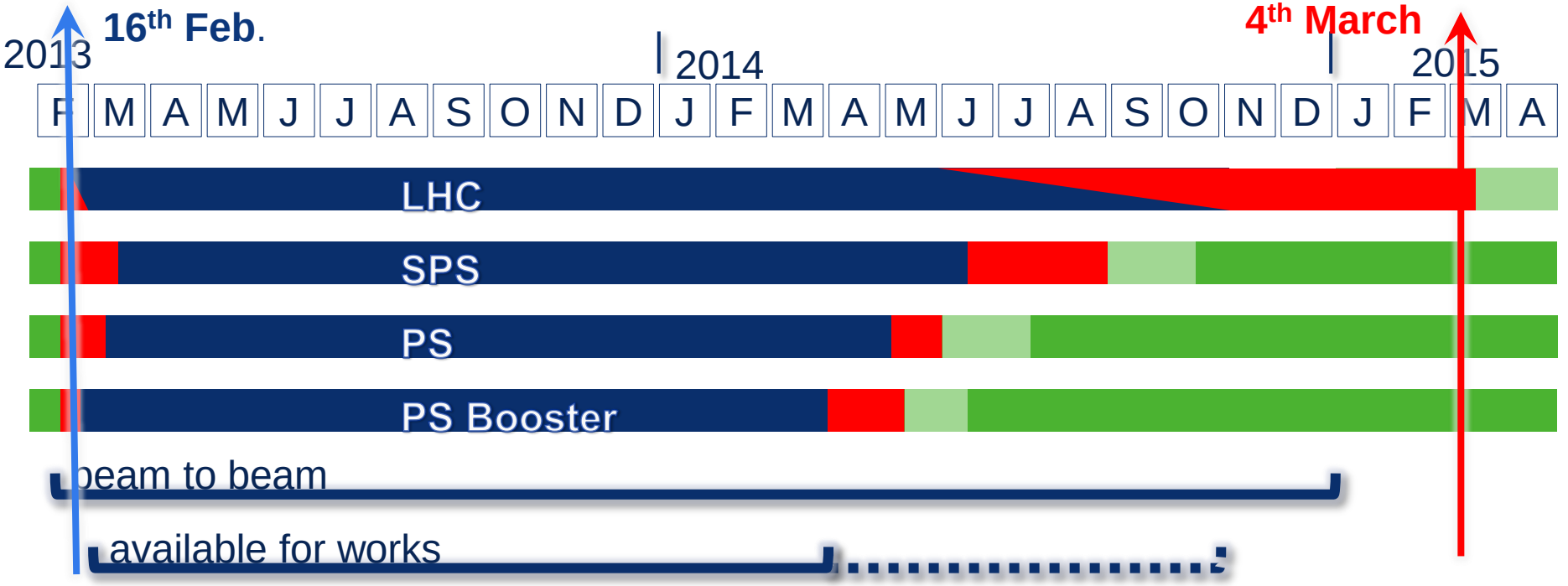
LHC Machine Status Report
121th LHCC

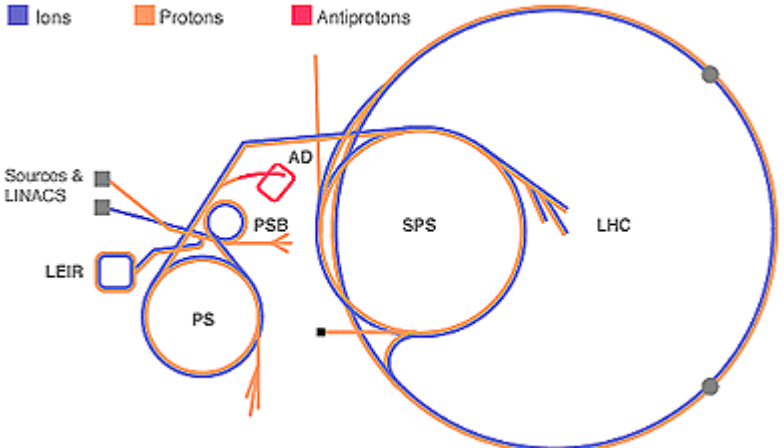
Frédérick Bordry

4th March 2015

LS 1 from 16th February 2013 to March 2015

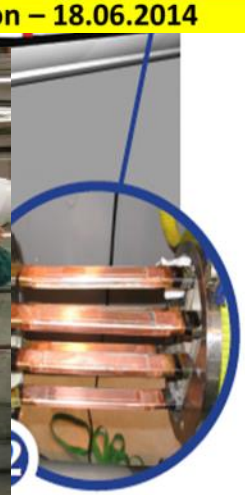


Safety First, Quality Second, Schedule Third.



The main 2013-14 LHC consolidations

SMACC project : Closure of the last interconnection – 18.06.2014



18 000 electrical
Quality Assurance tests

nsolidation of the
kA circuits in the 16
in electrical feed-
oxes

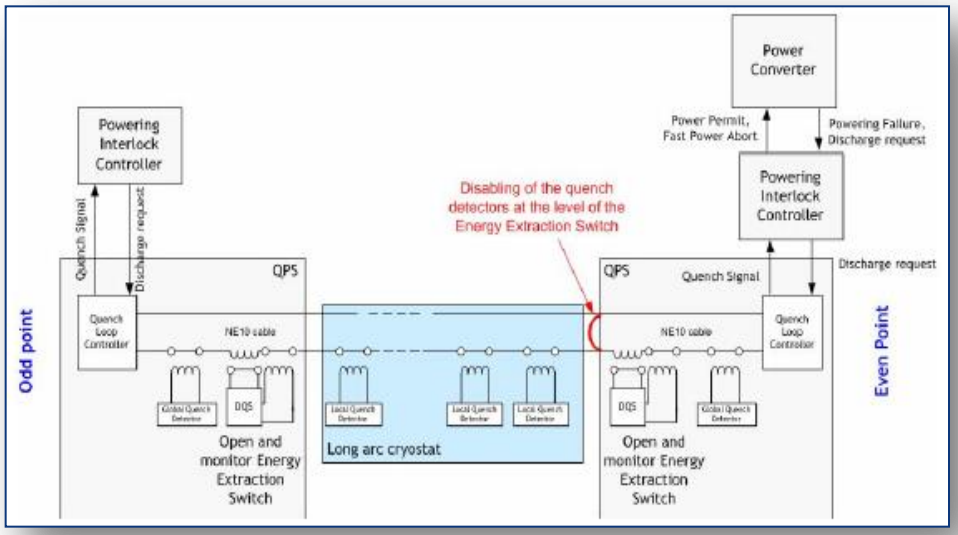
The Short Circuit Tests (SCT)

