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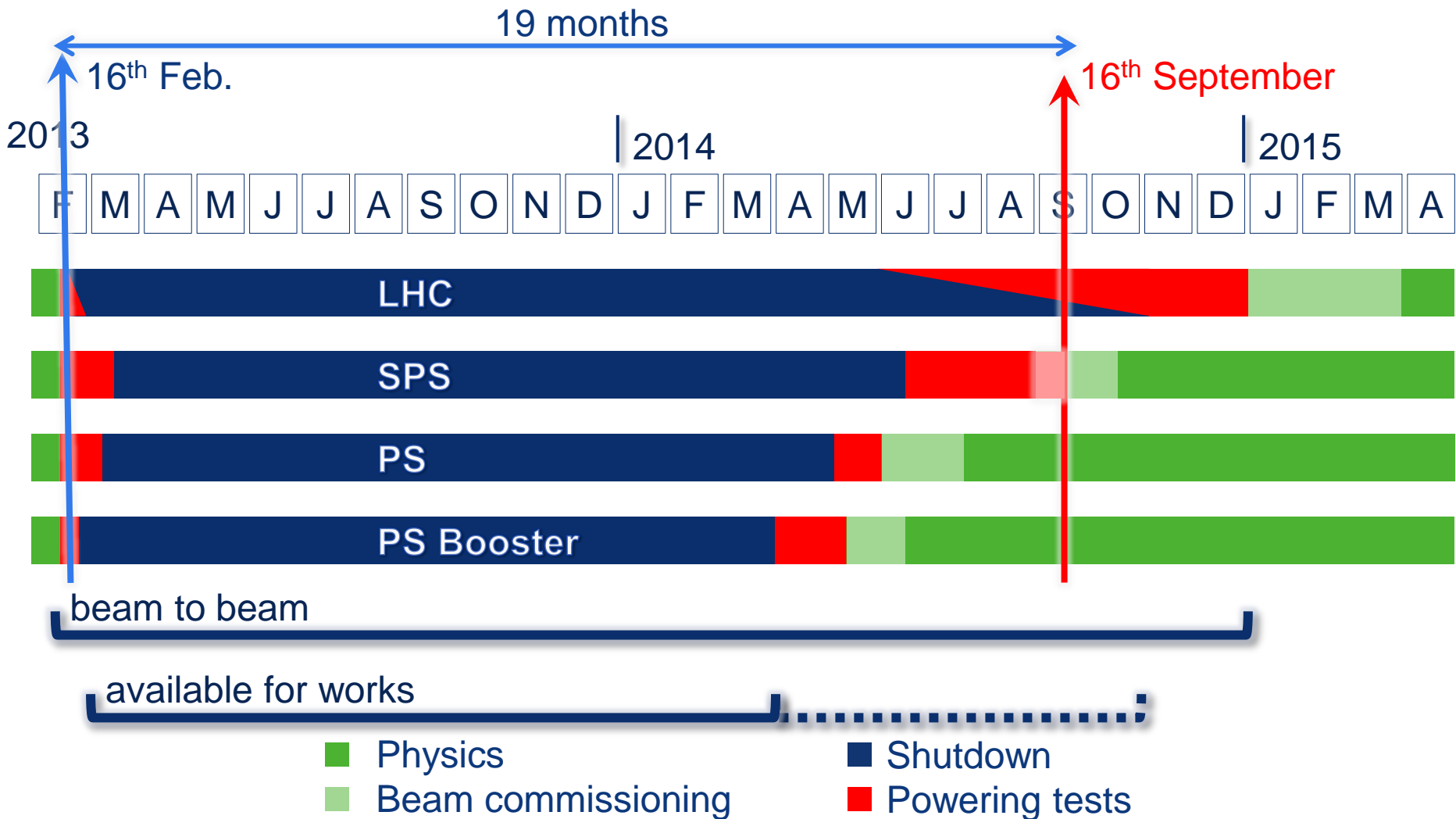
LHC Long Shutdown 1 Status

LS1@SPC (8th report)

Frédéric Bordry

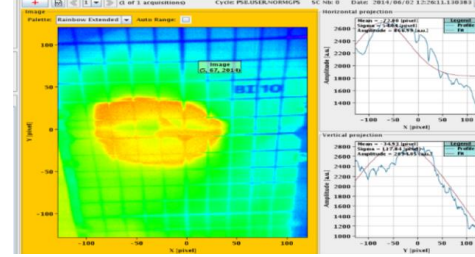
16th September 2014

LS 1 from 16th Feb. 2013 to Dec. 2014



Booster PSB start-up: Summary

- First beam in the machine rapidly
- Controls reasonably OK, issues attacked as they arose; the Control dry runs and good preparation paid off
- New Low Level RF successfully commissioned, RF specialists were working round the clock and did a great job
- Slow but steady progress, production beams to ISOLDE (24th July first beam, physics program started with 1 week delay – since then happy users),
EAST, TOF, AD now in good shape
- LHC beams in preparation.



June 2nd first beam



PS readiness after 1 year and 4 months LS1

- ▶ The PS stopped beams on Sat. 16-02-2013 @ 09:00
- ▶ LS1 for the injectors started with major changes:
 - ▶ PS Complex access and safety system changed for new
 - ▶ PS ventilation changed for new
 - ▶ Complete renovation of the low level and high level control system
 - ▶

LS1: All system fully commissioned and operational



Re-cabling



New PS Complex access control and safety system



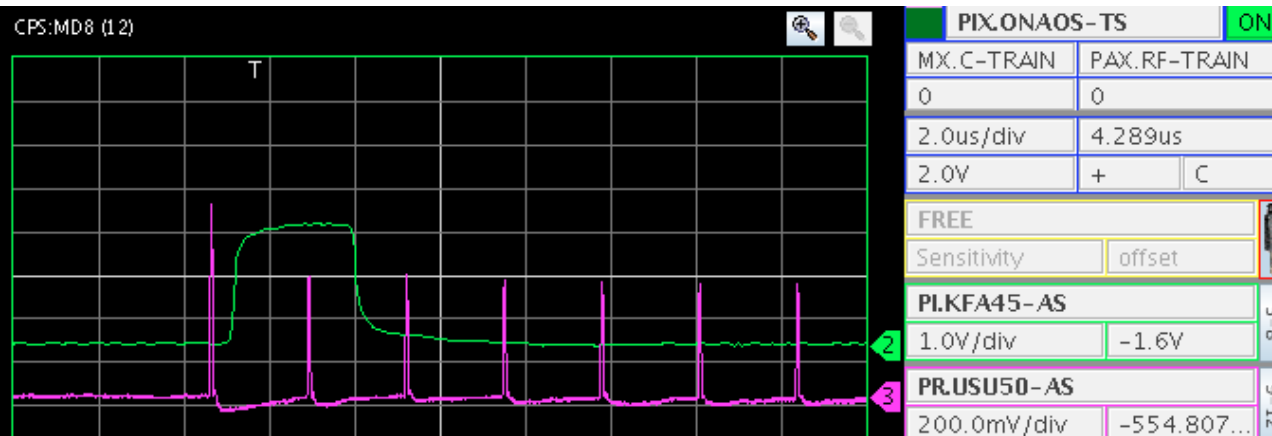
Magnet changes



New PS ventilation

PS readiness after 1 year and 4 months LS1

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 - ▶ PS Complex access and safety system changed for new
 - ▶ PS ventilation changed for new
 - ▶ Complete renovation of the low level and high level control system
 - ▶
- ▶ The first beam to the PS was planned for 20-06-2014
 - ▶ **First beam injected on 20-06-2014**, last day June council week.

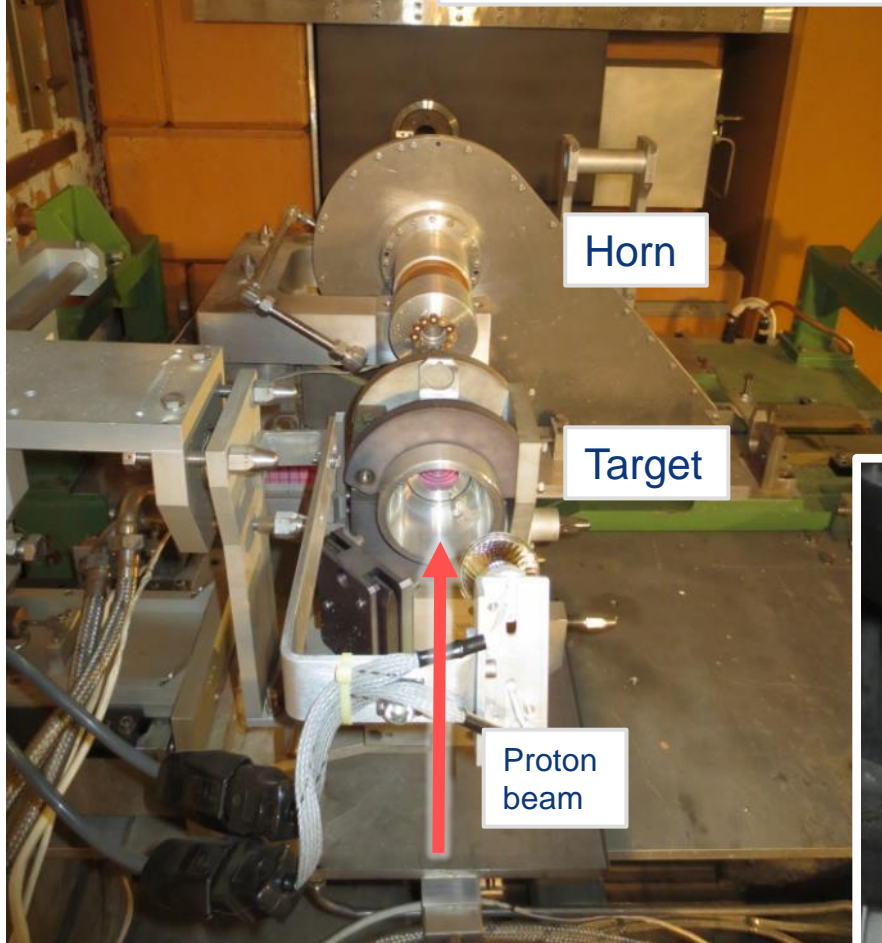


The PS injection kicker (green signal) sent the first proton bunch into the accelerator for thousands of turns. Beam position monitors see the bunch every time it completes one turn (purple signal).

