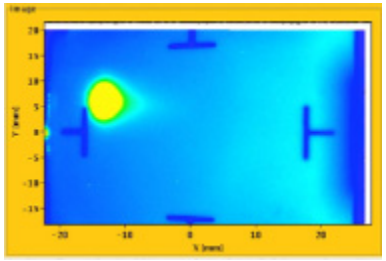
www.cern.ch

THE FIRST LONG SHUTDOWN (LS1) FOR THE LHC

F. Bordry

13th May 2013

August 2008
First injection test



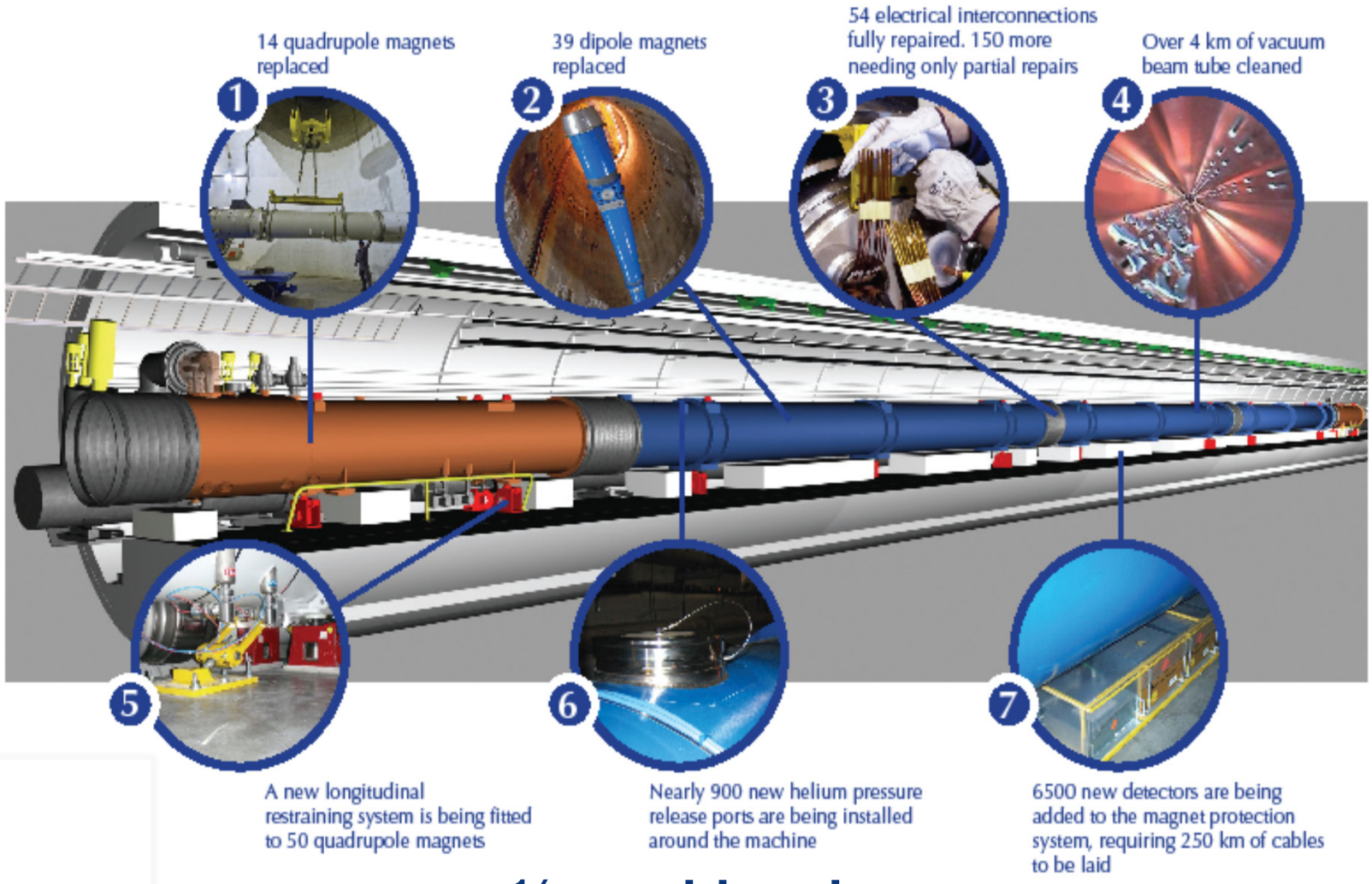
September 10, 2008
First beams around

2008 | 2009 | 2010 | 2011 | 2012

September 19, 2008
Incident
Accidental release of 600 MJ stored in one sector of LHC dipole magnets

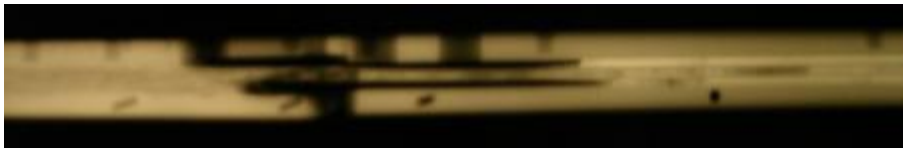
LHC Timeline

The LHC repairs in detail

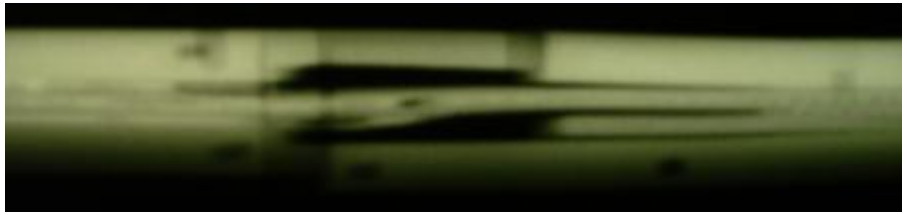


½ machine done

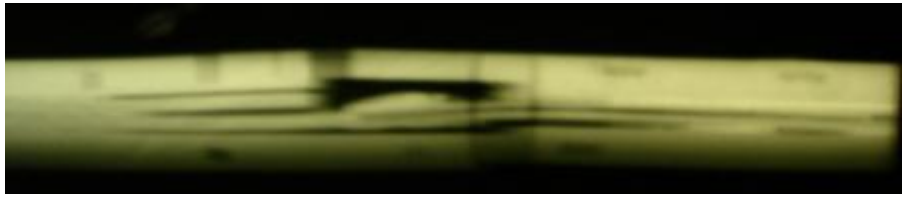
Sample pictures



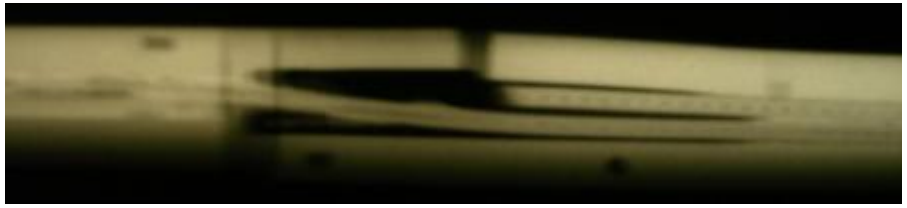
Sample 1 (61 μΩ)



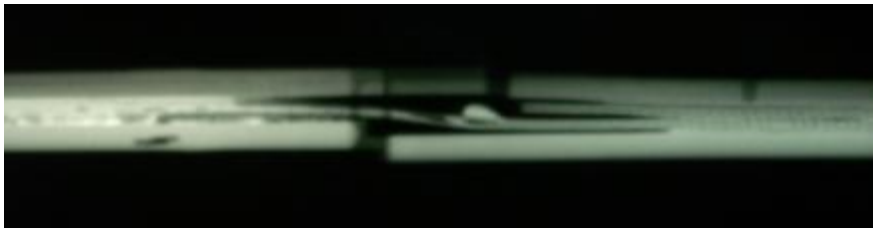
Sample 2A left (32 μΩ)



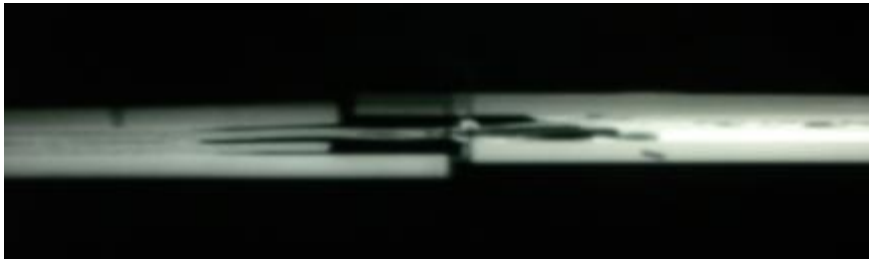
Sample 2A right (43 μΩ)



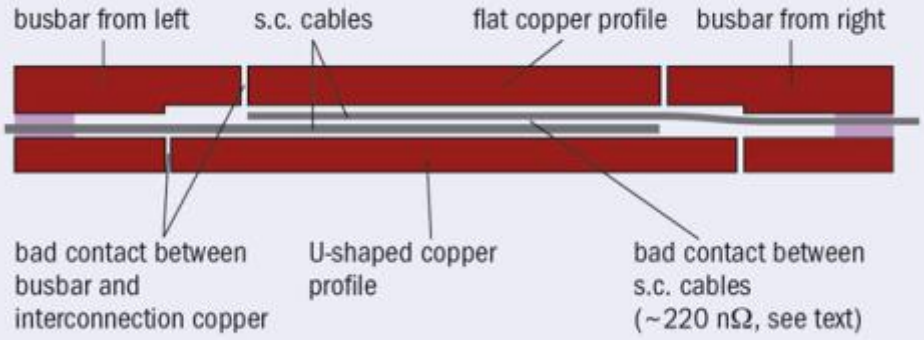
Sample 2B (42 μΩ)

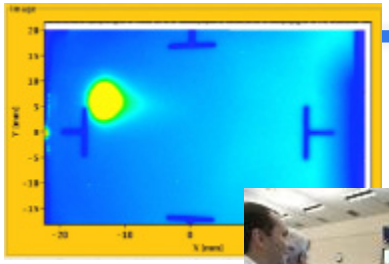


Sample 3A left (26 μΩ)



Sample 3A right (43 μΩ)