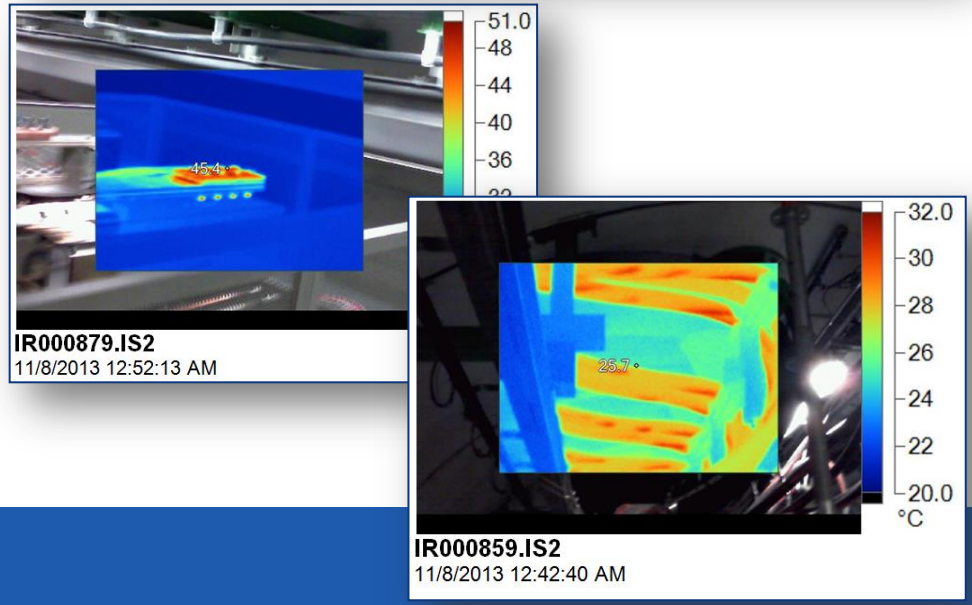
The Short Circuit Tests are meant to validate the warm part of the superconducting circuits, including:

- The Energy Extraction system
- The Power Converter
- The DC cables
- The conical connections
- The interlock signals

The tests include:

- Individual System Tests
- Interlock tests
- Conical connections validation
- Heat Run



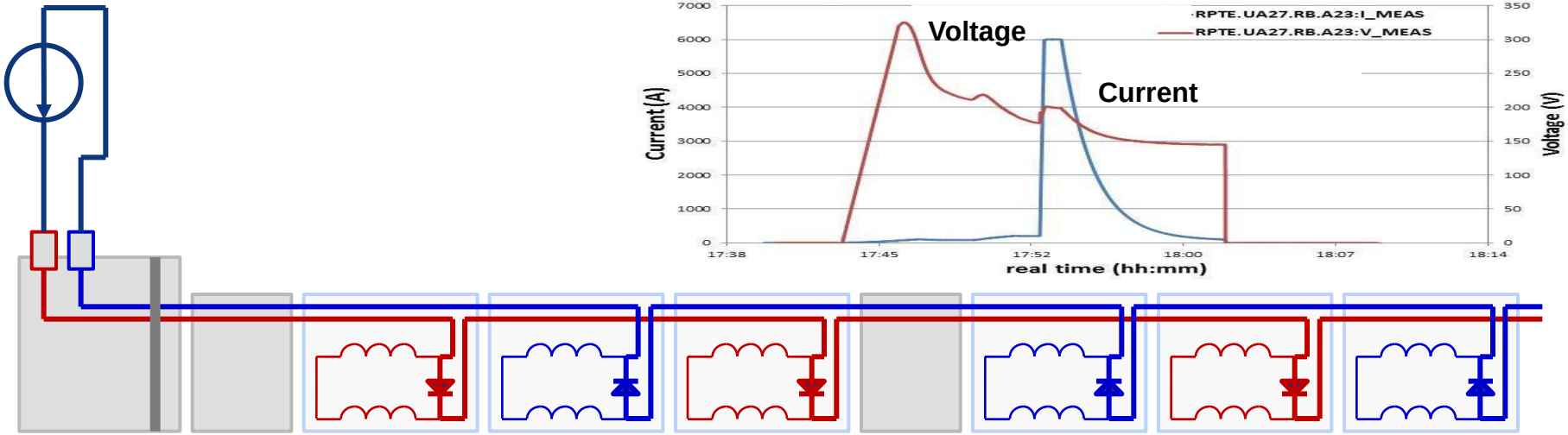


CSCM: Copper Stabilizer Continuity Measurement

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)

Basic idea

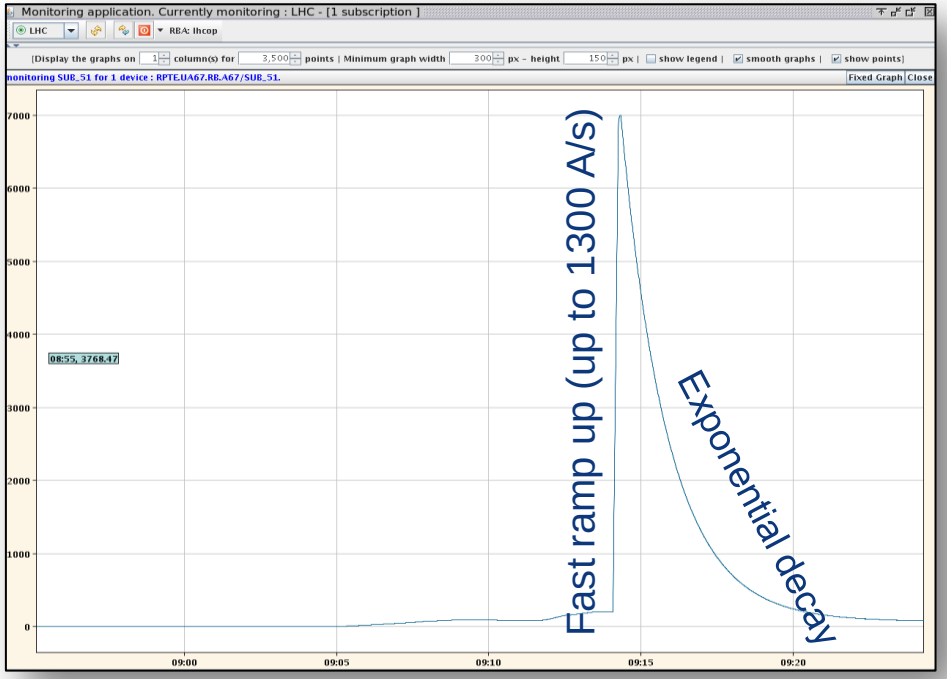
- Stabilize the entire sector at around 20 K, so the magnets and bus are not superconducting. Keep the DFB at 4.5 K.
- Connect the two 6 kA/200 V power converters in series ($\Rightarrow$ 400V)
- Apply several steps of current pulse, up to 11.1 kA (6.5 TeV), τ=100 s



CSCM status

- Sector 67 completed
- Sector 81 completed
- Sector 12 completed
- Sector 56 completed
- Sector 78 completed
- Sector 23 completed
- Sector 45 completed
- Sector 34 completed

(last test at 11.1 kA done on 10th December)