PS Physics has started

- **nTOF planned for 15-07-2014**
 - Slightly delayed start for EAR2 installation work
 - **First beam on target 25-07-2014**
 - Since, physics during night and weekends and continuation of installation during daytime.
- **East Area planned for 15-07-2014**
 - **First beam on 15-07-2014, physics start on 16-07-2014**
- **AD beam**
 - In March 2014, beam on target delayed by 3 weeks due to Horn strip line problem new optimistic date for beam on target 01-08-2014
 - **First beam delivered on target 05-08-2014**

Target and horn in beam position



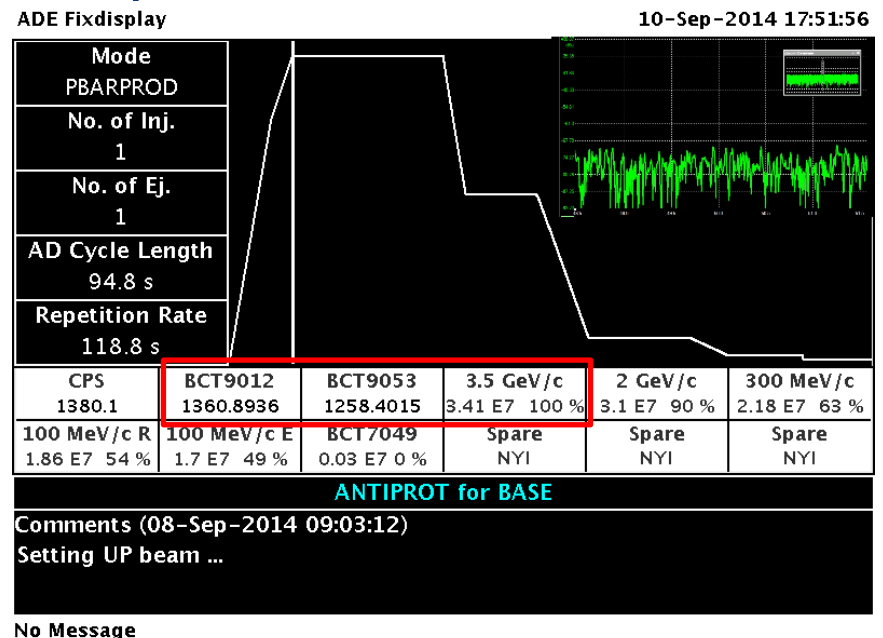
New clamping system and stripline in beam position



Antiproton fluence feedback

- Production of p-bars is **within ~10%** similar to what we had prior to the horn problem
 - $\sim 2.6 \cdot 10^{-6}$ p-/p⁺**
- Installed equipment is working fine!**
- Further optimization of the beam on target position and of the magnet tuning still required

**AD physics
on 16 Sept. 2014**

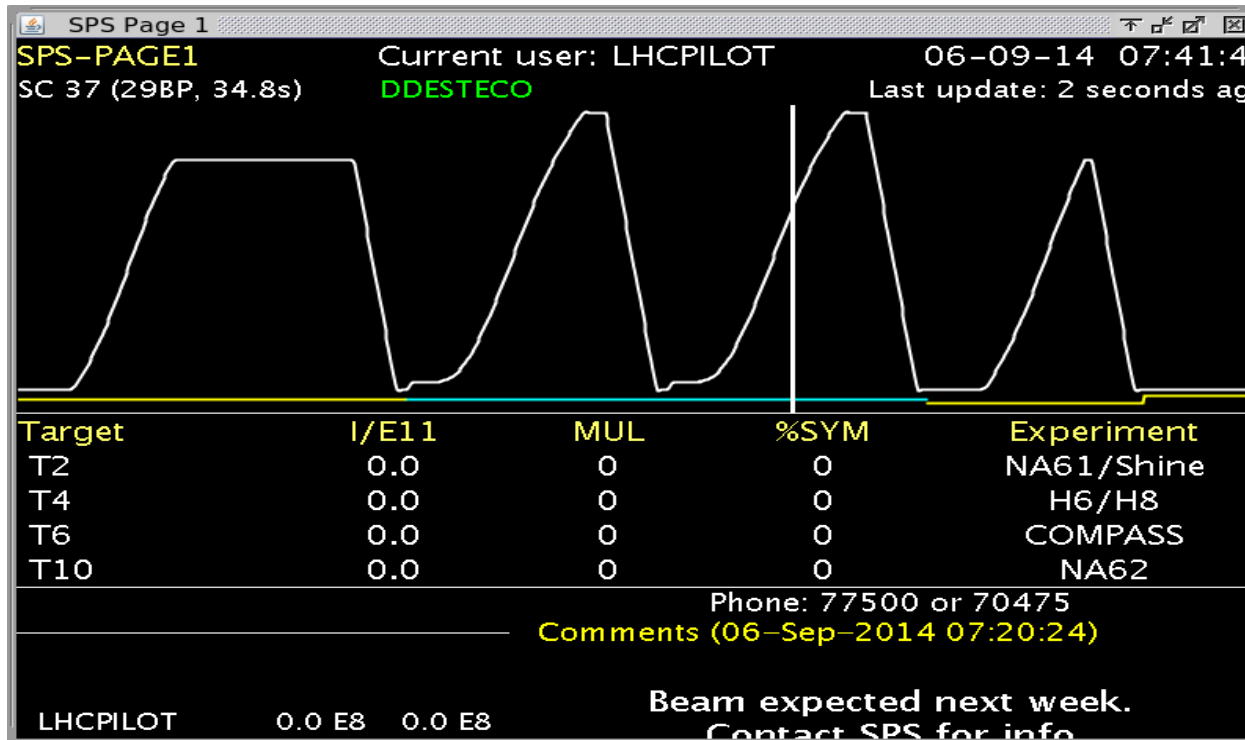


PS Physics has started

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- **AD beam**
 - In March 2014, beam on target delayed by 3 weeks due to Horn strip line problem new optimistic date for beam on target 01-08-2014
 - **First beam delivered on target 05-08-2014, physics start on 16-09-14**
- **Ion beam in preparation for 2015 run planed for 25-08-14**
 - **Argon Ions were successfully injected, accelerated and extracted from PS on 26-08-2014**

SPS preparing for start up with beam after LS1

- ▶ Final tests on the main dipole and main quadrupole circuits (new power transformers and new thyristor stacks)
- ▶ SPS is starting up with new power converter controls
 - ▶ FGC (Function Generator Controller) control for SPS converters like in the LHC
 - ▶ Will allow for much more flexibility and more effective economy cycles to save energy if beam is not requested



