number of experienced experts are present and available at the beginning, allowing also to train newcomers.



# What is relevant in the LS2 perspective ?

Description	😊	😐	😞	LS2	Comment
EIQA workflow adaptation	█			(X)	Depends on the interventions
Safety procedures	█			X	Pragmatic solutions, room for improvement
Planning	█			X	Staggered working times if necessary, + safety
Logistics	█			(X)	Dedicated team
Communication, I/F definition	█			(X)	Ad-hoc tool: WISh, organization charts, meetings,...
Margin for resources (before and after)		█		X	
Independent QA team	█			X	To adapt to the activities
Availability of experienced experts		█		X	
Collaboration/team spirit	█			X	SMACC & MNC
WIC for injectors & experimental areas		█			General / MNC



# Conclusions

## The interaction between MPE and (SMACC & MNC) during LS1 was successful

### The main lessons learnt to keep in mind for the future, especially for LS2:

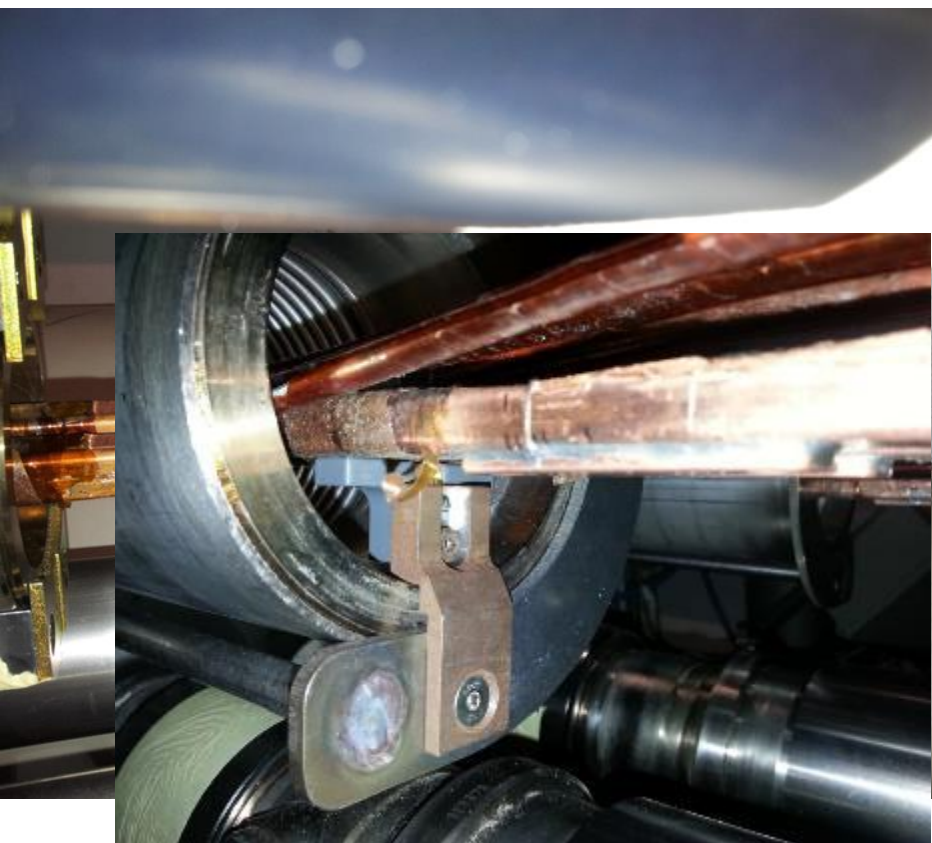
- ❑ Preparation well ahead was a key
  - Details are important
  - Including training and integration of newcomers
- ❑ Team spirit is more important than statutes
- ❑ A fair ratio of available expert/experienced staff allows for training and redirection of resources in function of the needs
- ❑ Announce that unplanned activities requiring experts will impact schedule and resources (CSCM)
- ❑ Margin to be foreseen to cope with extra work or schedule shift
- ❑ All injectors and experimental areas would benefit from a WIC