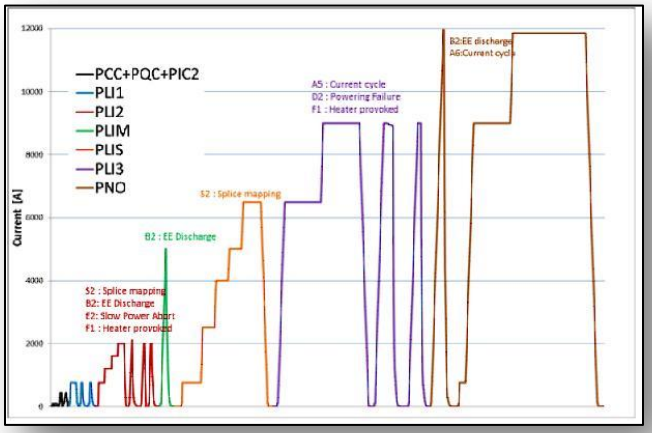


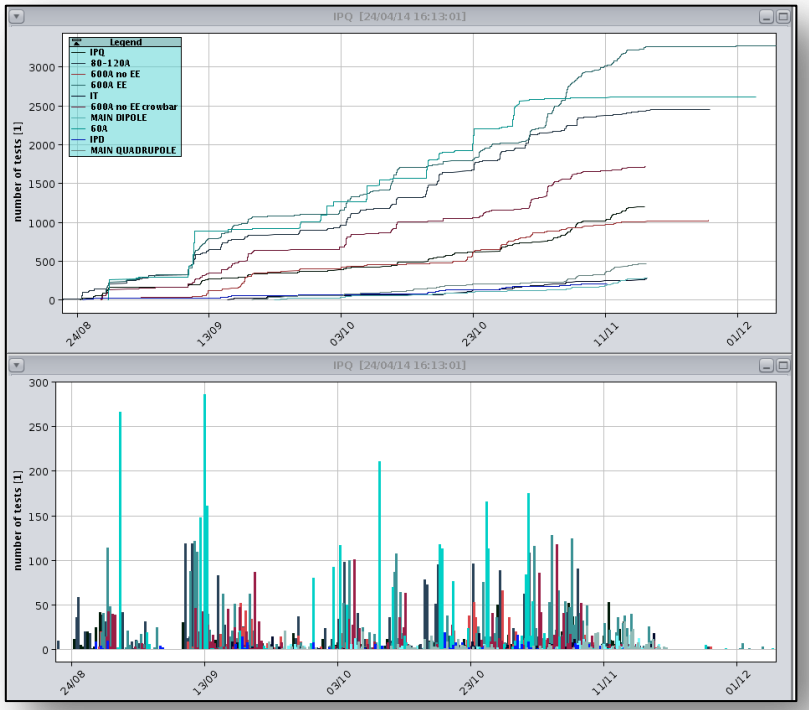
All the 8 dipole circuits have been entirely validated.

The Powering tests - plan and target

Almost 1600 circuits:

- 24 x 13 kA circuits
- 8 Inner Triplets
- 94 Individually Powered 4-6 kA circuits
- 1446 correctors (60 A to 600 A)



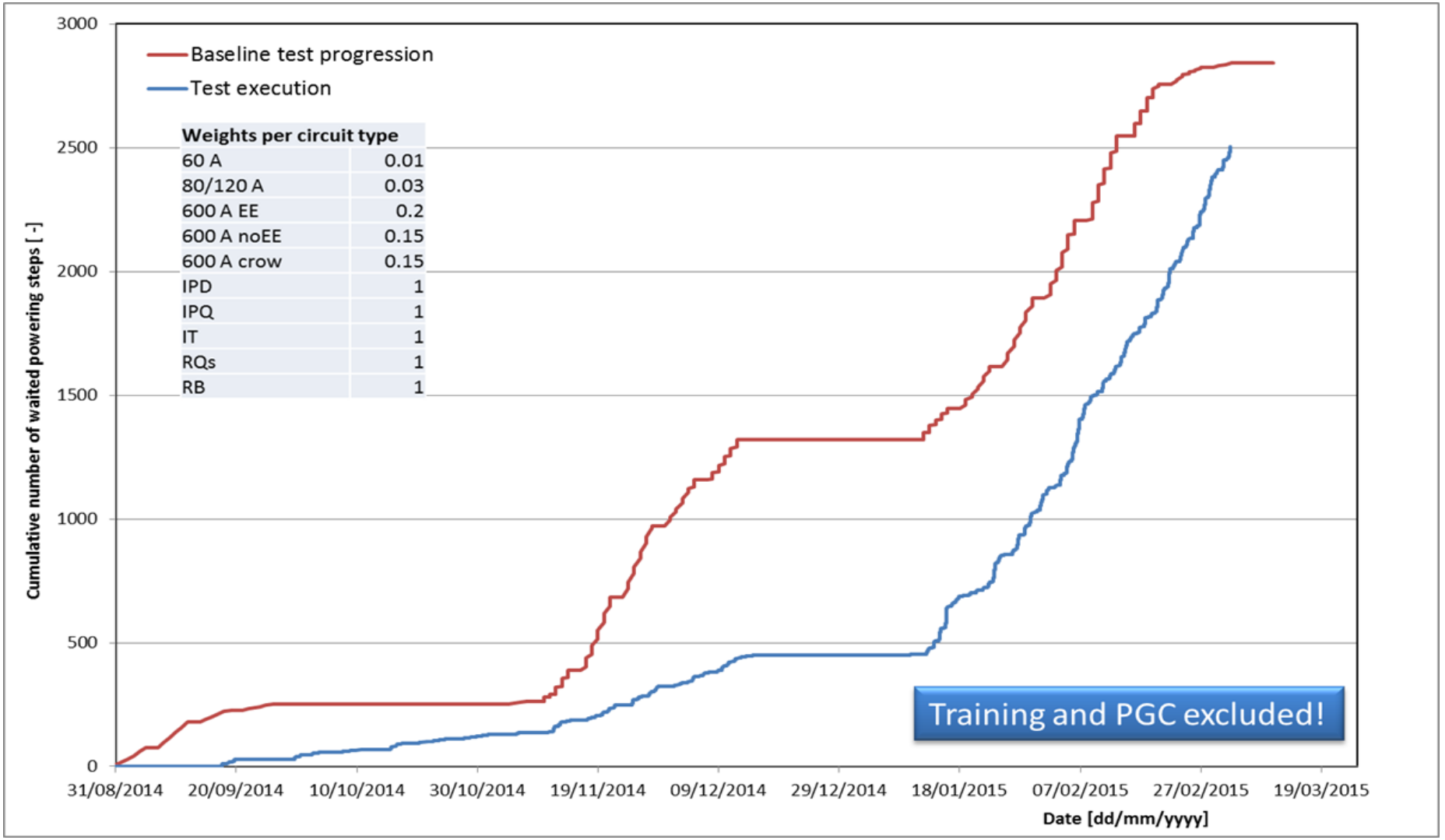


A total of **more than 10.000 powering test steps** in about 5 months!!

In 2009 the LHC was commissioned (to 3.5 TeV) in a similar amount of time.