SPS Page 1 – the main dipole circuit

SPS: start-up with beam more-or-less on schedule

Beam was foreseen for Monday 8th September,

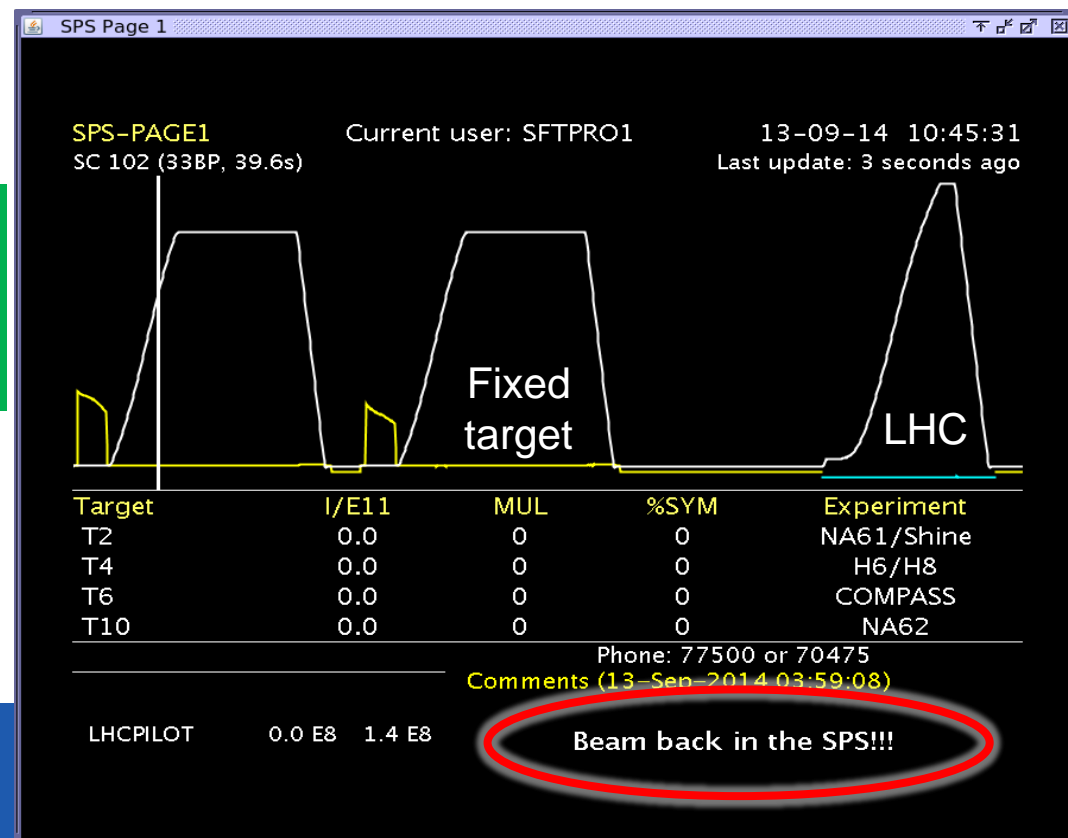
Despite...

- Conditioning of injection and dump kickers which took longer than foreseen after LS1
- Hardware testing of main circuits and debugging of converter software issues after updates during LS1
- Water leak on water cooled main bus bar in SPS point 3 was detected on 8th Sept.

1st beam on Saturday 13th September
Today:
Low intensity fixed target at 400 GeV/c
and LHC beams at 450 GeV/c.

North Area (start physics 6th Oct)
HiRadMat (first run 13th Oct)

LHC (2015)



The main 2013-14 LHC consolidations

Opening: 100%

1695 Openings and final reclosures of the interconnections

100 % done

Complete reconstruction of 3000 of these splices

100 % done

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

100 % done

Installation of 5000 consolidated electrical insulation systems

100 % done

300 000 electrical resistance measurements

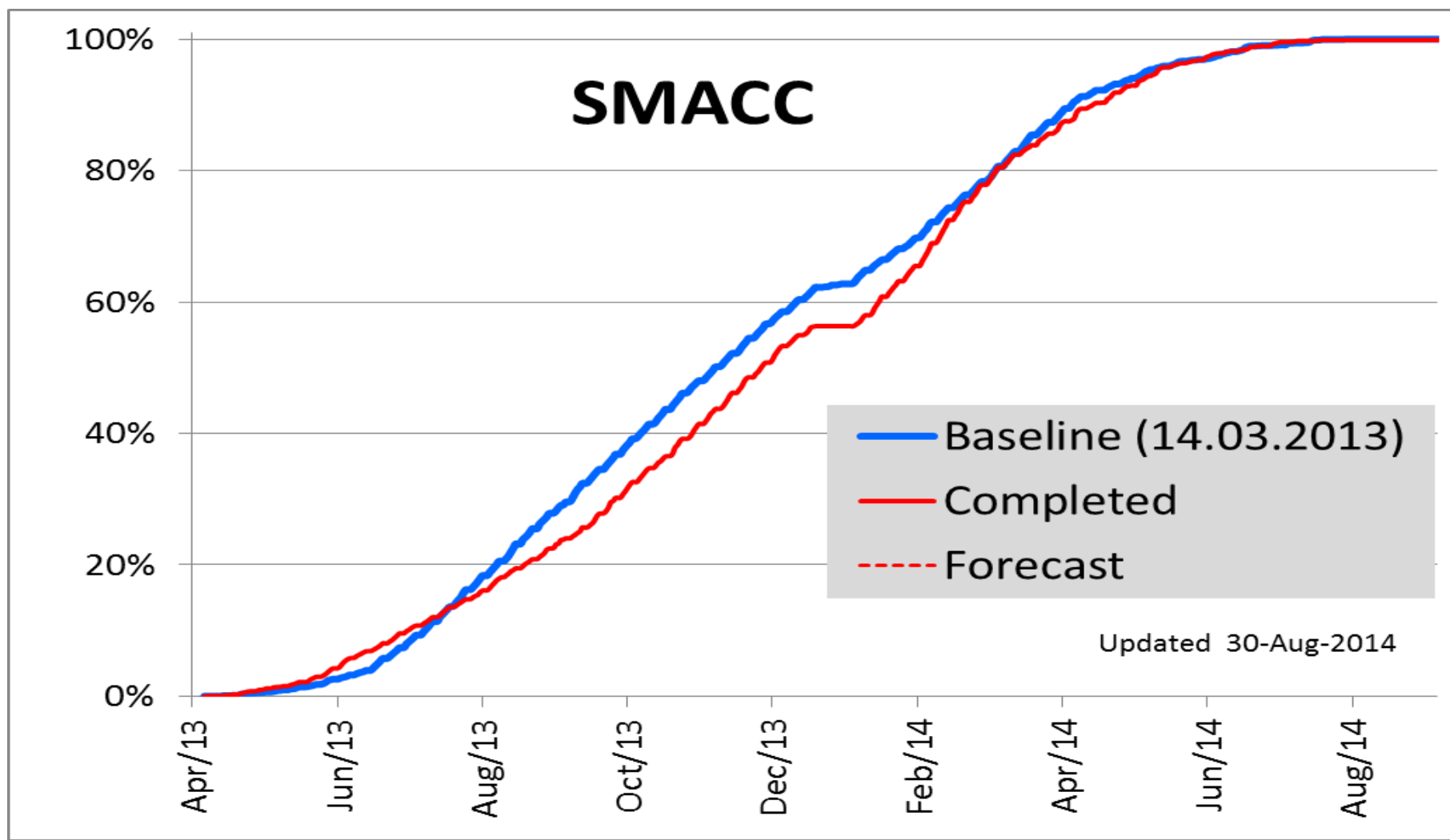
100 % done

10170 orbital welding of stainless steel lines

Closure: 100%



LHC Superconducting Magnets And Circuits Consolidation Dashboard



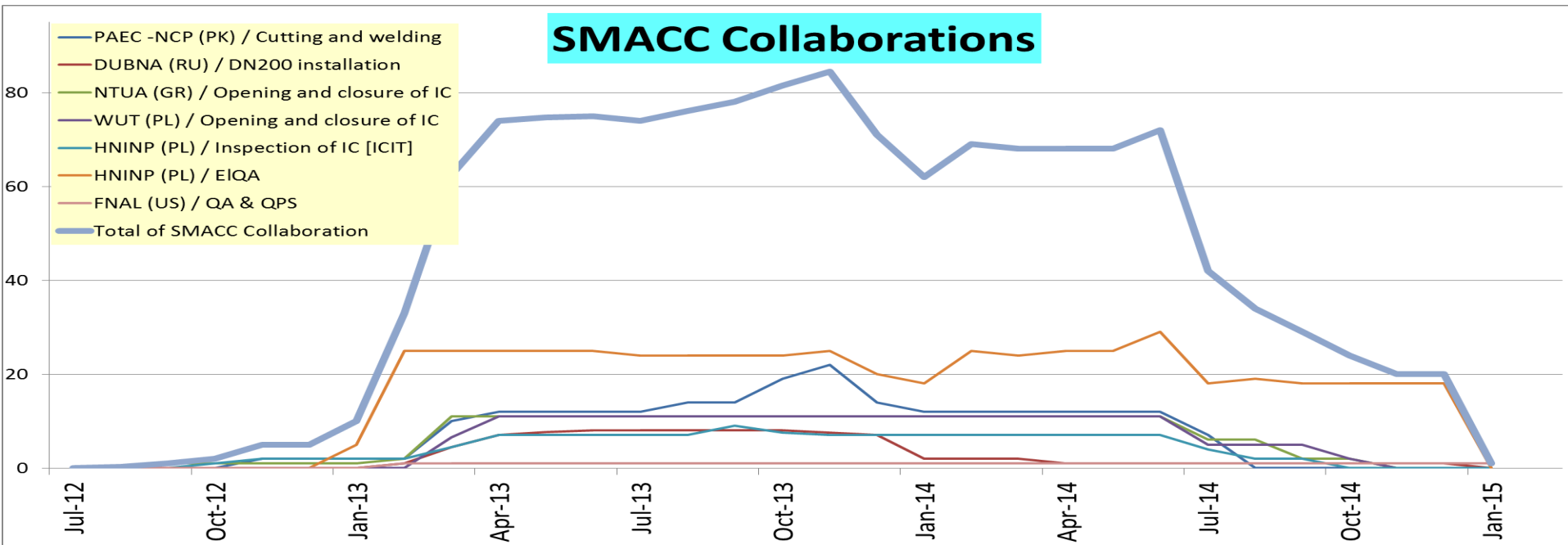


**Closure Nb1695
the last one!
18th June 2014**



NTUA (GR), HNINP, WUT (PL), DUBNA (RU)