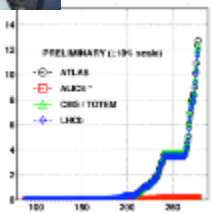




August 2008
First injection test

3.5 TeV

November 29, 2009
Beam back



September 10, 2008
First beams around

October 14 2010
1e32
248 bunches

April 2010
Squeeze to 3.5 m

2008 | 2009 | 2010 | 2011 | 2012

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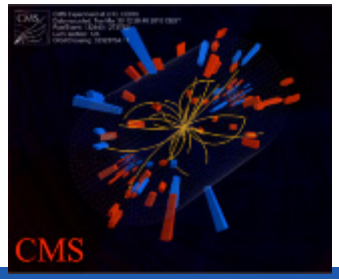
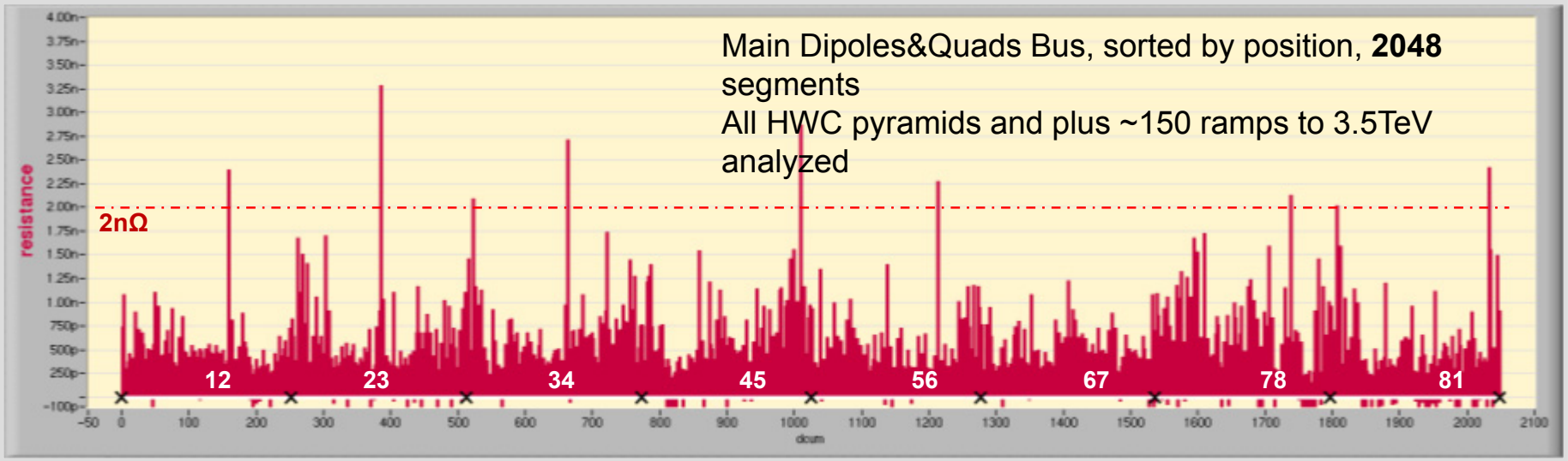
Disaster
Accidental release of 600 MJ stored in one sector of LHC dipole magnets

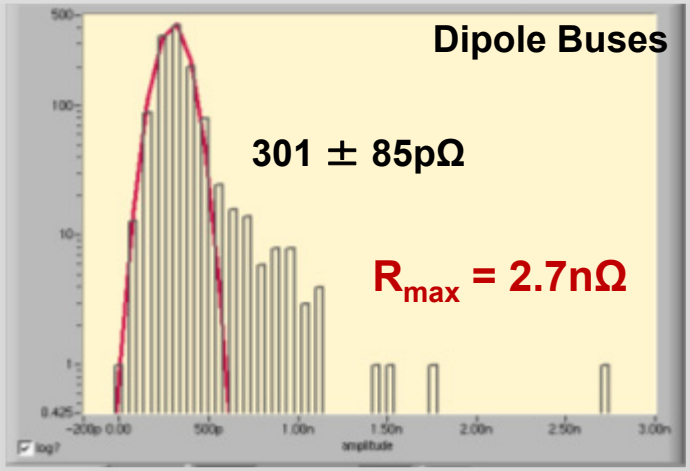
March 30, 2010
First collisions at

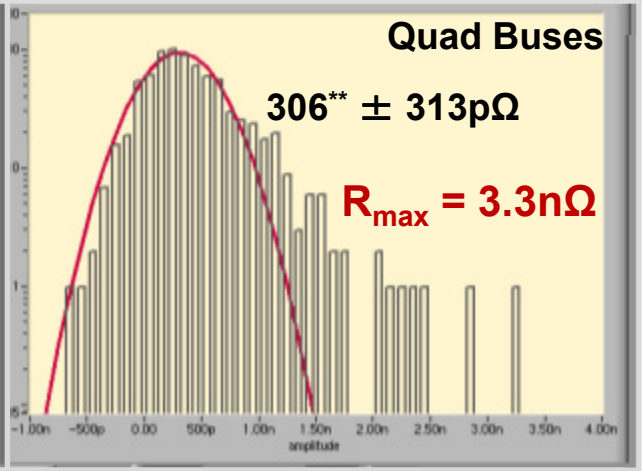


LHC Timeline

LHC main splices: busbars SC





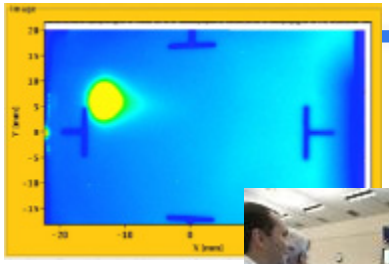


Top 10 Splice Resistances

MQ.A23	MQ.33L3.B2	<->	MQ.33R2.B2	3.28E-09
MQ.A45	MQ.12L5.B2	<->	MQ.11L5.B1	2.87E-09
MB.A34	MB.A31L4	<->	MB.C31L4	2.71E-09
MQ.A81	MQ.12L1.B2	<->	MQ.11L1.B1	2.42E-09
MQ.A12	MQ.27L2.B2	<->	MQ.25L2.B2	2.40E-09
MQ.A56	MQ.21L6.B2	<->	MQ.19L6.B2	2.27E-09
MQ.A78	MQ.20L8.B1	<->	MQ.22L8.B1	2.13E-09
MQ.A34	MQ.9R3.B2	<->	MQ.11R3.B2	2.09E-09
MQ.A81	MQ.11R8.B2	<->	DFLAS.7R8.4	2.02E-09
MB.A34	MB.C19L4	<->	MB.B20L4	1.74E-09

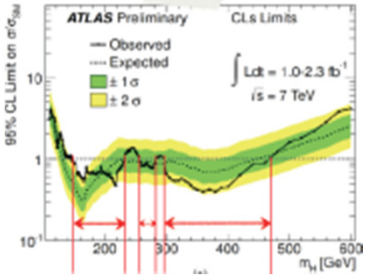
(**) number of splices in the quads segments corrected, 1.3 added

August 2008
First injection test

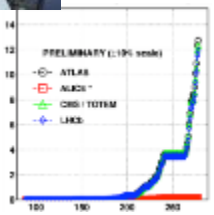


3.5 TeV

4.0 TeV



November 29, 2009
Beam back



August, 2011
2.3e33, 2.6 fb^{-1}
1380 bunches

September 10, 2008
First beams around

October 14 2010
1e32
248 bunches

June 28 2011
1380 bunches

1380

April 2010
Squeeze to 3.5 m

6 June, 2012
6.8e33

2008 | 2009 | 2010 | 2011 | 2012

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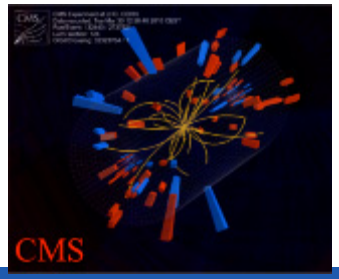
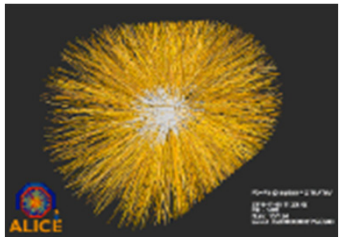


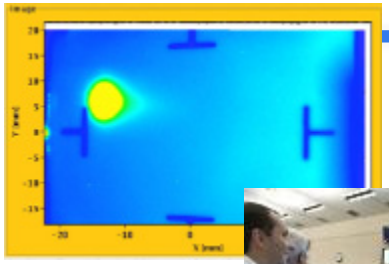
November 2010
Ions



18 June, 2012
6.6 fb^{-1}
to ATLAS & CMS

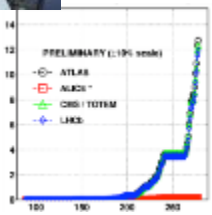
LHC Timeline

August 2008
First injection test



3.5 TeV

November 29, 2009
Beam back



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First beams around

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6 June, 2012
6.8e33

4 July, 2012
Higgs discovery

2008 | 2009 | 2010 | 2011 | 2012

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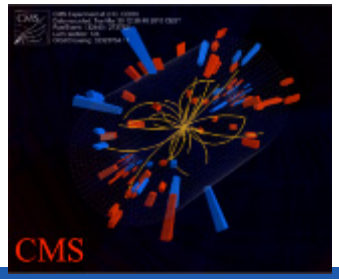
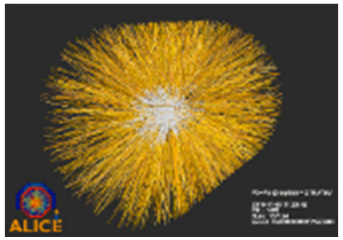


November 2010
Ions

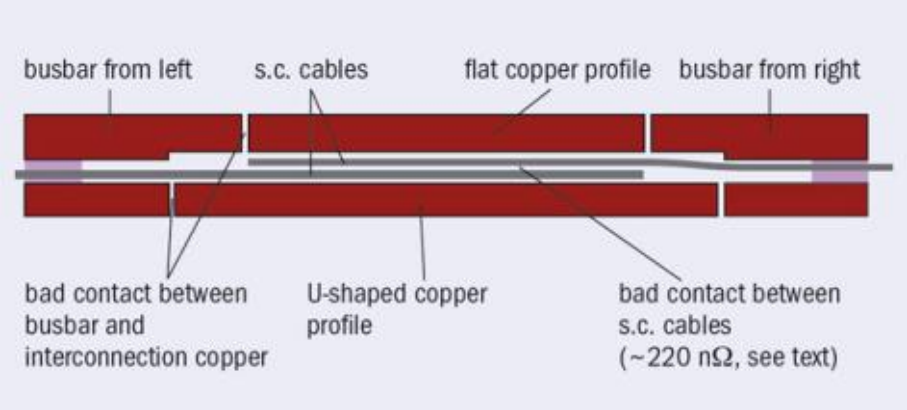


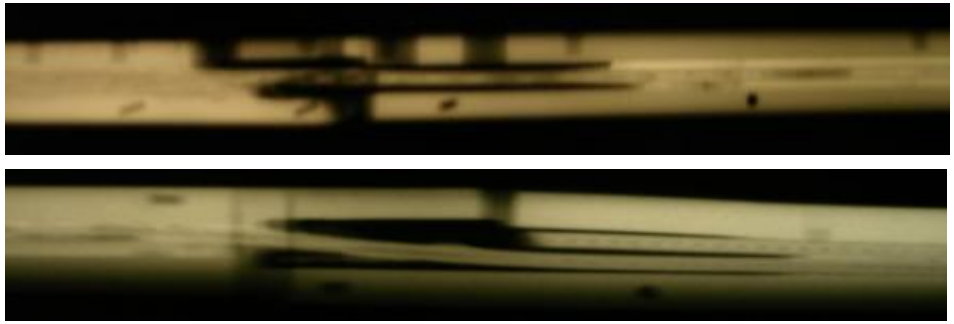
18 June, 2012
6.6 fb^{-1}
to ATLAS & CMS

LHC Timeline

Long Shutdown 1

LS1 starts as the shutdown to repair the magnet interconnects to allow nominal current in the dipole and lattice quadrupole circuits of the LHC.