A total of around 100-150 training quenches is expected to reach 6.5 TeV

Powering tests “Weighted” advancement

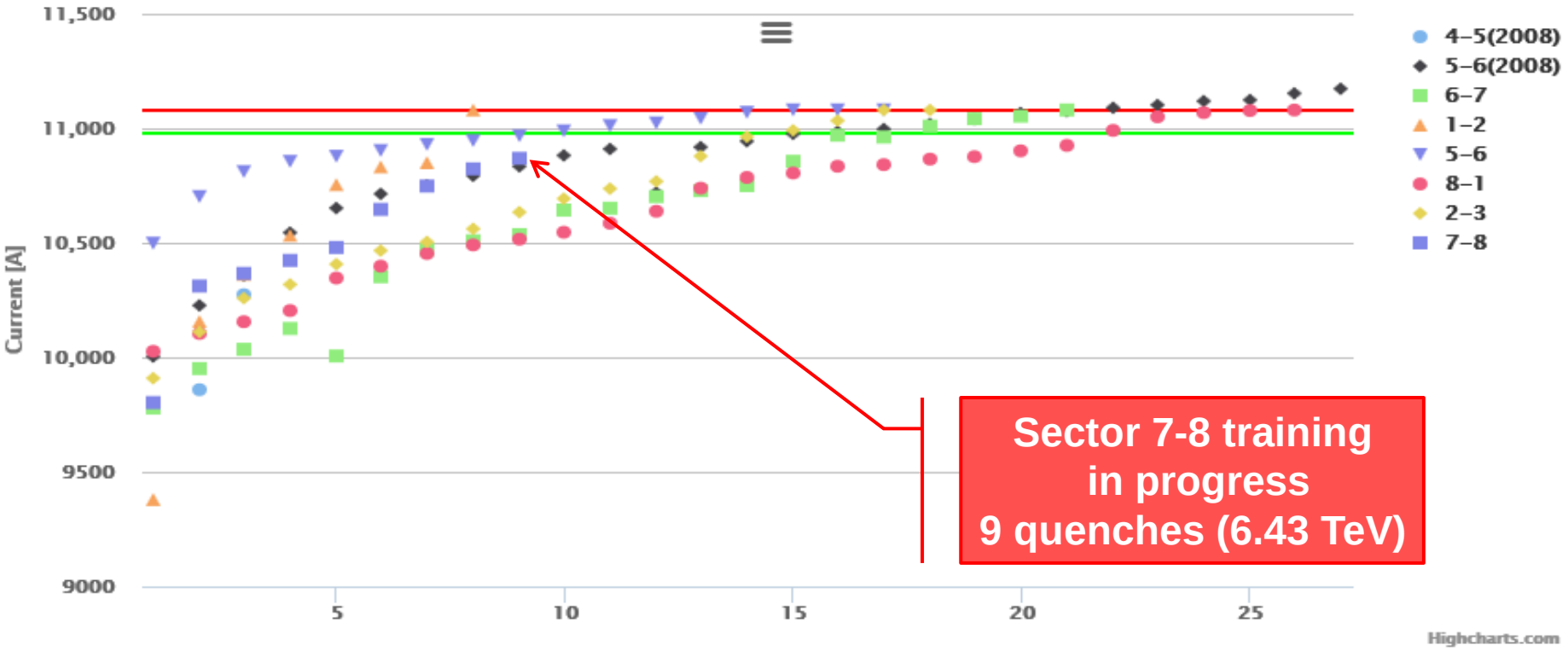


Courtesy of Mirko Pojer and Matteo Camillocci

Training quenches

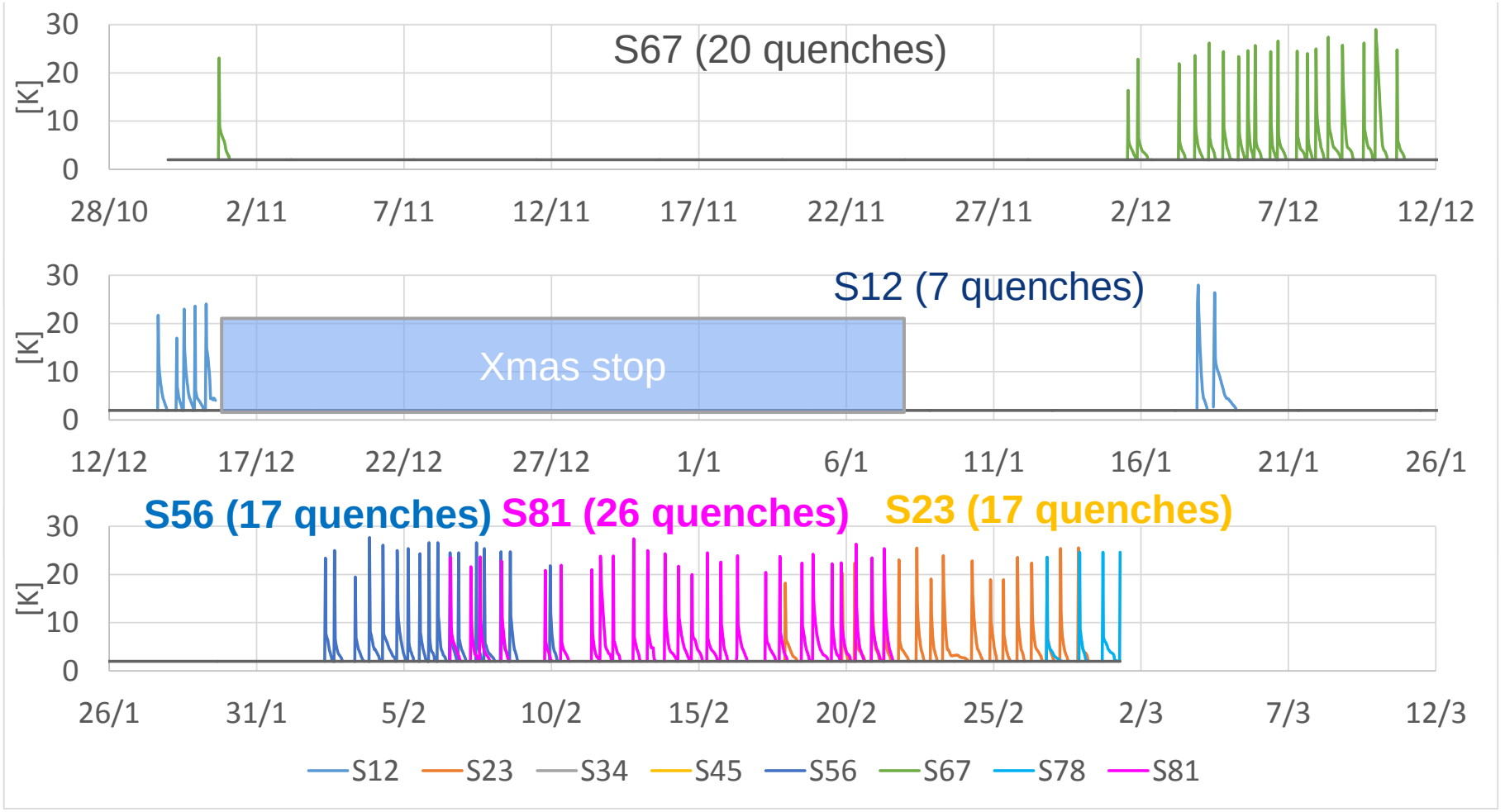
5 sectors are fully qualified at 6.5 TeV

6-7 : 20 quenches
1-2 : 7 quenches
5-6 : 14 quenches
8-1 : 25 quenches
2-3 : 17 quenches



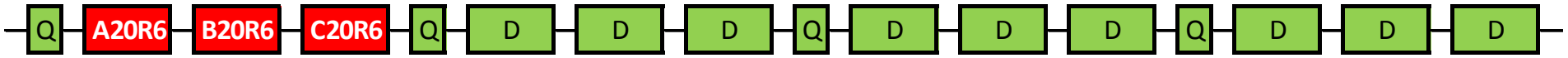
Sector 7-8 training in progress
9 quenches (6.43 TeV)