LHC SMACC: Ramping down collaboration agreements

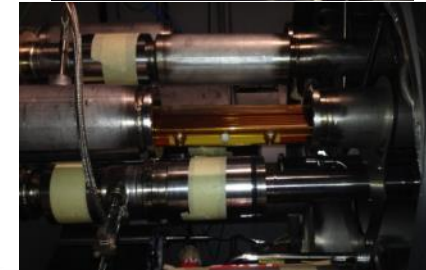


PAEC-NCP (PK)



NTUA (GR), HNINP, WUT (PL), DUBNA (RU)

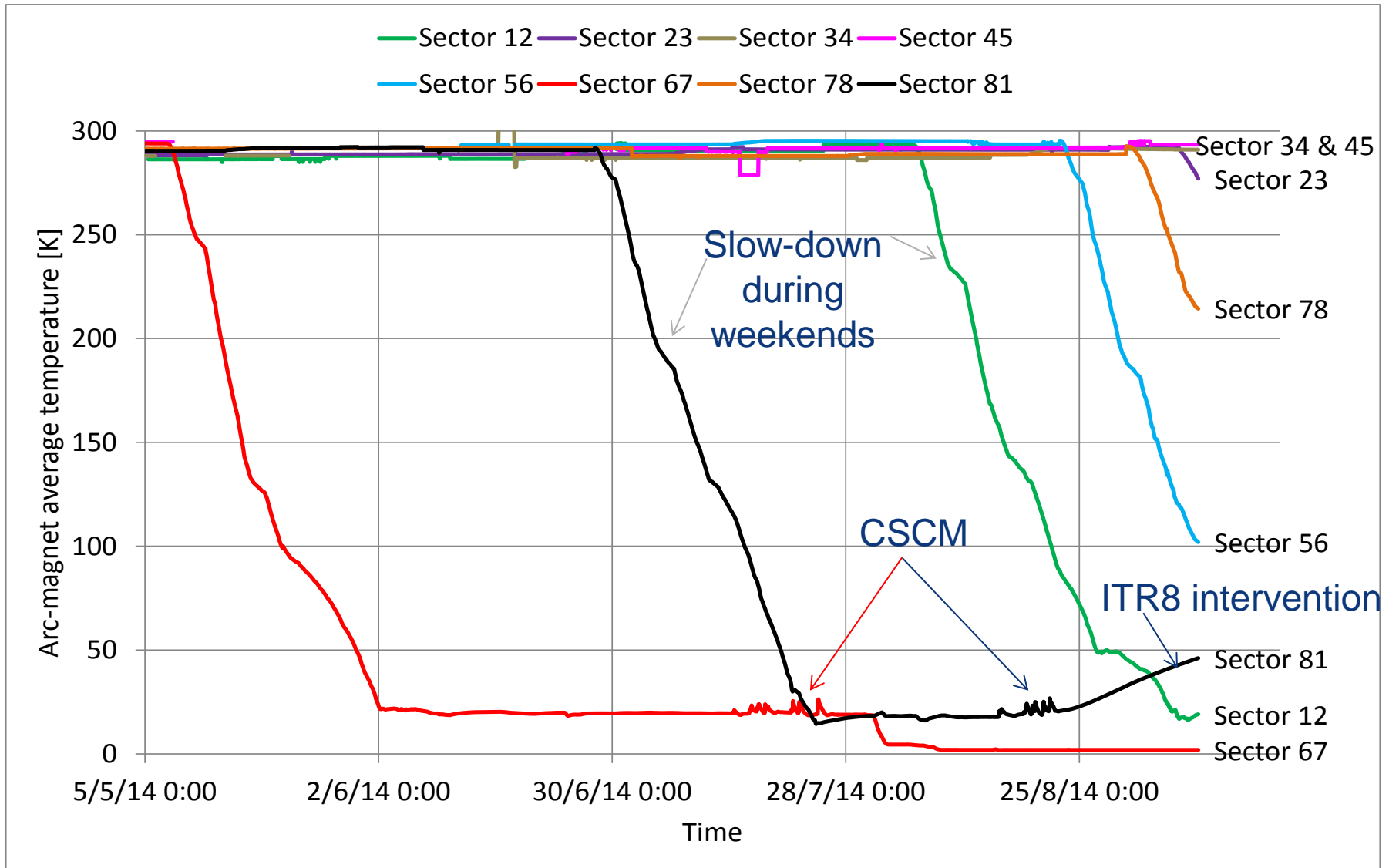
Some numbers of SMACC



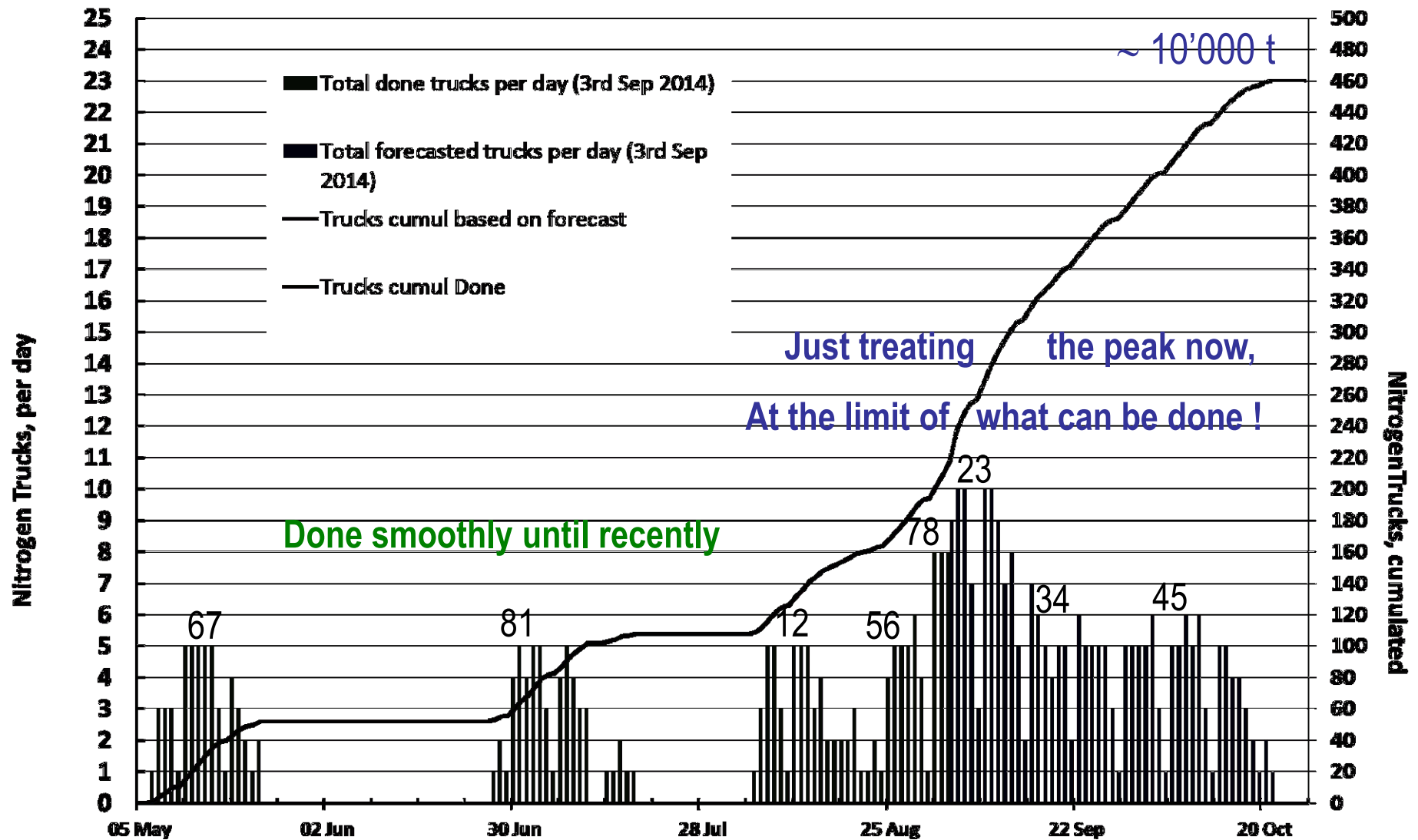
- 1 000 000 working hours, counting preparation
- > 1695 openings and reclosures
- > 3000 splices completely redone
- 10170 shunts installed,
(one every 3 working minute)
- > 5000 insulation systems installed
- \approx 300 000 local electrical tests (EIQC)
- \approx 18 000 electrical circuit tests (EIQA)
- > 10 000 TIG welds
- > 10 000 leak tests
- 612 safety relief devices installed (DN200)
- 18 main superconducting magnets
changed (15 dipoles, 3 SSSs)