Long Shutdown 1

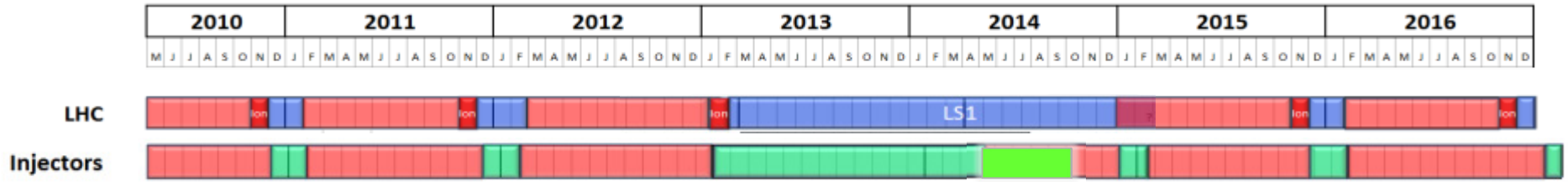
LS1 starts as the shutdown to repair the magnet interconnects to allow nominal current in the dipole and lattice quadrupole circuits of the LHC.

It has now become a major shutdown which, in addition, includes other repairs, maintenance, consolidation, upgrades and cabling across the whole accelerator complex and the associated experimental facilities.

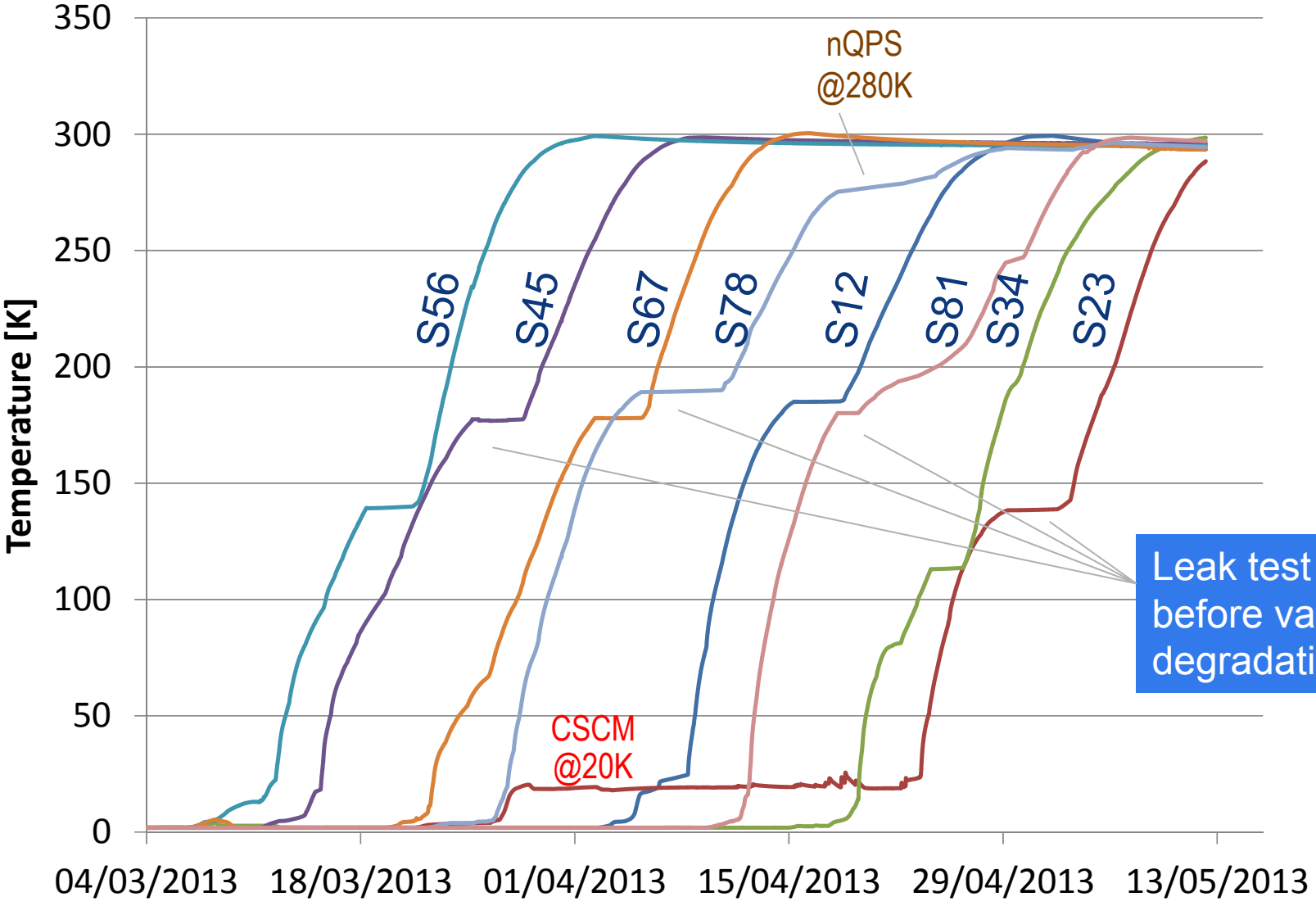
All this in the shadow of the repair of the magnet interconnects.

LS 1 (16th Feb. 2013 to Dec. 2014)

2013-02-16 08:25:27
***** END OF RUN 1*****
No beam for a while
Access required
time estimate: ~ 2 years



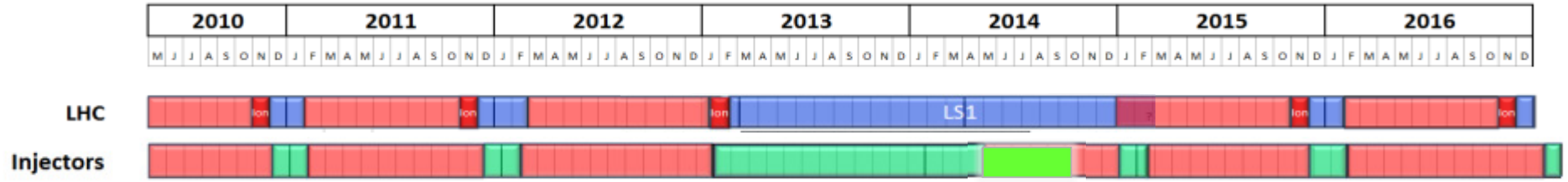
LHC Warm-Up 2013



LS 1 (16th Feb. 2013 to Dec. 2014)

- Numerous projects and activities:
  - SMACC (Superconducting Magnets And Circuits Consolidation)
  - R2E (Radiation to Electronics)
  - Massive shutdown maintenance after more than 3 years of operation
  - Several major consolidations PSB, PS, SPS , LHC and electricity network

  - A lot of projects (Linac 4, HIE-Isolde, Elena, nTof EAR 2, **High Luminosity LHC**, ….)
- Compared to previous shutdowns, an exceptional number of …
  - Simultaneous activities (co-activities) – **Planning and safety**
  - Non-CERN workers (FSU, collaborations, contracts,…)- **Logistics: Registration, training, transport, parking, access, dosimeter, PPE, catering, accommodation,…)**

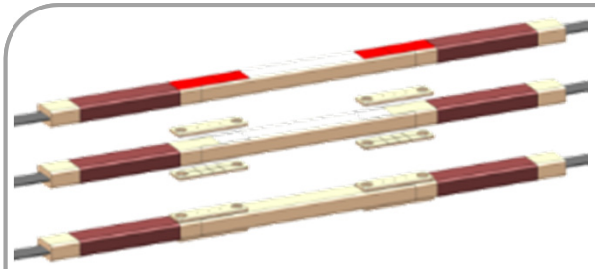


Main activities in LHC

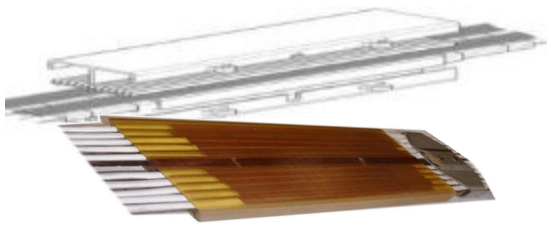
- The main key drivers are:

Superconducting Magnets And Circuits Consolidation *(SMACC)*

- Interconnections consolidation
  - Total magnet to magnet interconnects in the LHC: 1 695 (**10'170 high current splices**)
  - Number of splices to be redone: ~1'000 - 1'500 (~ 10-15%)
  - Number of shunts to be applied: > 27 000 (**100% of interconnections**)



✓ Consolidated dipole magnets bus splice



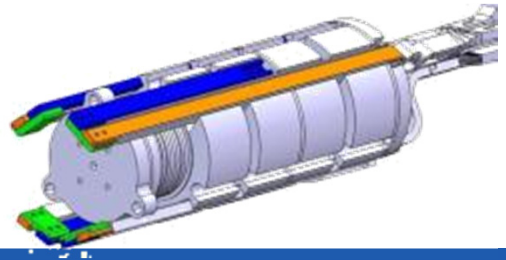
✓Consolidated electrical insulation system

Main activities in LHC

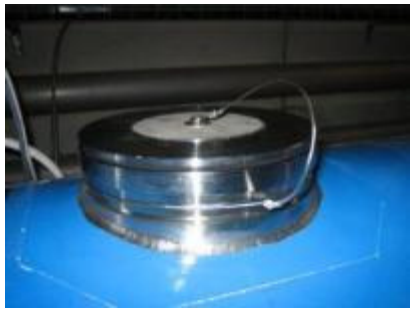
- The main key drivers are:

Superconducting Magnets And Circuits Consolidation (SMACC)

- Interconnections consolidation
- Magnets to exchange: 18 (15 dipoles and 3 quadrupoles)
- Cryogenic feedbox consolidation
- DN200
- ….
- Quadrupole diodes