Sector training toward 6.5 TeV

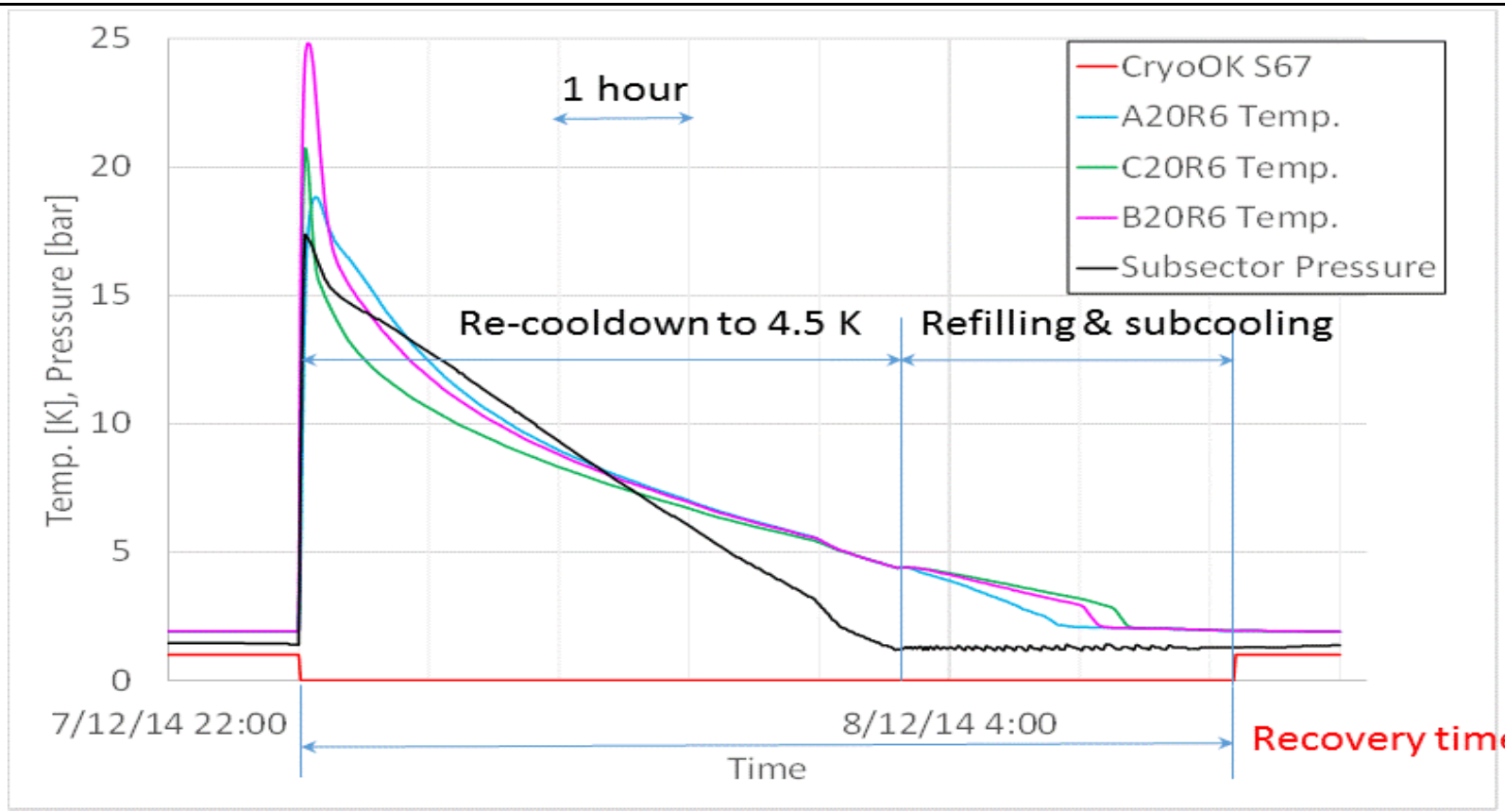


Typical quench recovery (S67 #15)