# Workflow Simplification – Continuous segments

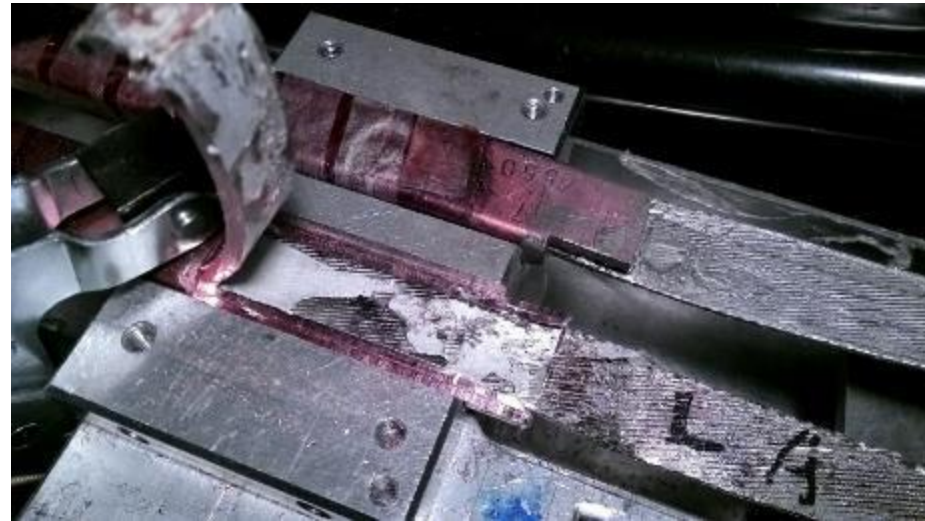
➤ Only 1 IC per sector to be left open



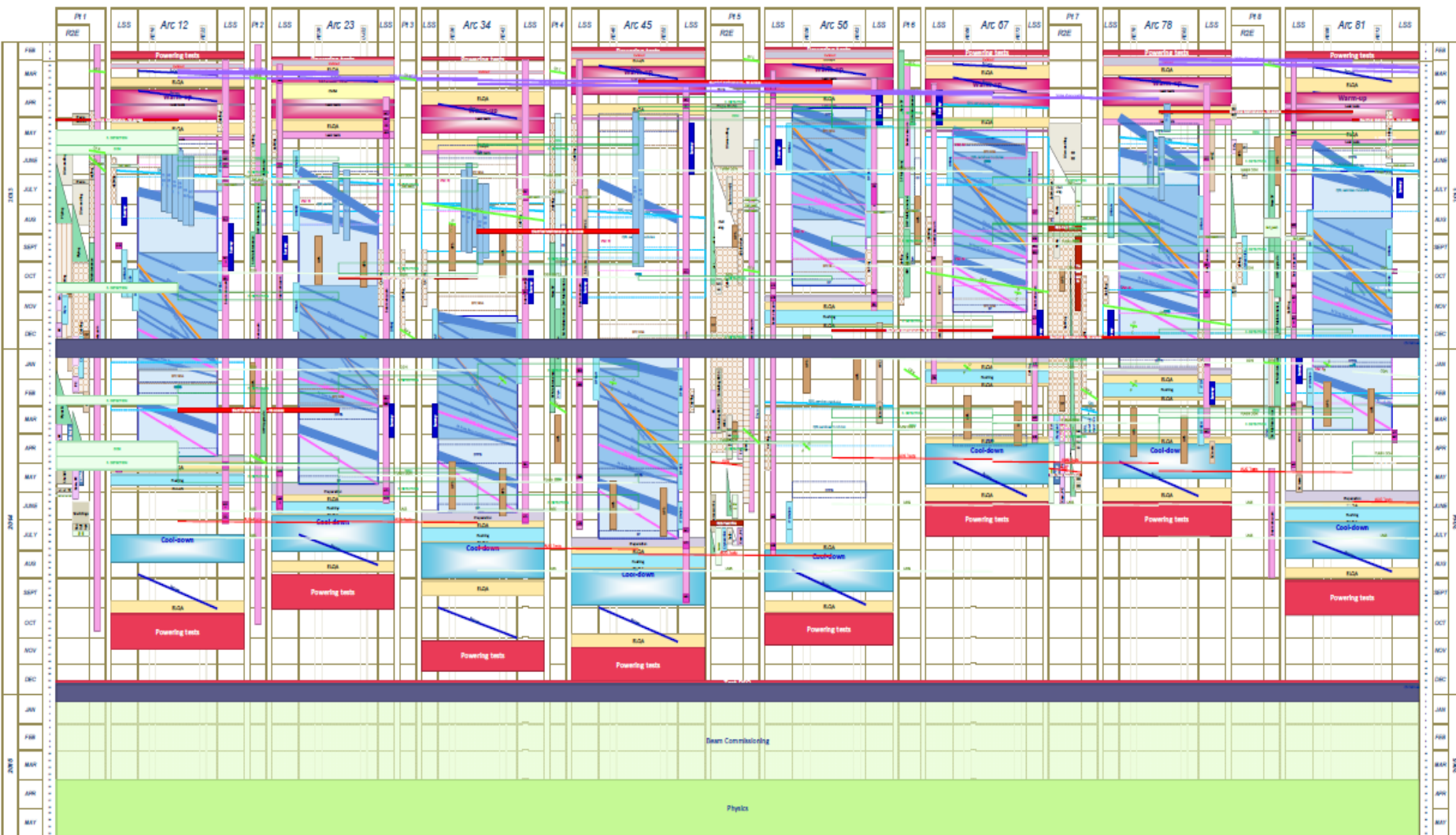
**PAQ**  
The  
bar is  
unkn



## QBBI.A21L6: OVERHEATED CABLE REPAIR



Hello, if all agree on Friday we will cut a strand piece for magnetisation measurements from both now accessible cables at the busbar extremity .  
Christian



# ELQA-PAQ IN S12

Dear all,

Yesterday our team in S12 had a very hard time, and the results are not satisfactory!!

The situation is not acceptable!

An action should be taken before next test Tuesday 19th (this Thursday test is cancelled due to Tomograph).