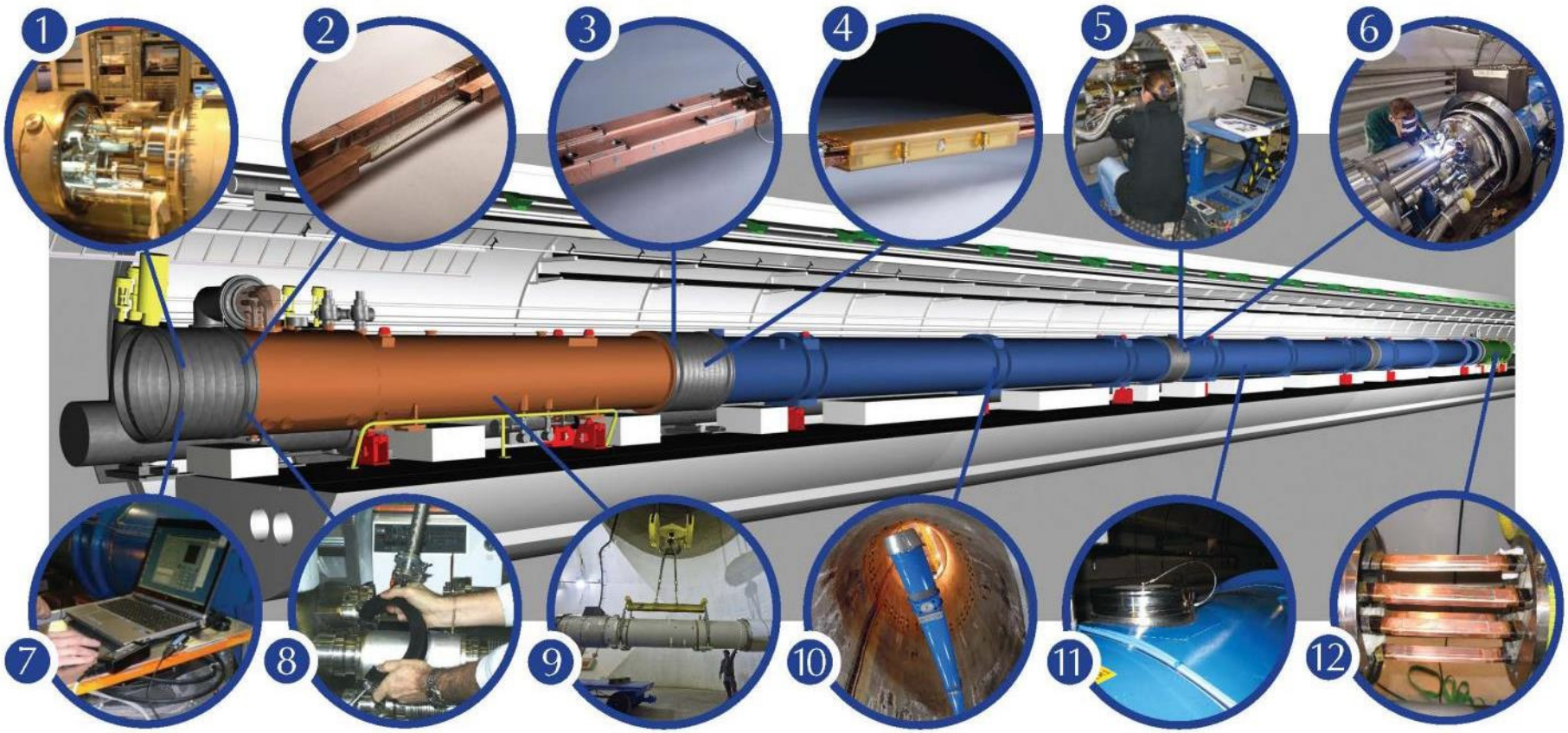


Magnet installation



DN200

The main 2013-14 LHC consolidations



SMACC Organization Chart

These activities will require 15 months and a combined effort of about 260 persons.

SMACC J.Ph. Tock (# 260)
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) [#10]

- -Splices and BB

Main arc splices cons.
F Savary (H Prin) #75

- -Sleeves cutting
- -BB surfacing
- -Shunt installation
- -Insulation
- -Splice de- & resoldering [15%]
- -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 #39

- -Electrical QC: #16: C.Scheuerlein (P.Thonet)
- -Welding QC: # 6 : JM Dalin
- -Beam vacuum QC: #6 : C Garion
- -Open/close IC QC: #7 [Shared]: D Bodart
- -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

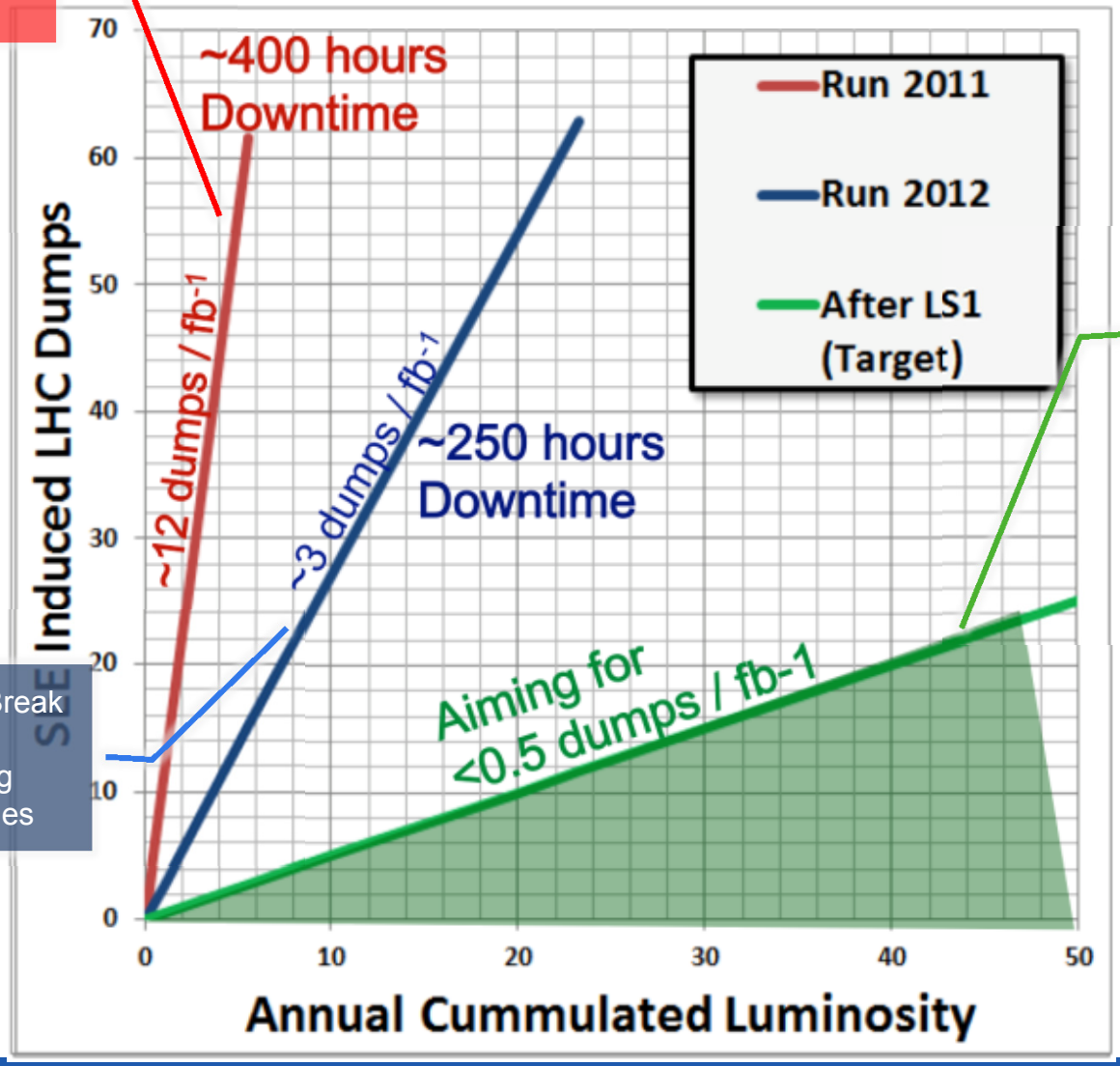
Project Office M Pojer (R Giachino) #11

- -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)

Radiation to Electronics

Several shielding campaigns prior 2011
+ Relocations 'on the fly'
+ Equipment Upgrades



2011/12 Christmas Break
'Early' Relocation
+ Additional Shielding
+ Equipment Upgrades