Cool-down of LHC sectors

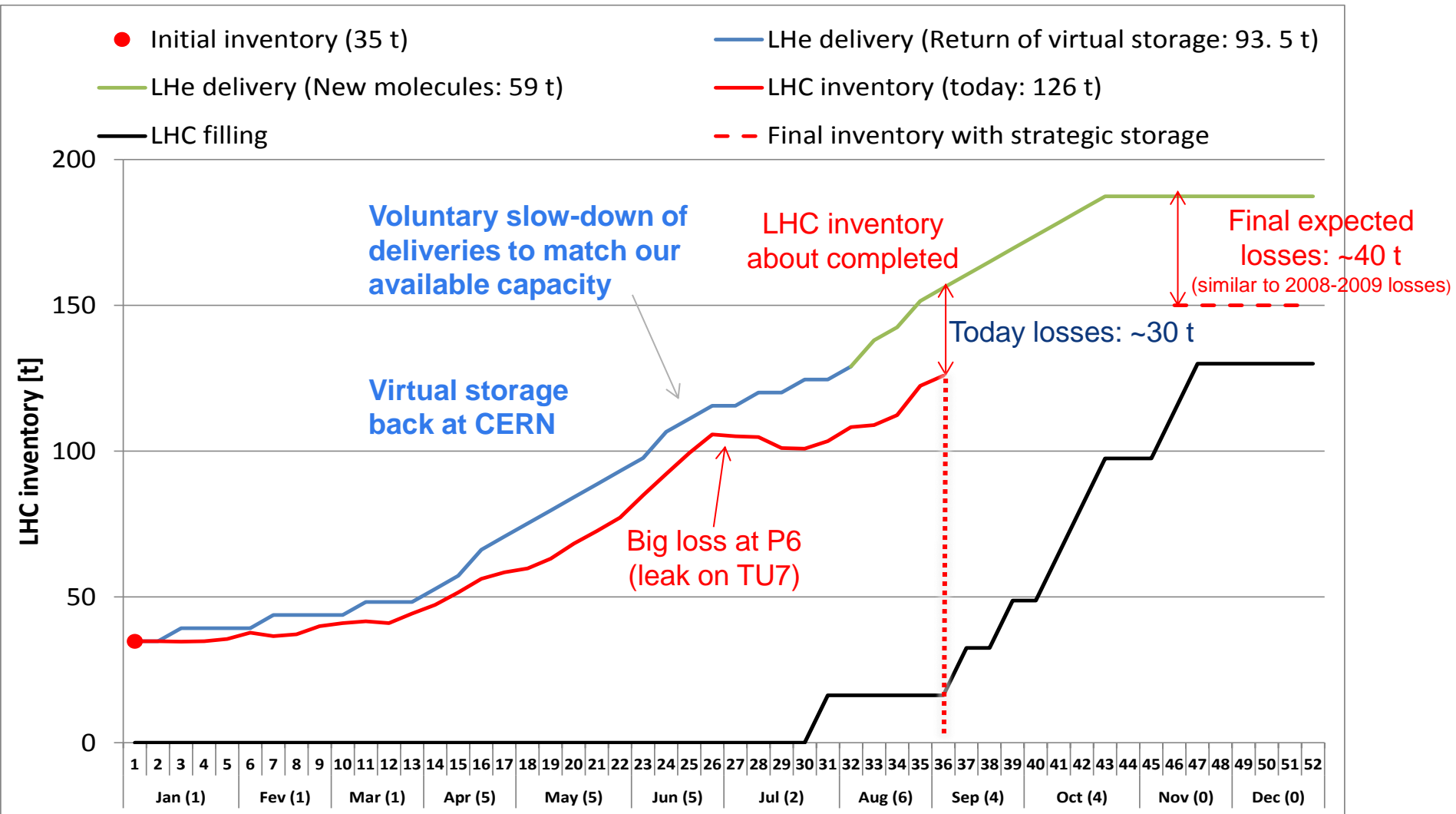


LHC and detectors cool-down: nitrogen deliveries in 2014



2014

Helium deliveries in 2014



LHC status Overview

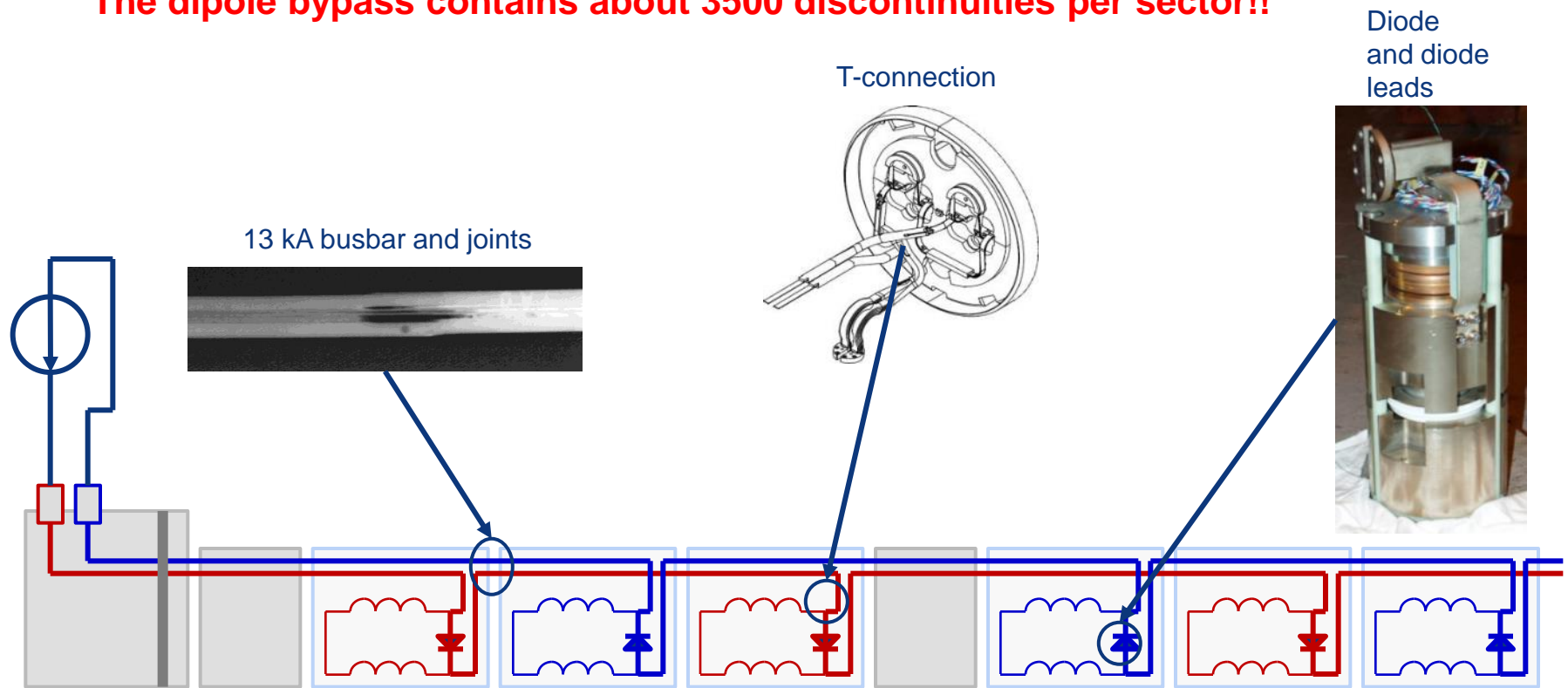
Powering tests
Start: 15-Sep-14

#	Sector	IC Closed	Final LT	Pressure Test	Flushing (end)	NC after P Test (end)	Cool-down	CSCM (end)	ElQA 1.9 K (start)	ElQA 1.9 K (end)	Powering Tests (start)
1	67	18-Nov-13	03-Dec-13	15-Jan-14	20-Feb-14	24-Mar-14	1.9 K	24-Jul-14	Done	10-Sep-14	On-going
2	81	27-Feb-14	02-Apr-14	08-Apr-14	20-May-14	10-Jun-14	55 K	22-Aug-14	30-Sep-14	17-Oct-14	17-Oct-14
3	12	02-Apr-14	05-May-14	16-May-14	27-Jun-14	16-Jul-14	20 K	26-Sep-14	13-Oct-14	31-Oct-14	03-Nov-14
5	56	07-May-14	11-Jun-14	18-Jun-14	20-Jul-14	19-Aug-14	75 K	17-Oct-14	28-Oct-14	10-Nov-14	11-Nov-14
6	78	22-Apr-14	03-Jul-14	02-Jul-14	04-Aug-14	20-Aug-14	140 K	23-Oct-14	05-Nov-14	25-Nov-14	12-Jan-15
4	23	30-Apr-14	28-May-14	05-Jun-14	11-Jul-14	26-Aug-14	190 K	30-Oct-14	17-Nov-14	02-Dec-14	03-Dec-14
7	34	20-May-14	24-Jun-14	16-Jul-14	25-Aug-14	On-going	01-Oct	14-Nov-14	26-Nov-14	09-Dec-14	10-Dec-14
8	45	18-Jun-14	04-Jul-14	31-Jul-14	03-Sep-14	On-going	30-Sep	24-Nov-14	08-Dec-14	16-Jan-15	19-Jan-15

CSCM: Copper Stabilizer Continuity Measurement

The CSCM is a test to **fully qualify** if the main dipole bypass can take over the current if the superconducting circuit quenches. A kind of dry-run of the bypass (very low energy 200 kJ and low time constant 0.2s)

Dipole bypass = copper stabiliser of the busbar + diode + diode leads
The dipole bypass contains about 3500 discontinuities per sector!!