3307	10856	6828	Quench current [A]
3	1	2	Quench order

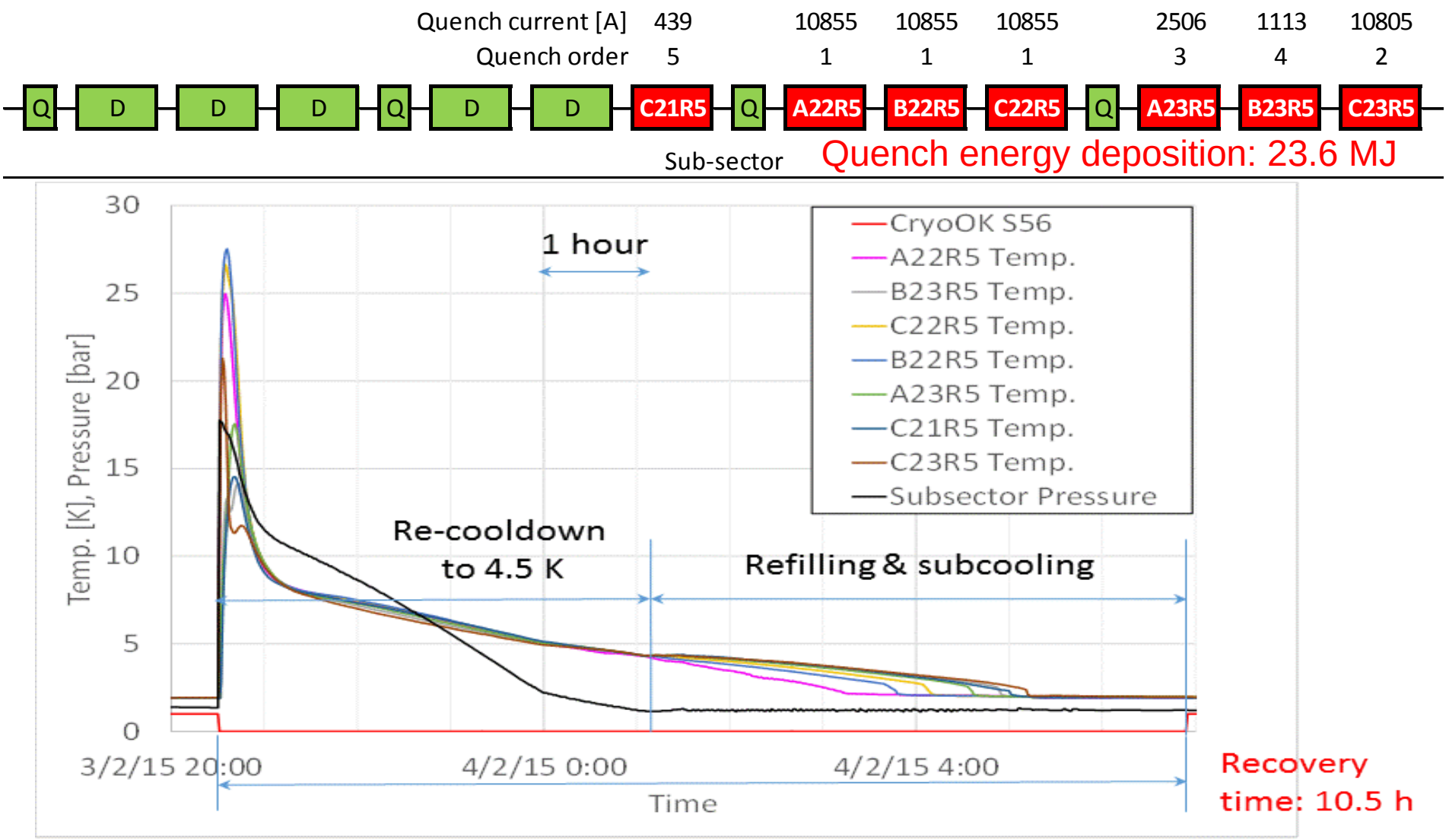


Sub-sector

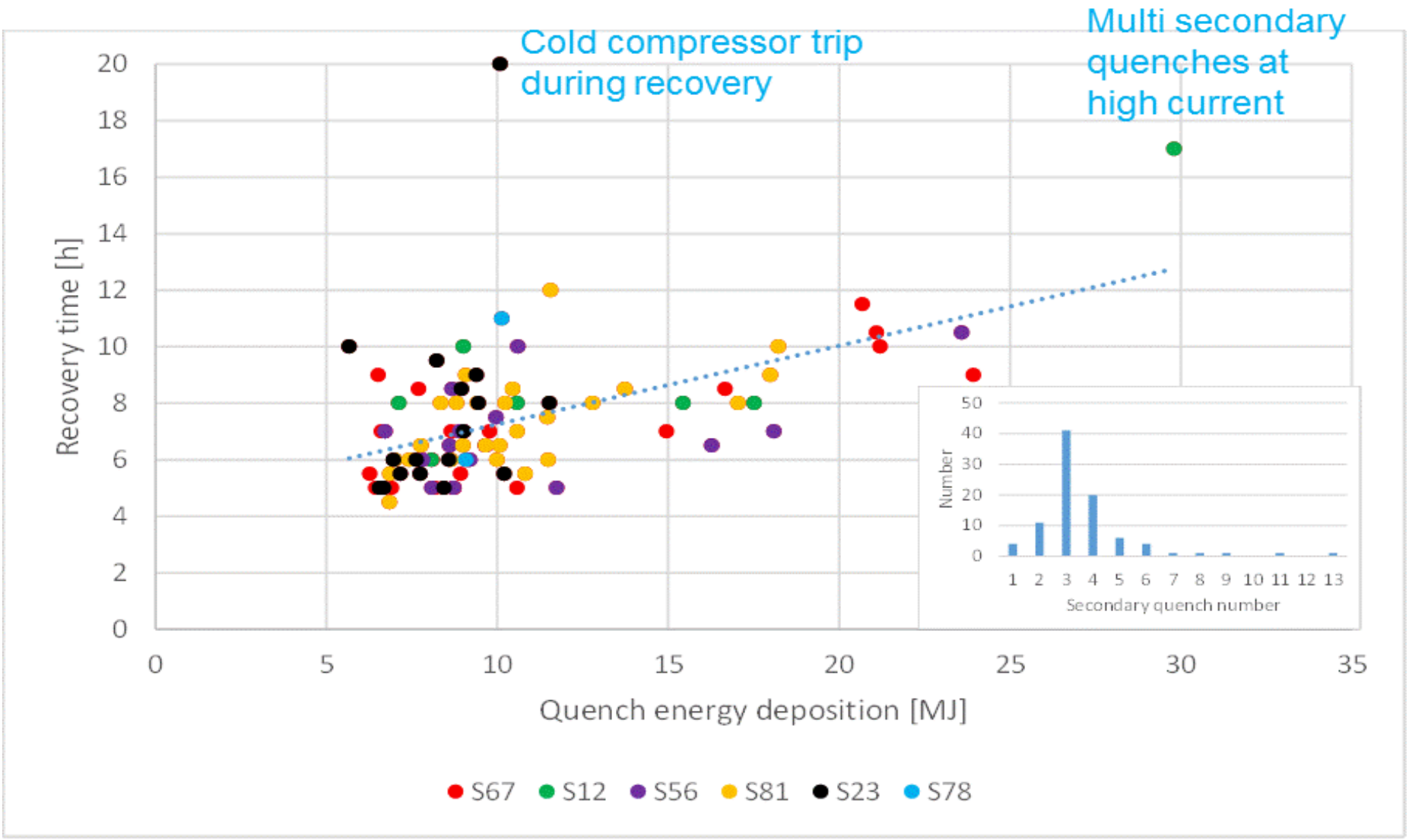


Courtesy of Laurent Tavian

Typical quench recovery (S56 #4)



Quench recovery time



Courtesy of Laurent Tavian

Training quench estimates (based on 6-7 and 1-2)

Estimation on 9th February 2015

Circuit	Status	#M Firm 1	#M Firm 2	#M Firm 3	#Q Firm 1	#Q Firm 2	#Q Firm 3	#Q total	Estimate
RB.A12	11080 A reached	50	95	9	2	1	4	7	-
RB.A23	not started	56	58	40	-	-	-	**17**	15
RB.A34	not started	44	81	29	-	-	-	-	12
RB.A45	not started	48	44	62	-	-	-	-	22
RB.A56	11080 A reached	28	42	84	-	-	16	16	29*
RB.A67	11080 A reached	57	36	61	0	1	19	20	-
RB.A78	not started	53	40	61	-	-	-	-	22
RB.A81	in progress	64	24	66	-	-	4	**25**	23

Quenches: 43 +4 done ; Estimation : 90 for the remaining 6 sectors

Training quench estimates (based on 6-7 and 1-2)

New Estimation on 26th February 2015

Circuit	Status	#M Firm 1	#M Firm 2	#M Firm 3	#MQ Firm 1	#MQ Firm 2	#MQ Firm 3	#MQ total	#CQ total	Estimate
RB.A12	11080 A reached	50	95	9	2	1	4	7	7	-
RB.A23	11080 A reached	56	58	40	0	2	15	17	17	16
RB.A34	not started	44	81	29	-	-	-	-	-	13
RB.A45	not started	48	44	62	-	-	-	-	-	24
RB.A56	11080 A reached	28	42	84	0	0	17	17	16	-
RB.A67	11080 A reached	57	36	61	0	1	19	20	20	-
RB.A78	in progress	53	40	61	-	5	2	7	7	23
RB.A81	11080 A reached	64	24	66	0	3	25	28	26	-

Maximum beam energy : **13 TeV c.m. in 2015**

Decision to run at a **maximum** energy of 6.5 TeV per beam during the powering tests and during 2015.
(10 to 15 training quenches per sector are expected to be needed to reach that energy).