R2E Project to reach nominal and ultimate luminosity

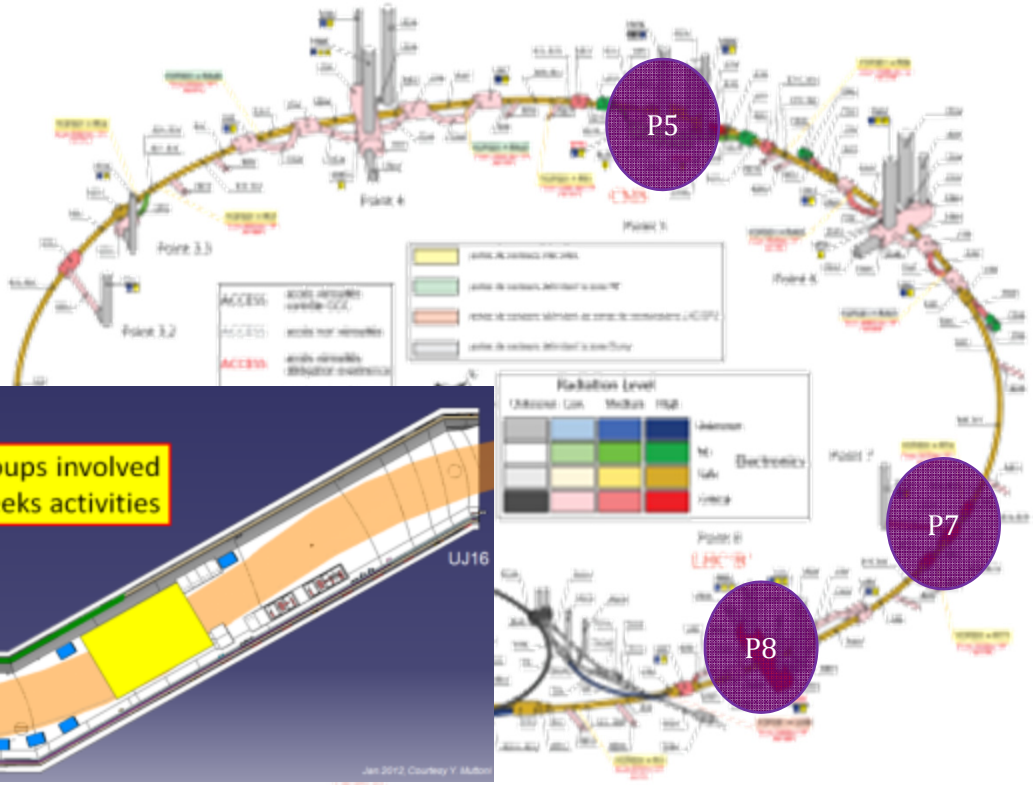
Courtesy Markus Brugger

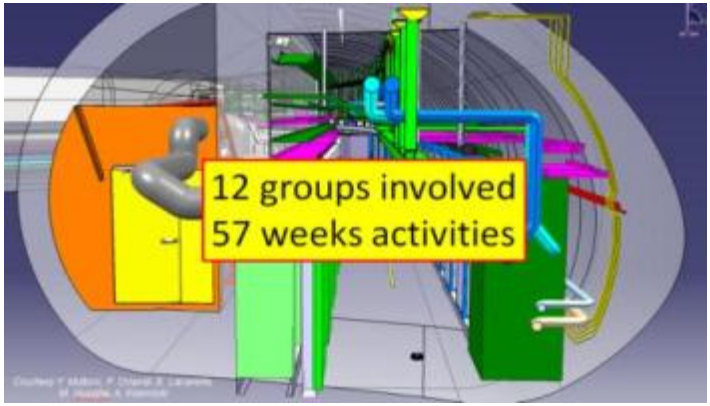
Main activities in LHC

In total 70 weeks and a combined effort of about 150 persons

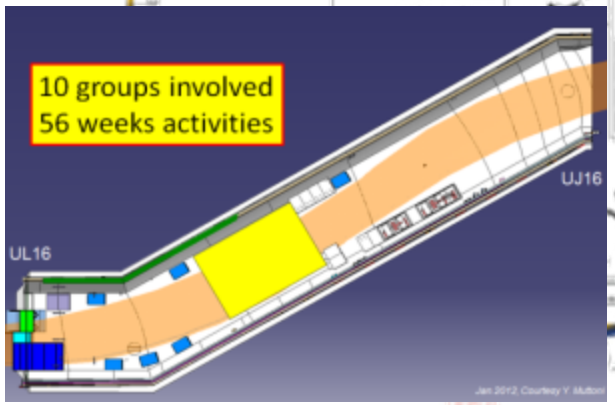
The main key drivers are:

- Superconducting Magnets And Circuits Consolidation
- **Radiation To Electronics – R2E**

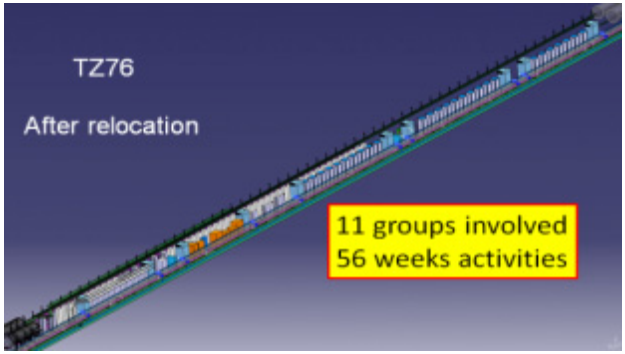




Point 5 – UJ56, UL55, RRs



Point 1 – ULs, Ujs, RRs



Point 7 – UJ, TZ

Courtesy: A.-L. Perrot, Y. Muttoni

Main activities in LHC

The main key drivers are:

- Superconducting Magnets And Circuits Consolidation
- Radiation To Electronics – R2E
- **Full maintenance of all equipment**

Main activities in LHC

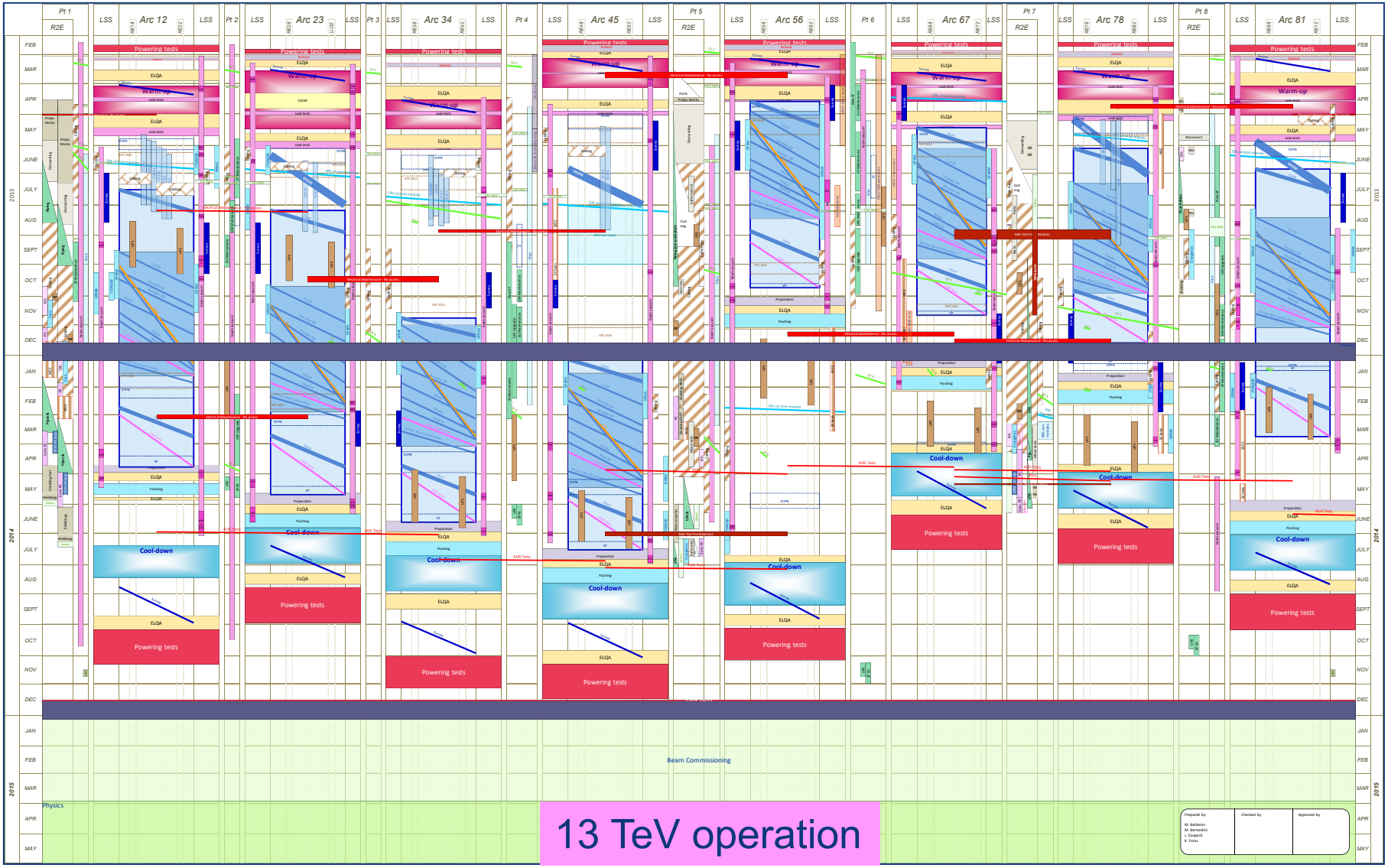
The main key drivers are:

- Superconducting Magnets And Circuits Consolidation
- Radiation To Electronics – R2E
- Full maintenance of all equipment

Cabling !!!	Km	years	persons	km/person per year
LHC installation	3’500	5	60	11.7
LHC LS1	700	1	100	7.0

Flexwell @ P4

LS1: LHC schedule



SMACC: Opening of interconnections

Collaborations with NTUA (Athens), WUT (Wroclaw) and support of JINR-DUBNA

SMACC: 7th May: the last interconnection in sector 5-6 was opened

SMACC: Opening of busbar lines

Opening of M lines started on 18.04.2013

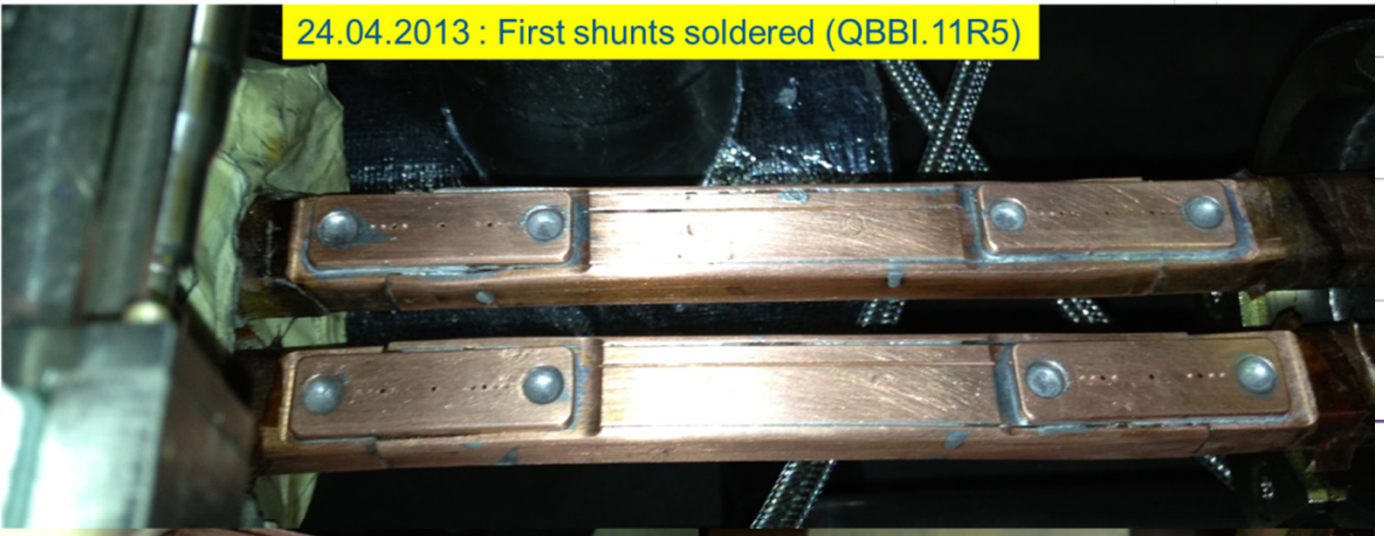
- 96 IC opened in sector 56 (About 45% of one sector)
- Rate according to plan after 1 week of learning = 10.6 IC/day