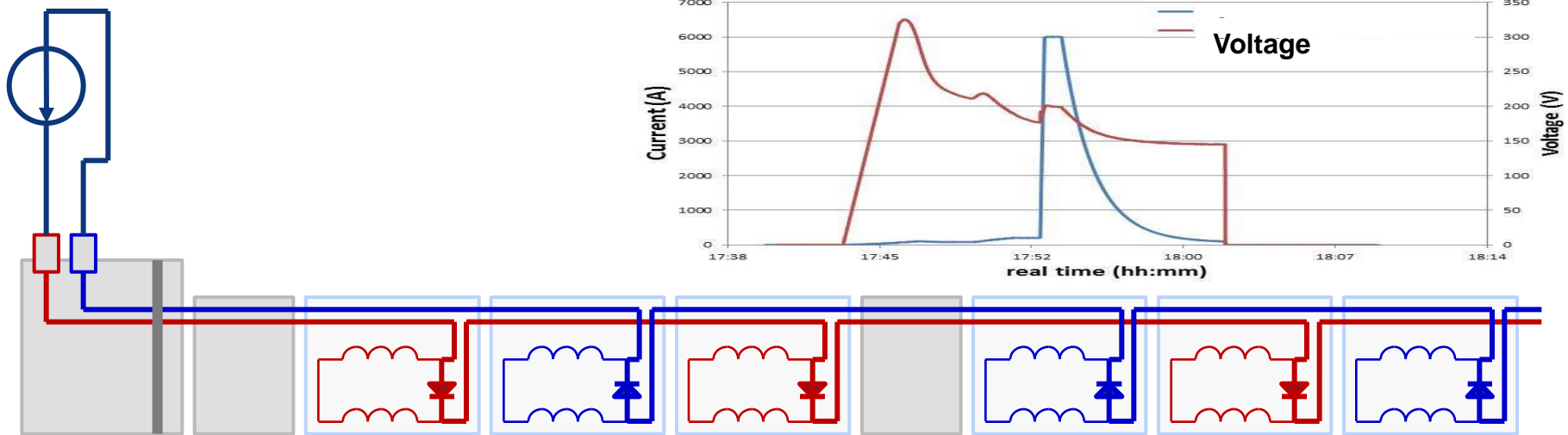


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Basic idea

- Stabilize the entire sector at around 20 K, so the magnets and bus are not superconducting. Keep the DFB at 4.5 K.
- Connect the two 6 kA/200 V power converters in series (\Rightarrow 400V)
- Put a current pulse of maximum 11 kA, $\tau=100$ s

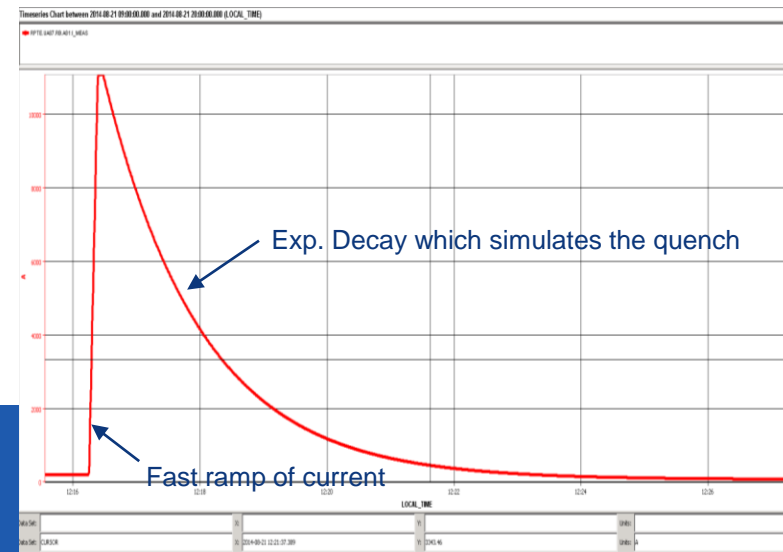


CSCM test in 6-7 and in 8-1

- ❑ The CSCM tests in sector 6-7 and 8-1 were successful:
 - ❑ Maximum pressure is small (<9 bar)
 - ❑ Temperature homogeneity along the sector is good (± 3 K)
 - ❑ Temperature recovery after a run as expected (10-20 hrs)
 - ❑ Bus signals as expected (RRR of 160-220, resistances after test equal to resistances before the test, consistent signals from run to run)
 - ❑ Diode and diode leads signals as expected, with a few anomalies, which do - although not really understood – not cause any significant temperature increase
- ❑ **The RB bypass, including its 3500 discontinuities, has now been fully qualified for 6.5 TeV operation in sector 6-7 and 8-1.**

**CSCM test will be done
in the 6 other sectors.**

Next sector is sector 1-2 in September.



Safety in LS1 “Safety First, Quality Second, Schedule Third”

LS1 Accidents 2014 (until Sept.)

Facility	Total	Minor	With days of absence	Total days**
PS	1	-	1	6
SPS	4	3	1	3
LHC	10	6	4	66
Surface	16	12	4	17
Experiments*	2	1	1	6
Total	33	22	11	98

LS1 in 2013: 20 175

Statistical Indicators until September 2014

- ▶ approximately 1.5 million hours of LS1 work delivered
- ▶ 22 minor accidents (no absence)
- ▶ 11 accidents with 98 days of absence

LS1 (2014 until Sept.)
Frequency rate : 7.3
Severity rate : 0.07

LS1 (2013)
Frequency rate : 9.1
Severity rate : 0.08

Safety in LS1 : Accidents 2014 (until Sept)

Description	All	Minor	With days of absence	Days of absence
Moving objects, manual handling	11	5	6	53
Falls of persons	3	2	1	29
Handheld tools	6	4	1	9
Struck by moving objects or particles	5	4	1	6
Striking against stationary objects, strenuous movements	6	5	1	1
Fixed tooling machines	1	1	-	-
Exposure to chemical products	1	1	-	-
Total	33	22	11	98