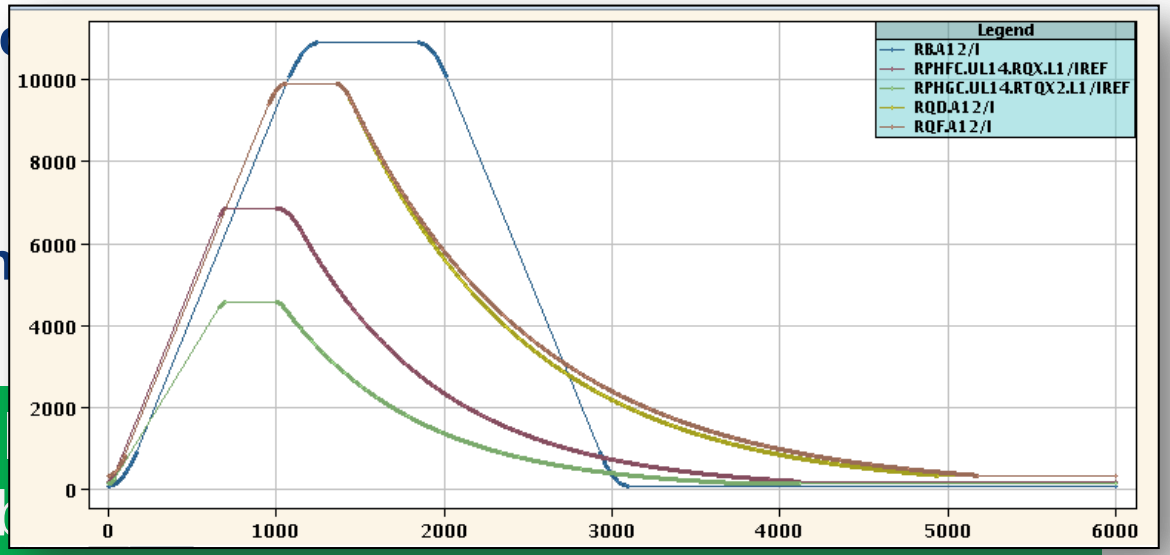
NO change of beam energy in 2015.

A decision regarding the possibility of increasing the energy will be taken later in 2015, based on the experience gained in all eight sectors at 6.5 TeV per beam during powering tests and operation with beams.

LHC goal for **2015 and for Run 2 and 3**

Priorities for the 2015 run :

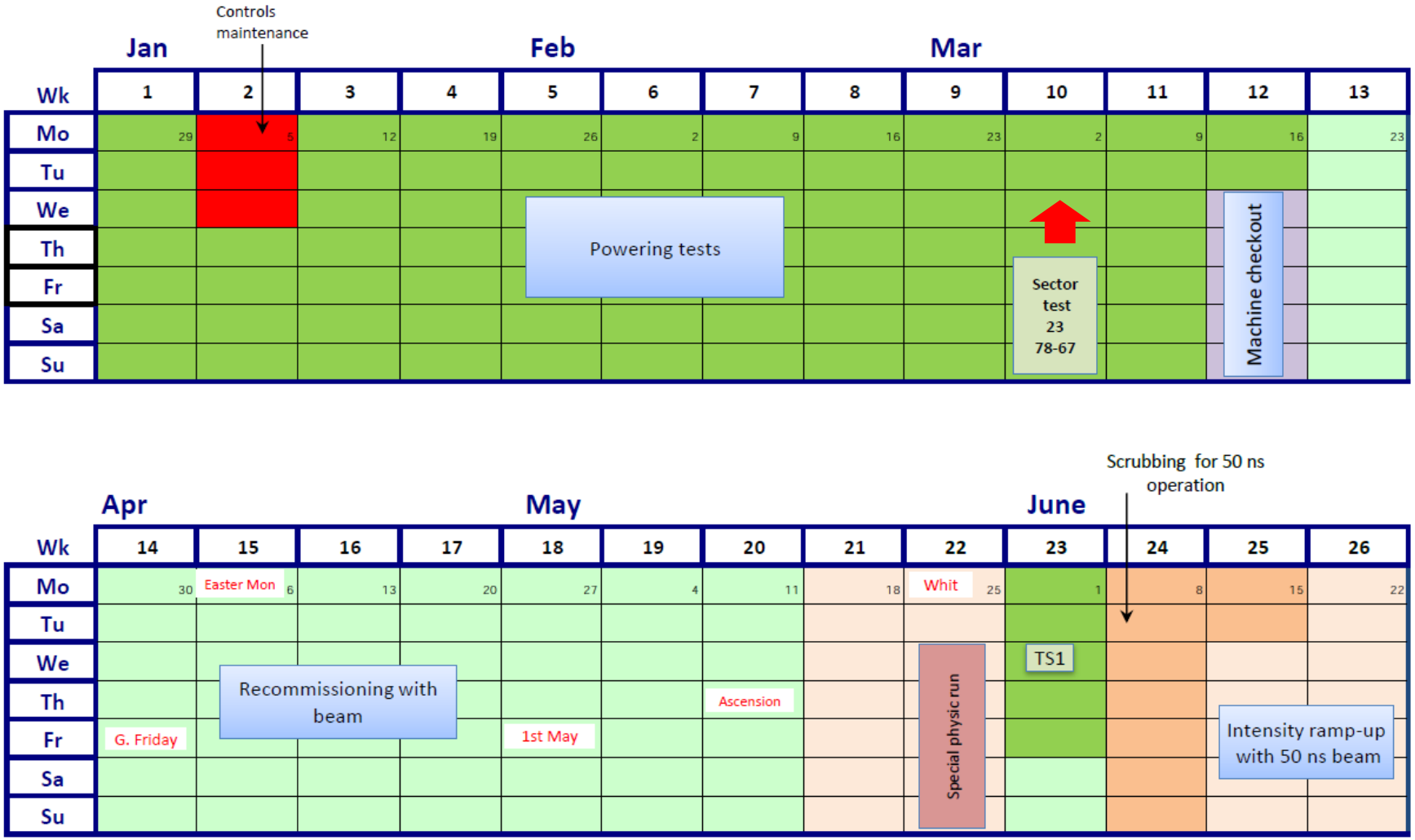
- **Establish proton-proton collision at 13 TeV with 25ns and *low* β* to prepare production run in 2016.**
  Optimisation of physics-to-physics duration
- **Later in 2015: decisi**
  (90m optics): not in
  recommendation
- **Pb-Pb run: one month**