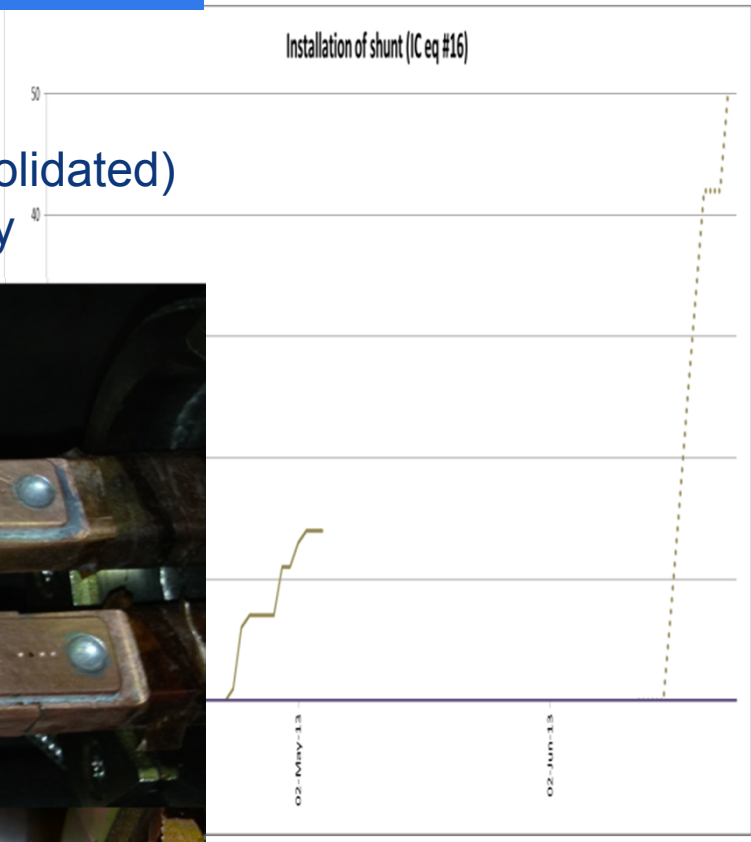
Thursday 18th April 2013

SMACC: Installation of shunts

First shunt soldered on 24.04.2013

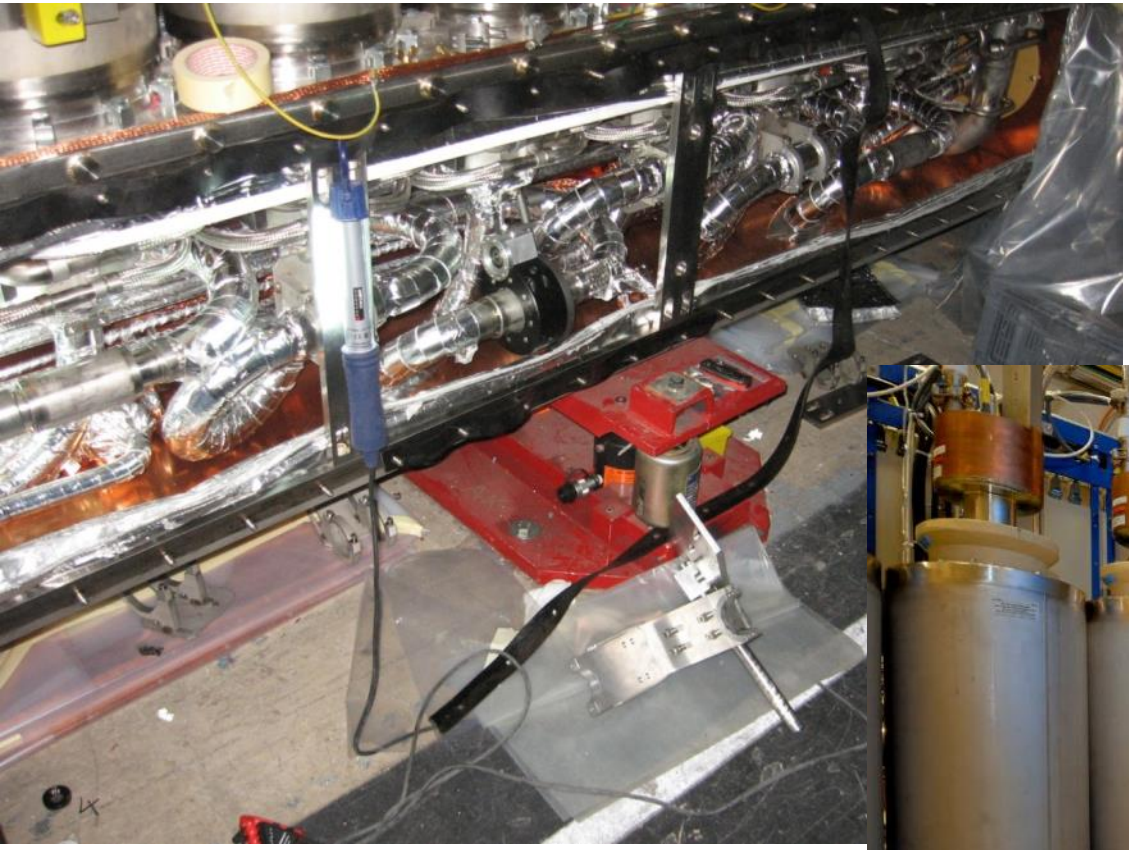
- 14 IC equipped with shunts (only one line to be consolidated)
- Started ahead of schedule, learning for critical activity



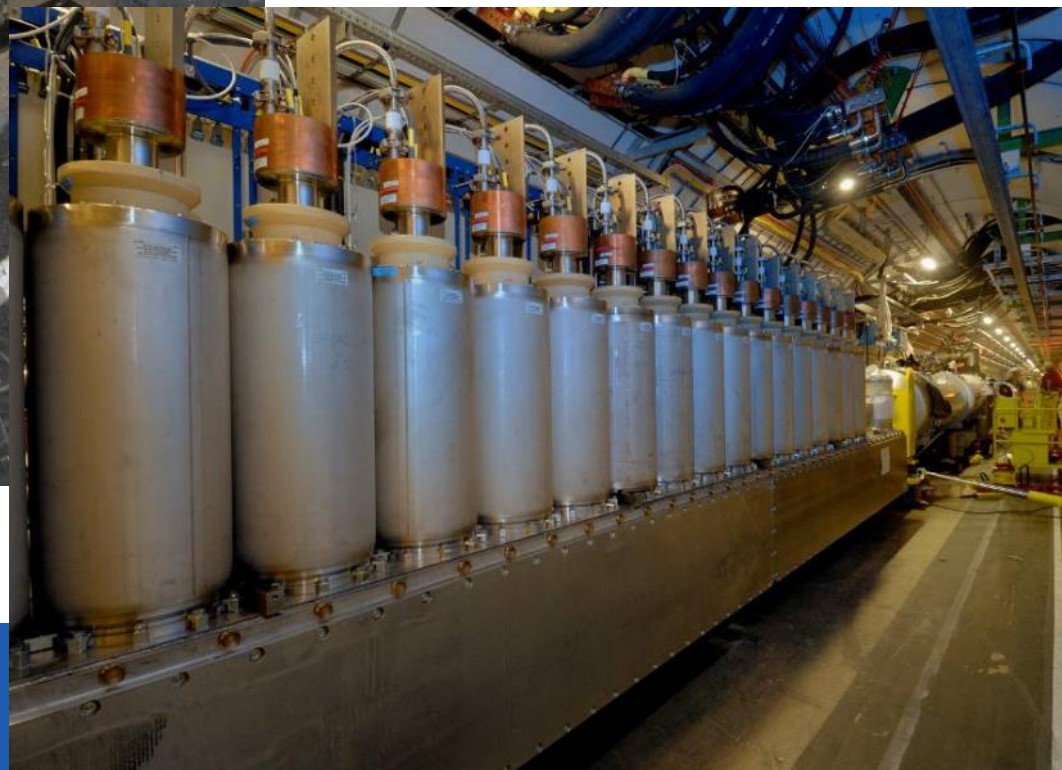


SMACC: Cryo-feedbox (DFBA) consolidation

Started



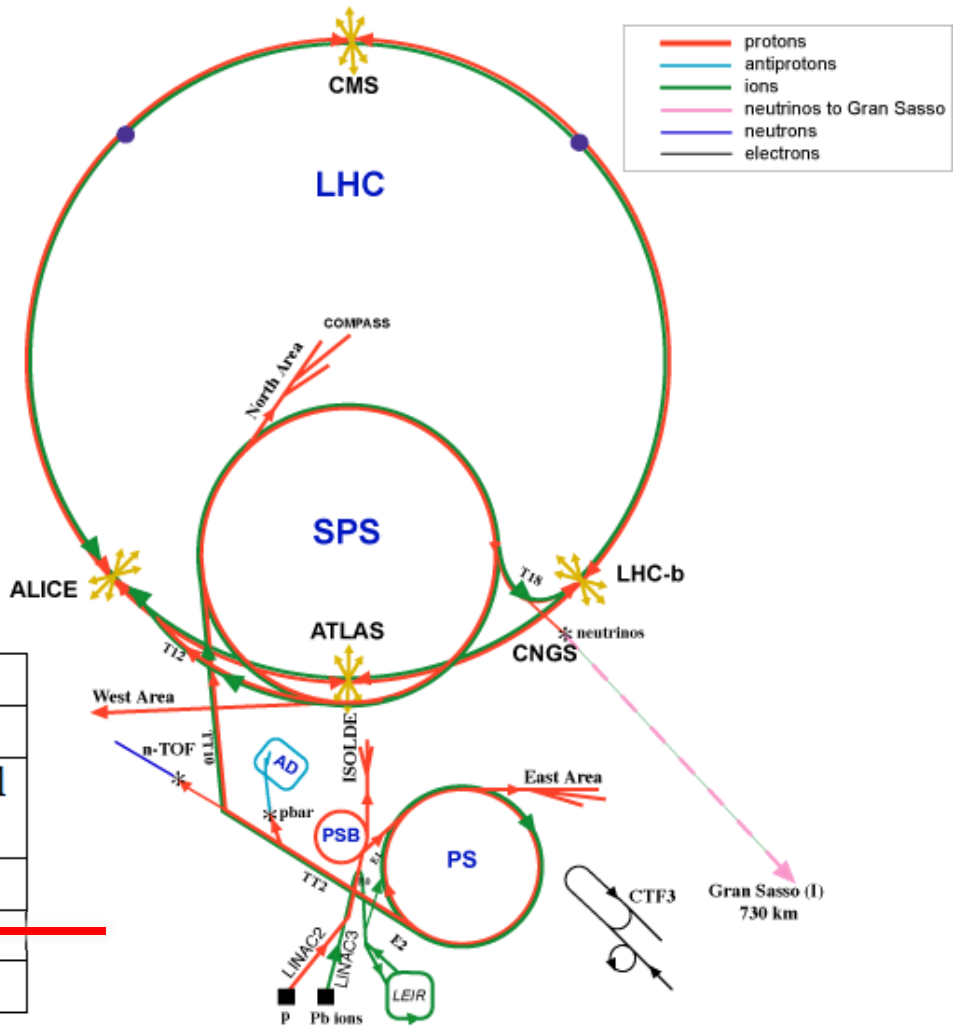
First sleeves cut
in the DFBAK HCM



The CERN accelerator complex

After more than three years of operation without the long winter shutdowns that were the norm in the past, the LHC injectors and the associated experimental areas need a full maintenance of all the equipment systems.