Many thanks for your understanding!

Best regards



# ELQA-PAQ

		Sat									
		Sun									
Week 18	5.May	Mon							S34 LS1-PAQ	S45 LS1-PAQ	
	6.May	Tue									
	7.May	Wed							S34 LS1-PAQ	S4-5 LS1-PAQ	
	8.May	Thu									
	9.May	Fri									
		Sat									
	Sun										
Week 19	12.May	Mon							S34 LS1-PAQ	S45 LS1-PAQ	
	13.May	Tue									
	14.May	Wed							S34 LS1-PAQ	S4-5 LS1-PAQ	
	15.May	Thu									
	16.May	Fri									
		Sat									
	Sun										
Week 20	19.May	Mon							S34 LS1-PAQ	S45 LS1-PAQ	
	20.May	Tue									
	21.May	Wed							S34 LS1-PAQ	S4-5 LS1-PAQ	
	22.May	Thu									
	23.May	Fri									
		Sat									
	Sun										



# ELQA ISSUES IN S67, S78 AND 81?

Our team completed tests in sector 8-1.

Continuity test are OK, without lines M1 int -ext, because mechanical support is connect between busbar and ground in the interconnection QBQI.31L1 -see photos.

HV test are OK without spoolpieces 3,4,9,10 -we will check next time, because continuity test for this spoolpieces are OK.

Best regards



**SECTOR G-7  
OK TO INSTALL N INSULATION**

0301.0001	0301.0002	0301.0003	0301.0004	0301.0005	0301.0006	0301.0007	0301.0008	0301.0009	0301.0010	0301.0011	0301.0012	0301.0013	0301.0014	0301.0015	0301.0016	0301.0017	0301.0018	0301.0019	0301.0020	0301.0021	0301.0022	0301.0023	0301.0024	0301.0025	0301.0026	0301.0027	0301.0028	0301.0029	0301.0030	0301.0031	0301.0032	0301.0033	0301.0034	0301.0035	0301.0036	0301.0037	0301.0038	0301.0039	0301.0040	0301.0041	0301.0042	0301.0043	0301.0044	0301.0045	0301.0046	0301.0047	0301.0048	0301.0049	0301.0050	0301.0051	0301.0052	0301.0053	0301.0054	0301.0055	0301.0056	0301.0057	0301.0058	0301.0059	0301.0060	0301.0061	0301.0062	0301.0063	0301.0064	0301.0065	0301.0066	0301.0067	0301.0068	0301.0069	0301.0070	0301.0071	0301.0072	0301.0073	0301.0074	0301.0075	0301.0076	0301.0077	0301.0078	0301.0079	0301.0080	0301.0081	0301.0082	0301.0083	0301.0084	0301.0085	0301.0086	0301.0087	0301.0088	0301.0089	0301.0090	0301.0091	0301.0092	0301.0093	0301.0094	0301.0095	0301.0096	0301.0097	0301.0098	0301.0099	0301.0100
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**SECTOR 7-8  
OK TO INSTALL N INSULATION**

0302.0001	0302.0002	0302.0003	0302.0004	0302.0005	0302.0006	0302.0007	0302.0008	0302.0009	0302.0010	0302.0011	0302.0012	0302.0013	0302.0014	0302.0015	0302.0016	0302.0017	0302.0018	0302.0019	0302.0020	0302.0021	0302.0022	0302.0023	0302.0024	0302.0025	0302.0026	0302.0027	0302.0028	0302.0029	0302.0030	0302.0031	0302.0032	0302.0033	0302.0034	0302.0035	0302.0036	0302.0037	0302.0038	0302.0039	0302.0040	0302.0041	0302.0042	0302.0043	0302.0044	0302.0045	0302.0046	0302.0047	0302.0048	0302.0049	0302.0050	0302.0051	0302.0052	0302.0053	0302.0054	0302.0055	0302.0056	0302.0057	0302.0058	0302.0059	0302.0060	0302.0061	0302.0062	0302.0063	0302.0064	0302.0065	0302.0066	0302.0067	0302.0068	0302.0069	0302.0070	0302.0071	0302.0072	0302.0073	0302.0074	0302.0075	0302.0076	0302.0077	0302.0078	0302.0079	0302.0080	0302.0081	0302.0082	0302.0083	0302.0084	0302.0085	0302.0086	0302.0087	0302.0088	0302.0089	0302.0090	0302.0091	0302.0092	0302.0093	0302.0094	0302.0095	0302.0096	0302.0097	0302.0098	0302.0099	0302.0100
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<p><b>Interconnection with activity on hold.</b>              Interconnection with activity done or suspended.              Interconnection with activity ready to start.              Interconnection with repeated activity ready to start.</p>	<p><b>Interconnections with activities blocked.</b>              Interconnections with activity on hold to start.              Interconnections with no work forecast for the activity.</p>	<p><b>Interconnections with activity on hold.</b>              Interconnections with activity done or suspended.              Interconnection with activity ready to start.              Interconnections with repeated activity ready to start.</p>	<p><b>Interconnections with activities blocked.</b>              Interconnections with no work forecast for the activity.</p>
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