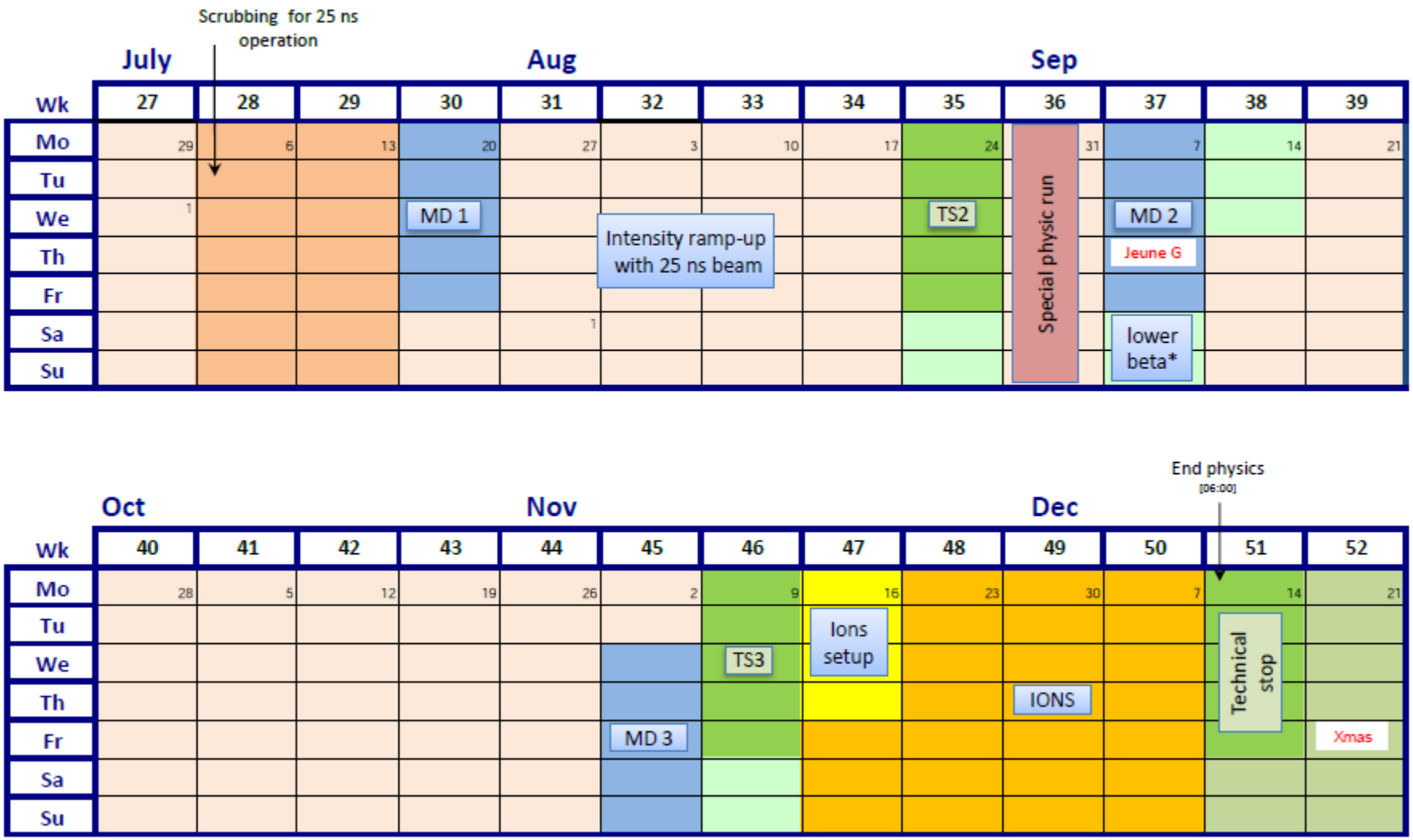
The goal for Run 2
operation with 25 ns b
an estimated pile-up of 40 events per bunch crossing.

"A maximum pileup of ~50 is considered to be acceptable for ATLAS and CMS"

LHC: Getting ready for Run 2 !



- 8 weeks beam commissioning
- LHCf and VdM ($\beta^* = 19$m) just before TS1
- TS1 shifted by a week



- 4 day floating MD removed
- Otherwise as was

Courtesy Mike Lamont

2015 version 0.5

Phase	Days
Initial Commissioning	56
Scrubbing	23
Early special physics run (LHCf/VdM)	5
Proton physics 50 ns	**7 + 21**
Proton physics 25 ns – phase 1	**44**
Change in beta*	**5**
Proton physics phase 2 (including ramp-up)	**44**
Special physics runs (TOTEM/VdM) Intermediate energy run - to be scheduled	7
Machine development	19
Technical stops	15
Technical stop recovery	6
Ion setup/Ion run	4 + 24
Total	**280 (40 weeks)**

Mike Lamont - 120th LHCC meeting – 19th November 2014

LHC schedule 2015 version 1.1

Phase	Days	
Initial Commissioning	56	
Scrubbing (for 50 and 25 ns)	23	
Early LHCf/VdM1	5	
Proton physics 50 ns	**9 + 19**	
Proton physics 25 ns – phase 1	**30**	**- 14**
Change in beta*	**5**	
Proton physics phase 2 (including ramp-up)	**48**	**+ 4**
Special physics runs (TOTEM/VdM2) Intermediate energy run - to be scheduled	7	
MD	15	**- 4**
Technical stops	15	
Technical stop recovery	6	
Ion setup/Ion run	4 + 24	
Total	**266 (38 weeks)**	

LHC goal for **2015 and for Run 2 and 3**

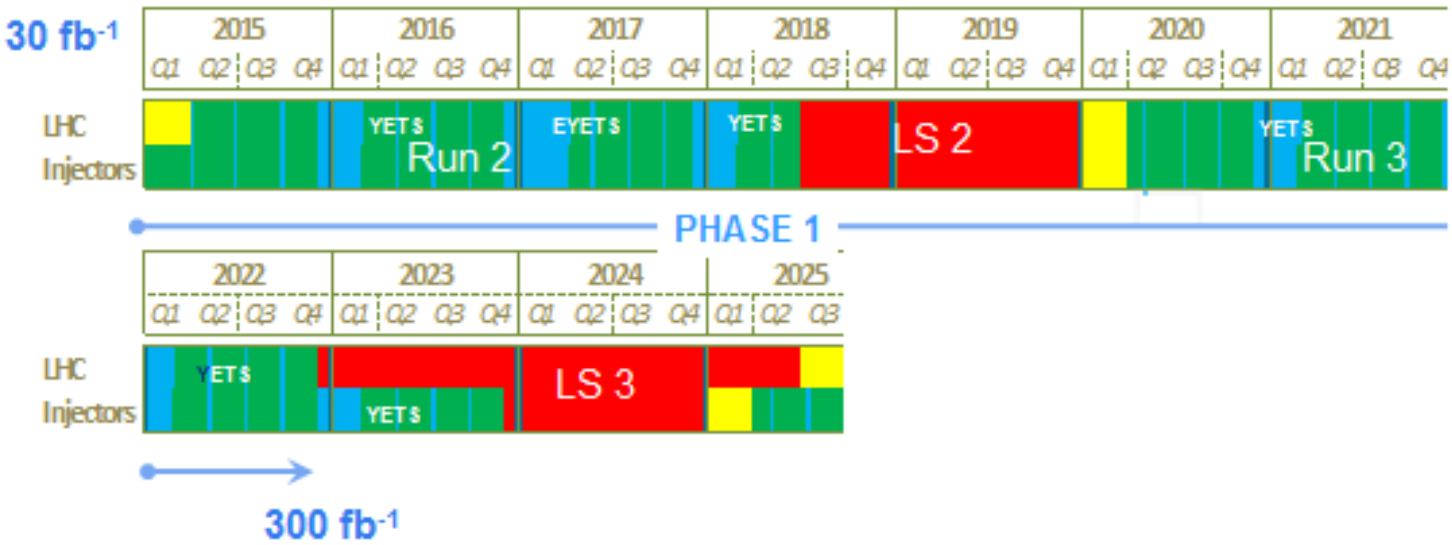
Integrated luminosity goal:

2015 : 10 fb^{-1}

Run2: ~100-120 fb^{-1}

(better estimation by end of 2015)

300 fb^{-1} before LS3



Conclusion

LS1 was not all plain sailing but CERN and collaborations have shown an impressive reactive force to overcome the obstacles and continued progressing towards its target of restarting the LHC for physics at 13 TeV

The hardware and beam commissioning are and will be an absorbing and captivating period.

Beam is knocking at the door !

www.cern.ch