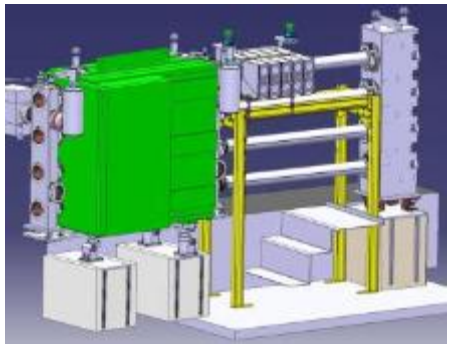
Priority	
P0	safety
P1	the LHC operation at 7 TeV with nominal performance
P2	the reliable operation up to LS2
P3	the CERN approved projects
P4	the non-CERN approved projects



Main activities in Booster & PS

- **Full maintenance** of all the equipment
- **Installation of the new access systems**
- **Cooling and ventilation renovation**
- **Upgrade of the RF systems**
- Improve the **radiation shielding** over the PS and Septum 16
- Renovation of the PS vacuum control system
- Installation of interlocks
- ….

Goward road shielding



PSB - New wide band system of RF power Courtesy M. Paoluzzi

Access test plateform Courtesy P. Ninin

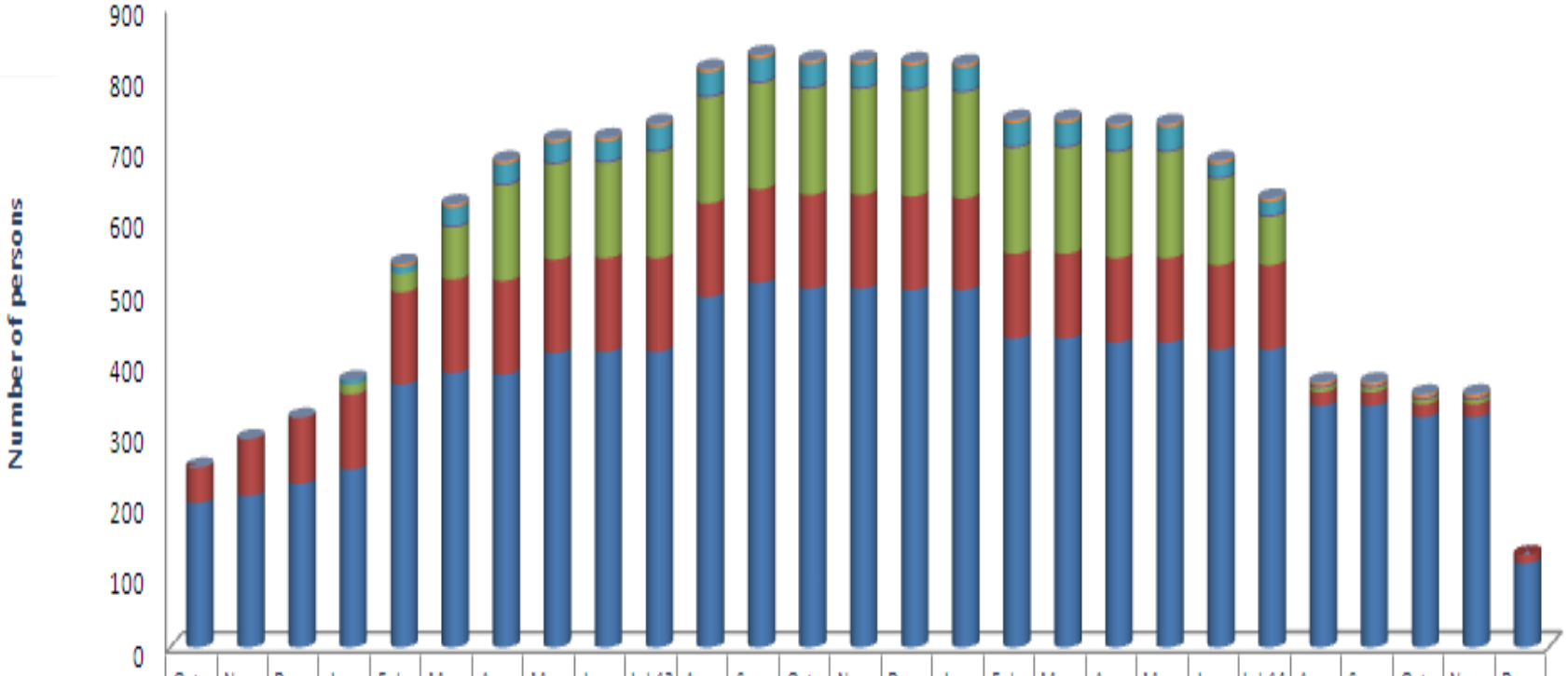
Main activities in SPS

- **Full maintenance** of all the equipment
- Replacement of **18 kV transformers for the main power converters**
- Replacement of **irradiated cables** in BA1 and in TCC2
- Installing new Fibres systems in BA5, BA6 and BA1
- New coated magnets in BA5
- Major consolidation of the valves **– CV**
- Vertical realignment in BA6

Magnet exchange in SPS
Courtesy J. Bauche

SPS irradiated cables
Courtes: D. Ricci

Overall additional number of persons at CERN during LS1 per status

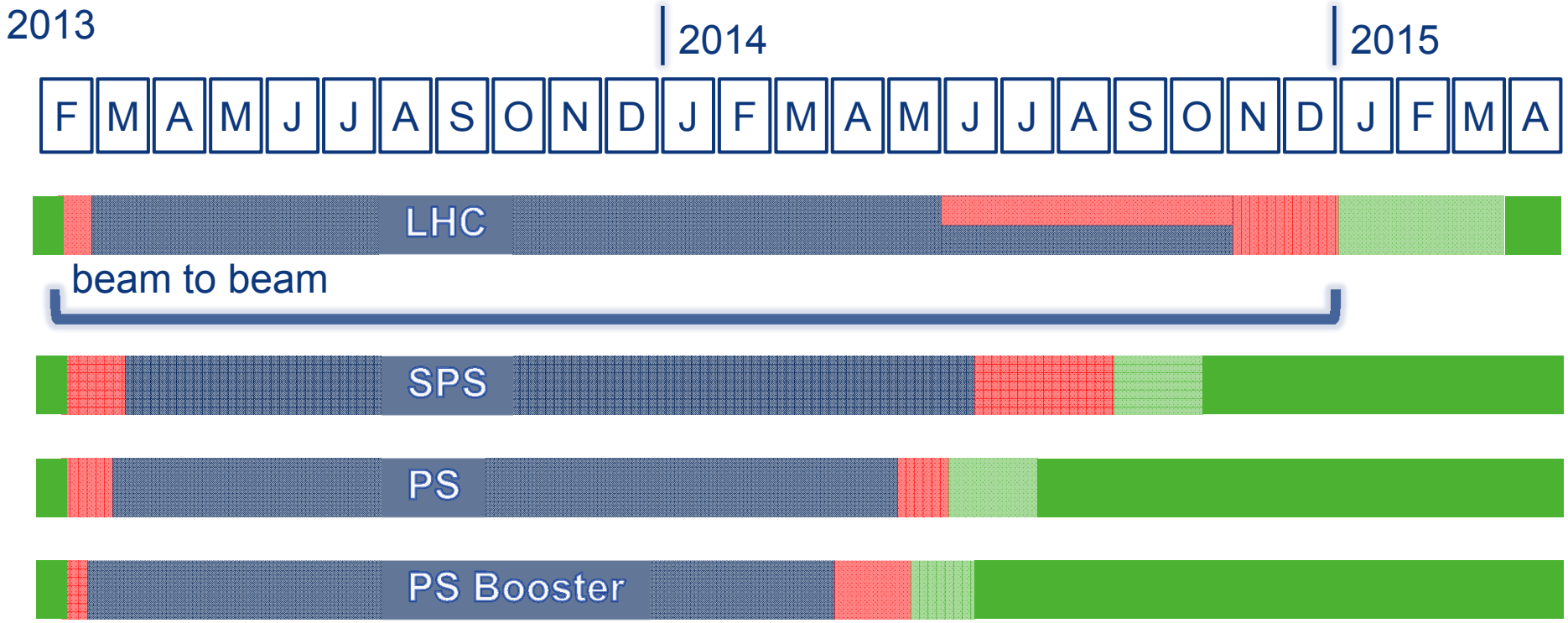


	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14
Total Other	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Total Fellow	0	0	0	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0
Total Users	0	0	0	6	10	25	27	27	27	32	32	32	32	32	32	32	32	32	32	32	18	18	0	0	0	0	0
Total Staff	0	0	0	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0
Total PJAS	0	0	0	14	26	73	134	134	134	149	149	149	149	149	149	149	149	149	149	149	121	68	6	6	6	6	0
Total FSU	50	80	93	106	130	132	132	132	132	132	132	132	132	132	132	129	119	119	119	119	119	119	19	19	18	18	12
Total Contractors	203	213	230	250	370	386	384	414	416	416	493	513	505	505	503	503	435	435	429	429	419	419	340	340	324	324	118