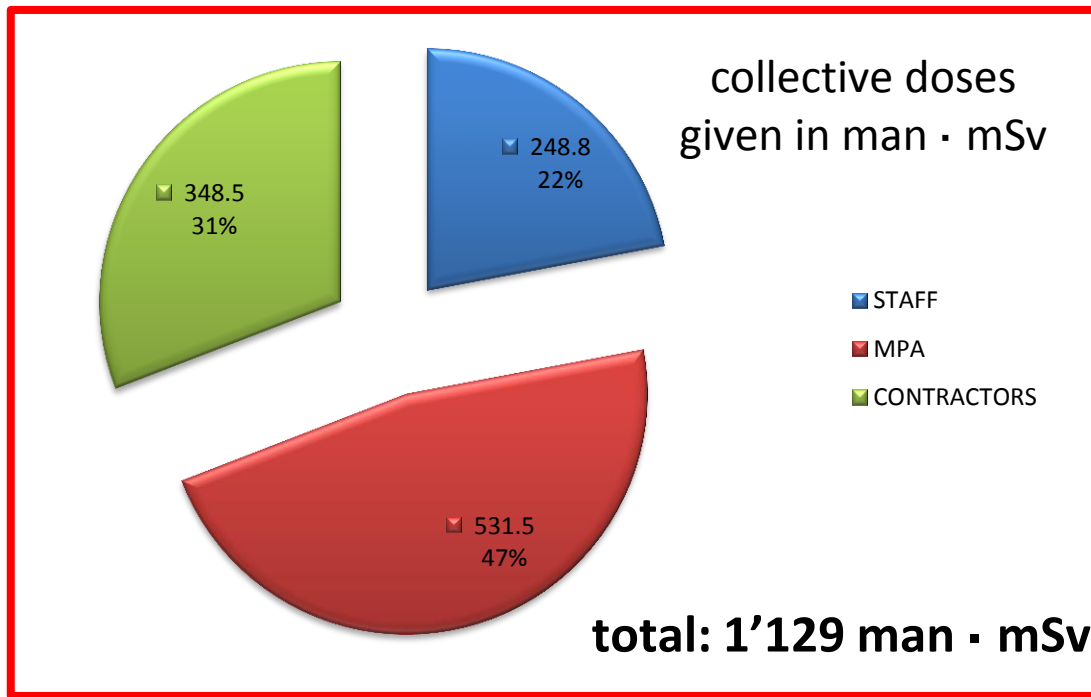
LS1 Personal Dosimetry

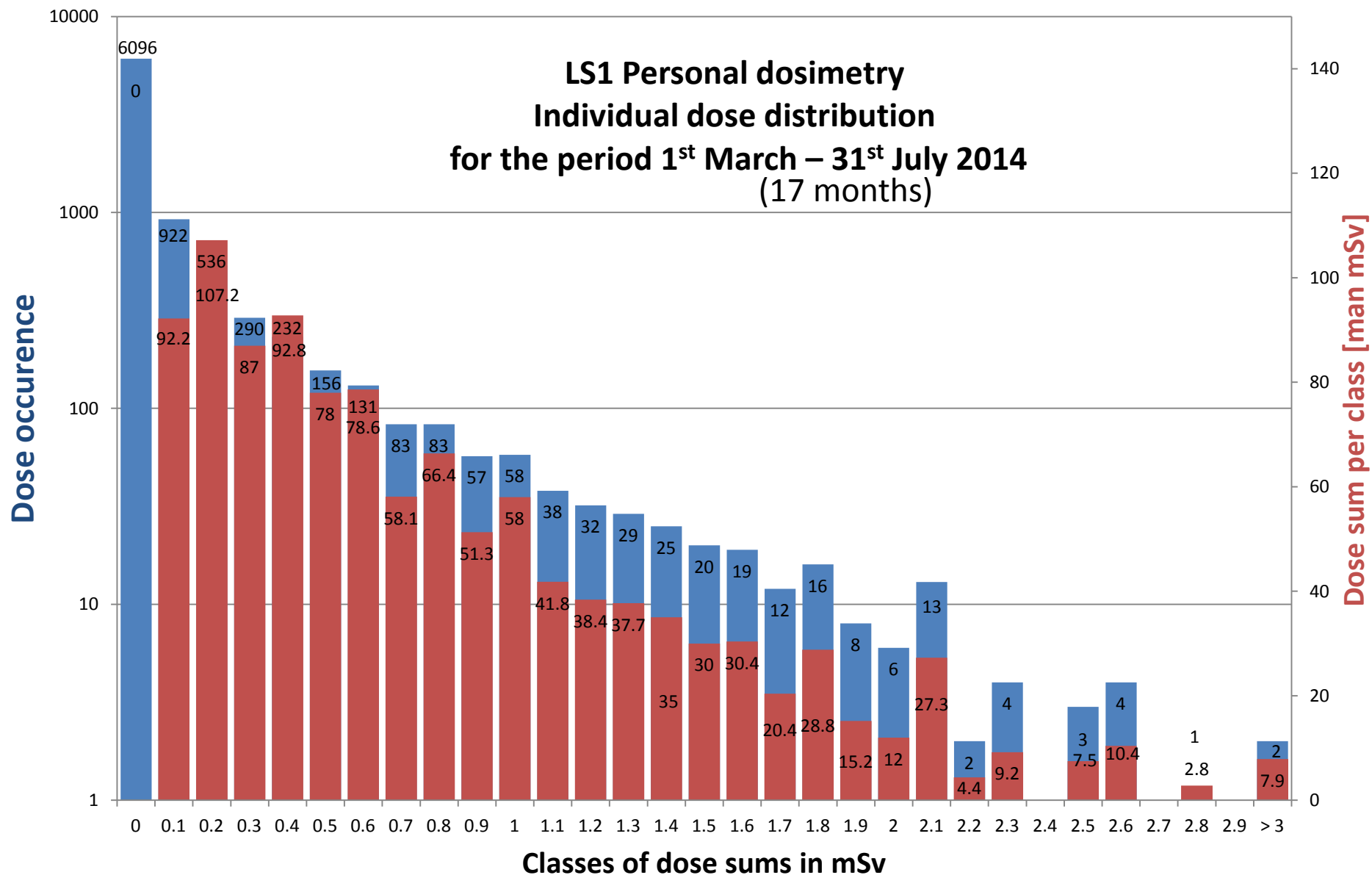
Collective dose for the period **1st of March 2013 – 31st of July 2014**

- **presently 5977 DIS dosimeters in use at CERN**
- **maximum individual dose during LS1: 4.2 mSv (PS/SPS vacuum interventions – 17 months)**
- **only two persons with dose above 3mSv/y (3.4 and 3.1)**
(CERN's dose objective: < 3mSv/y)



DIS Personal Dosimeter
(passive)





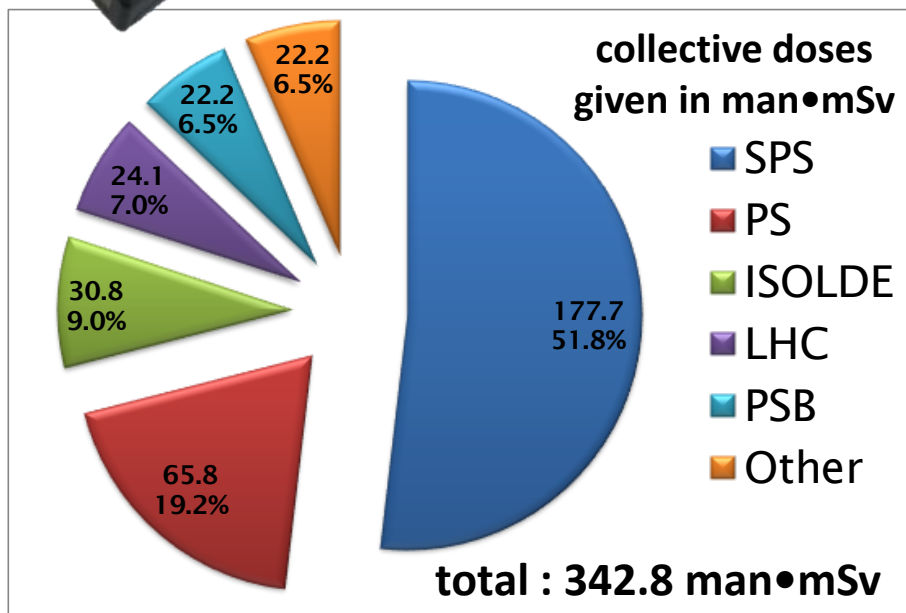
LS1 Operational Dosimetry

Collective dose for the period 18 February 2013 – 31 May 2014

- obligatory for all work in **Limited Stay and High Radiation Areas**
- use in other Radiation Areas as function of job and dose planning
- **presently 1323 DMCs in use**



DMC Operational
Dosimeter
(active with alarm function)



Main contributors:

SPS

- All BA1 activities: 97.5 man.mSv
- All BA80 activities: 33.2 man.mSv
- Survey activities (in other places): 17.5 man.mSv
- Cabling activities (in other places): 11.8 man.mSv

PS

- Magnet activities: 23.8 man.mSv
- Ventilation exchange: 13.7 man.mSv
- Cabling interventions: 8.3 man.mSv

PSB

- Cabling interventions: 4.7 man.mSv
- Septa: 4.6 man.mSv
- Dump removal: 1.4 man.mSv