- Physics
- Beam commissioning
- Shutdown
- Tests

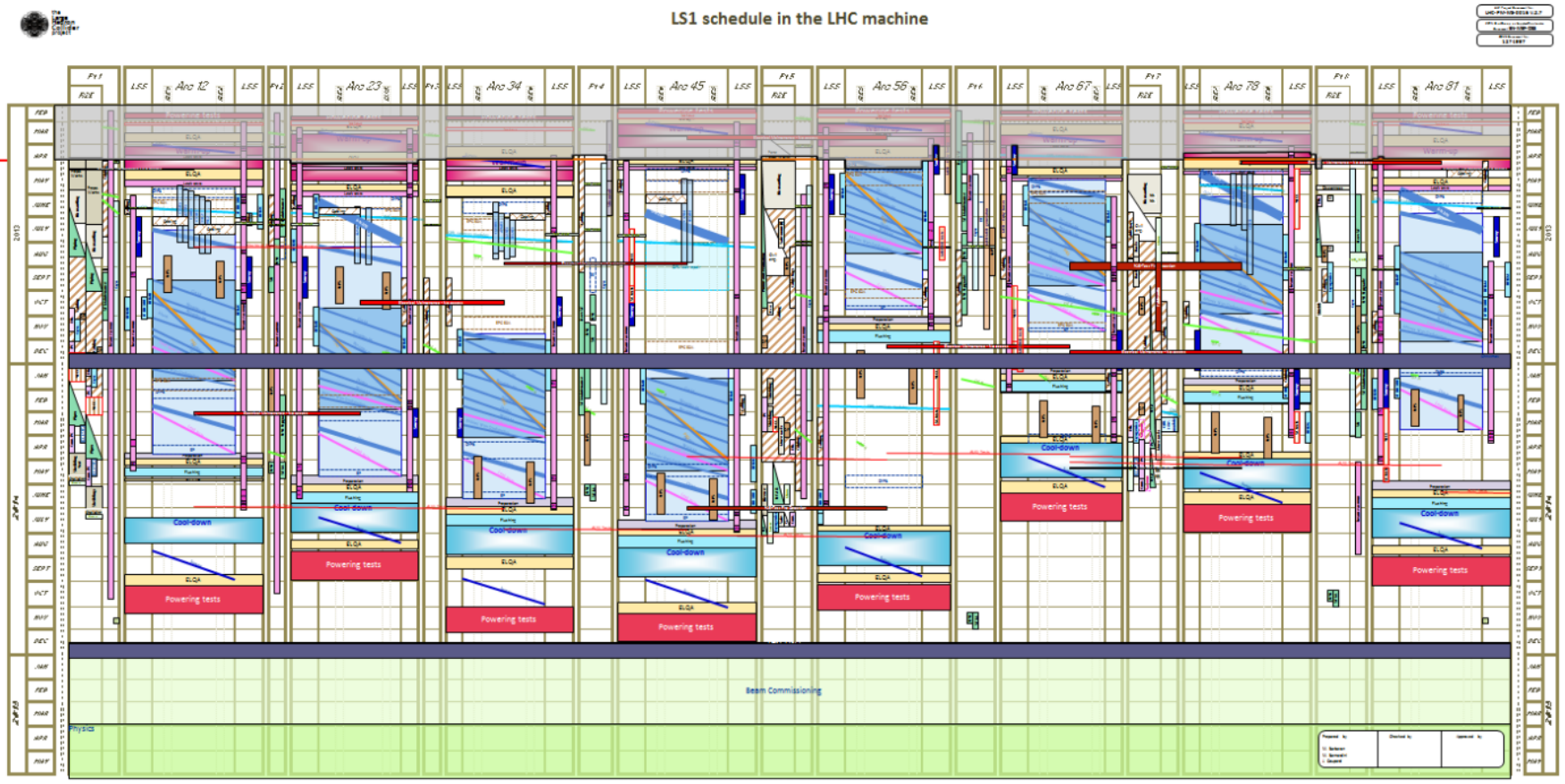
LS1

from mid February 2013 to end December 2014

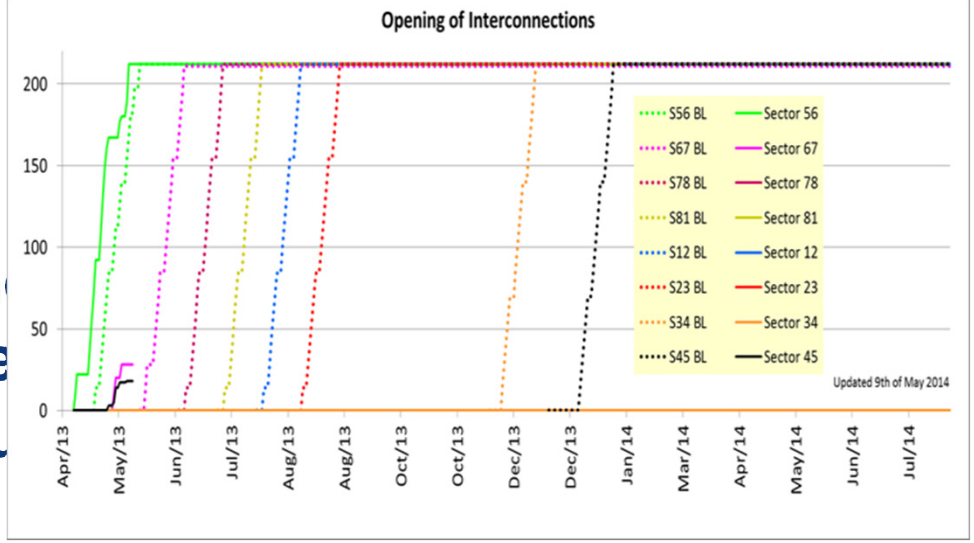


Conclusion

The main projects across the accelerator complex have now started, after the powering tests (LHC and in the injectors) and are on schedule after the first 3 months.

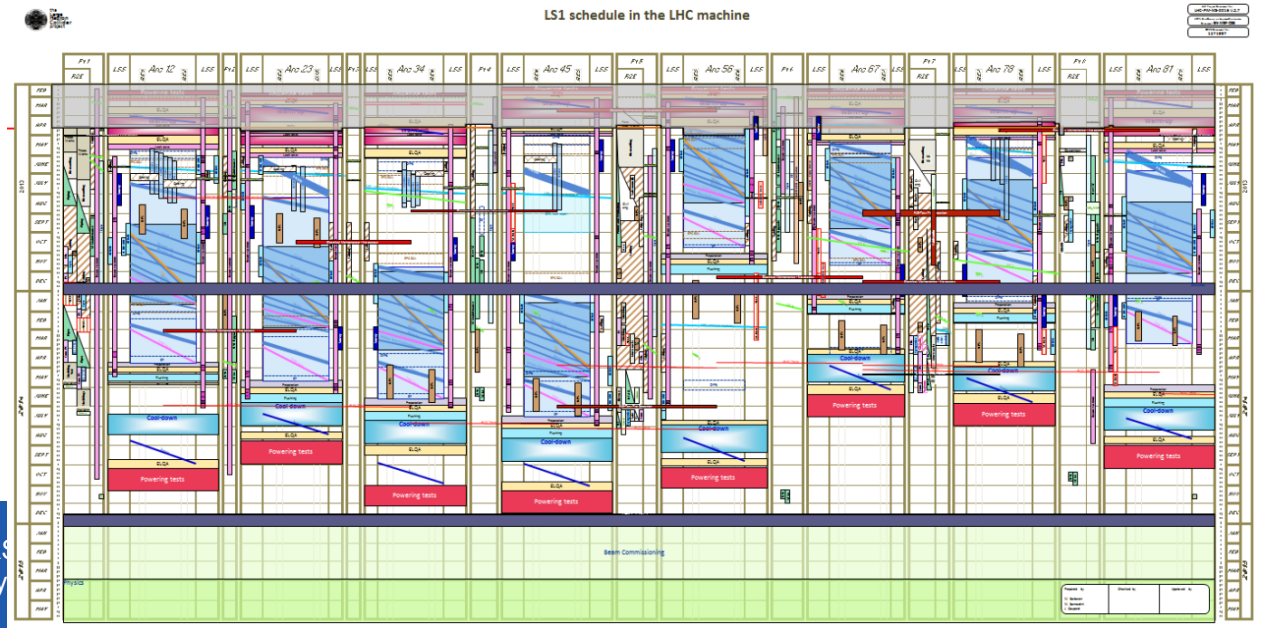


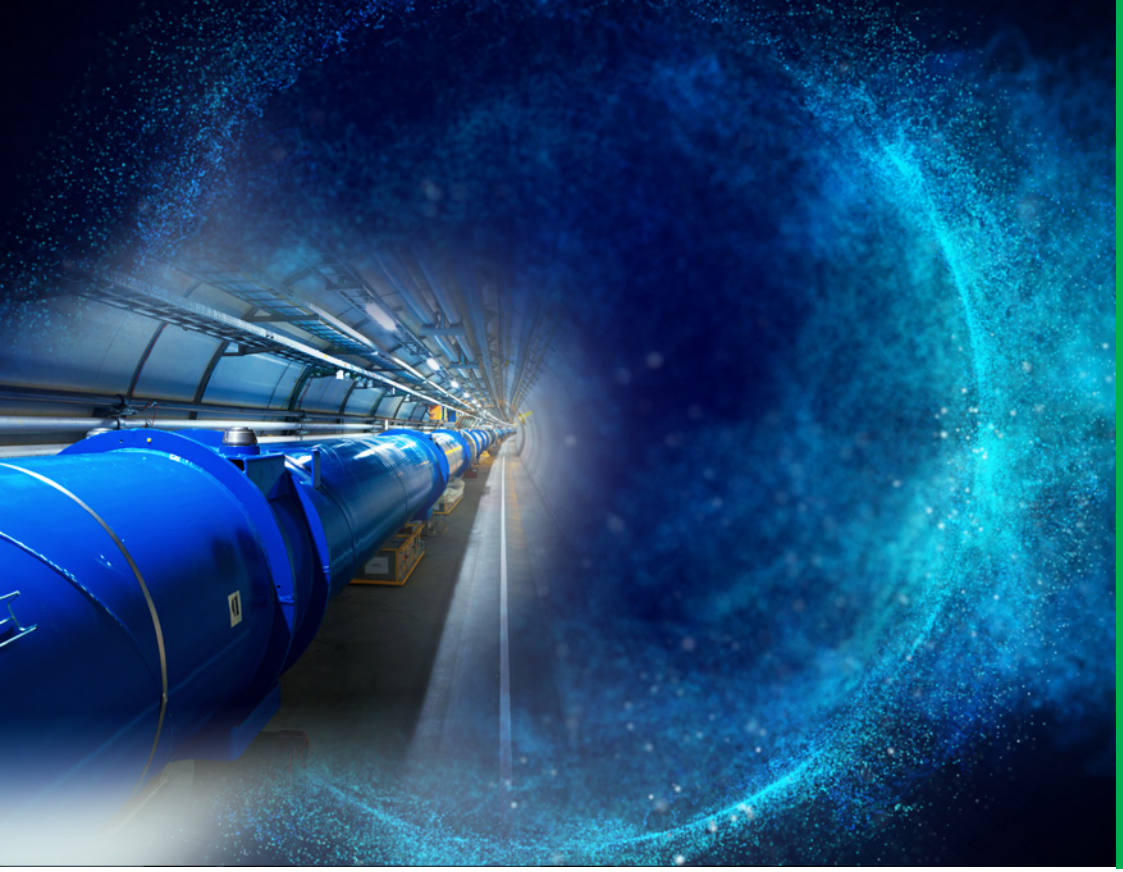
Conclusion



The main projects across th
now started, after the powe
injectors) and are on schedu

The progress of the LS1 can be followed with dashboards updated every week
http://lhcdashboard.web.cern.ch/lhcdashboard/ls1





The LS1 is a marathon and will not be all plain sailing but thanks to a solid preparation and to the dedication of numerous persons, crossing the finish line should be done by end of 2014, respecting the LS1 slogan:

1st Safety
2nd Quality
3rd Schedule

Thanks for your attention

IPAC 上海 13
The 4th International Particle Accelerator Conference
第四届国际粒子加速器会议

Shanghai China
12-17 May 2013
Shanghai International Convention Center

IPAC13