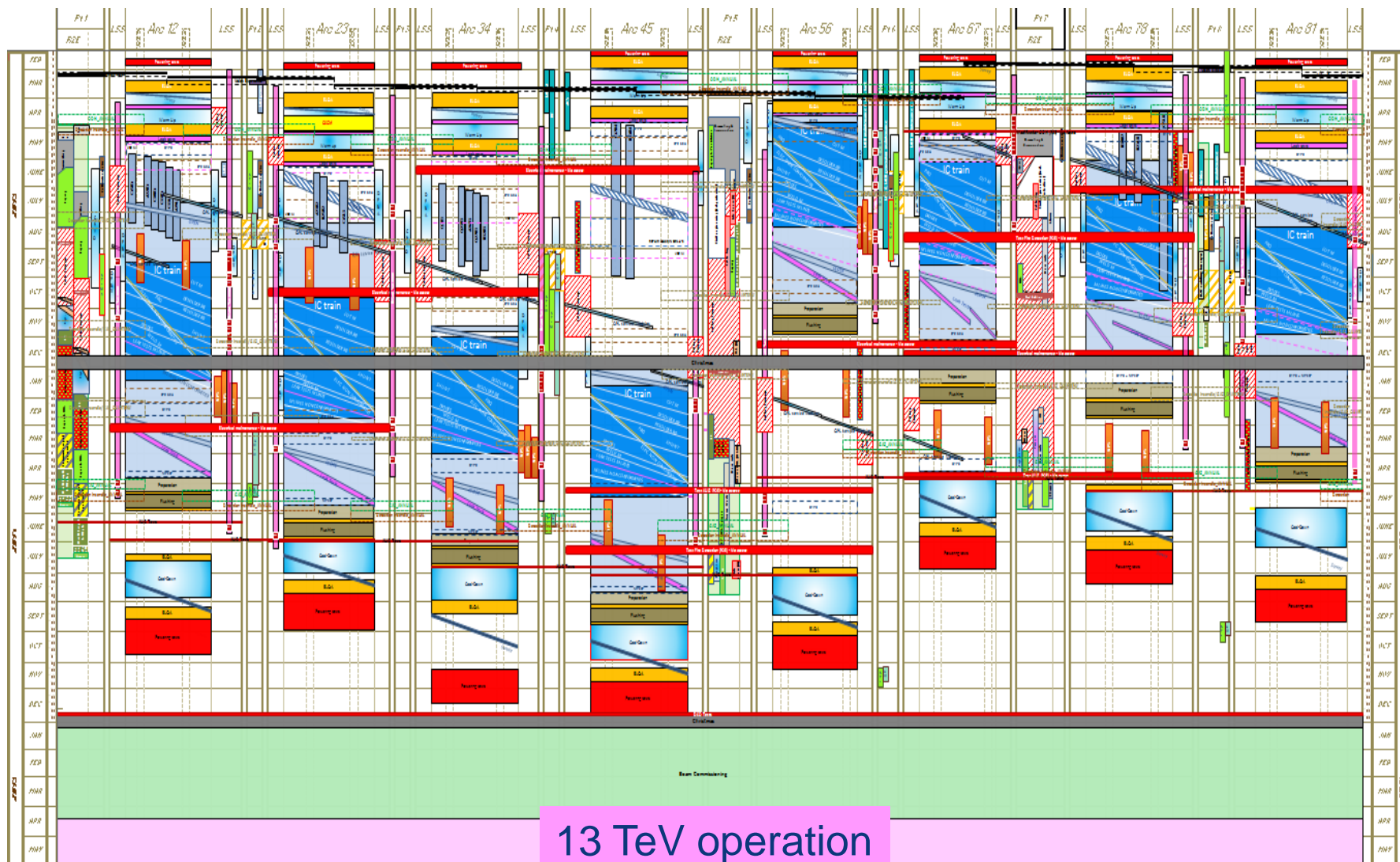
LHC

- Vacuum interventions: 10.4 man.mSv
- Cabling: 3.9 man.mSv
- Survey: 3.7 man.mSv

ISOLDE

- Robots exchange: 13.4 man.mSv
- GPS/HRS works: 4.7 man.mSv
- MEDICIS installation: 2.8 man.mSv

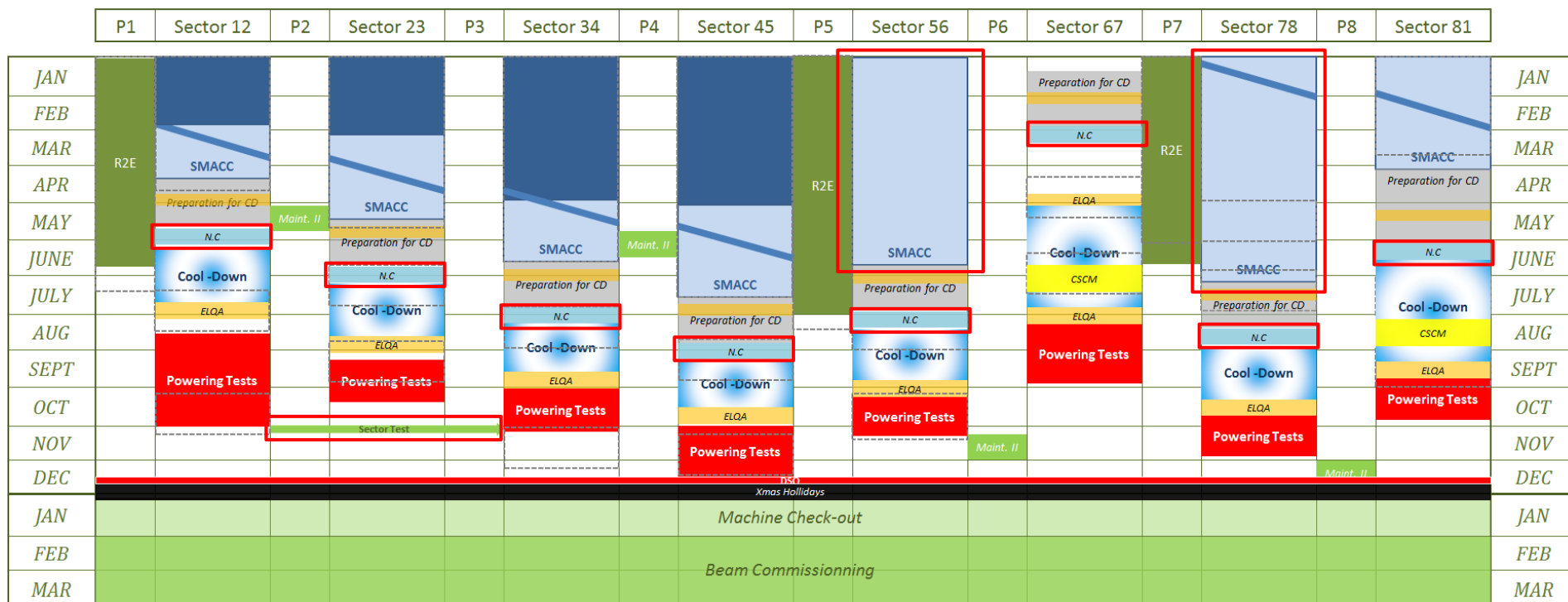
LS1: LHC schedule



Schedule: version 3.0 to 3.1

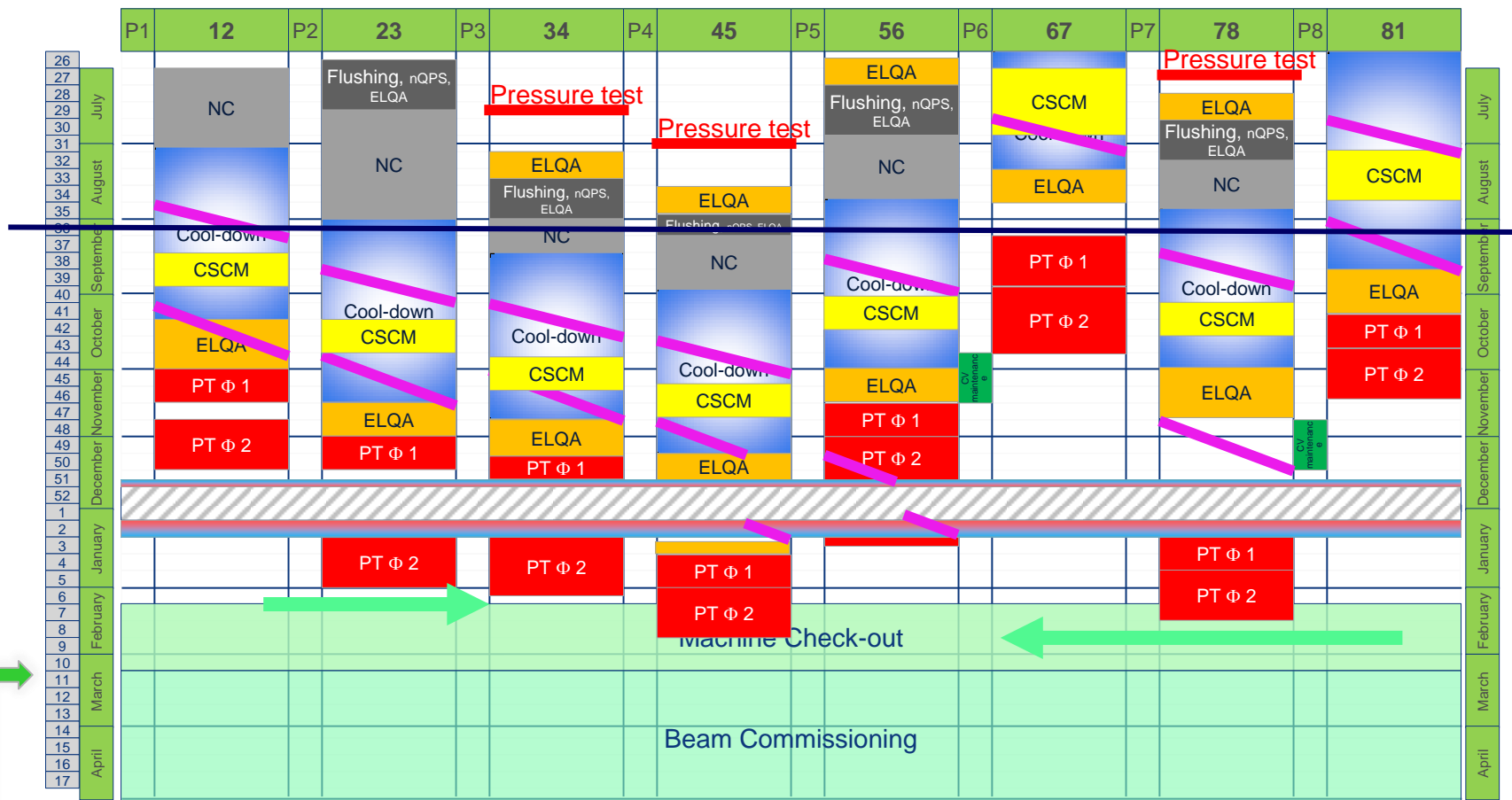
LHC injectors getting ready for hardware tests
LHC: all signals are green for beam on February 2015

- Schematic view of version 3.1, now includes
 - DFBA repairs at P6 and P8
 - a margin of 2 weeks after flushing for N.C. solving
 - The sector test from P2 to P3



LHC schedule V4.1

**Safety First,
Quality Second,
Schedule Third**



1st beam on week 11 (starting 9th March 2015)



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