

Status of injectors and LHC machine

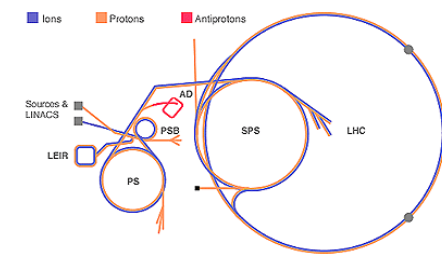
Council

Frédéric Bordry

17 June 2016



Injector Schedule: April to June 2016



Wk	Apr 14	Apr 15	Apr 16	Apr 17	Apr 18	Apr 19	Apr 20	Apr 21	Apr 22	Apr 23	Apr 24	Apr 25	Apr 26
Mo	4	11	18	25	2	9	16	23	30	6	13	20	27
Tu										UA9 [24 h] TS2 8 hrs COLDEX 24 hrs			
We		Technical stop			Injector MD 10 hrs 8 to 18	Injector MD 10 hrs 8 to 18	Injector MD 10 hrs 8 to 18	Injector MD 10 hrs 8 to 18	Injector MD 10 hrs 8 to 18		Injector MD 10 hrs 8 to 18	Injector MD 10 hrs 8 to 18	Injector MD 10 hrs 8 to 18
Th						Ascension							
Fr						May Day comp							
Sa													
Su				1 st May									

Linac 2 : Beam availability 96.4%

Booster (PSB) : Beam availability 94%

ISOLDE 35 Successful experiments already completed

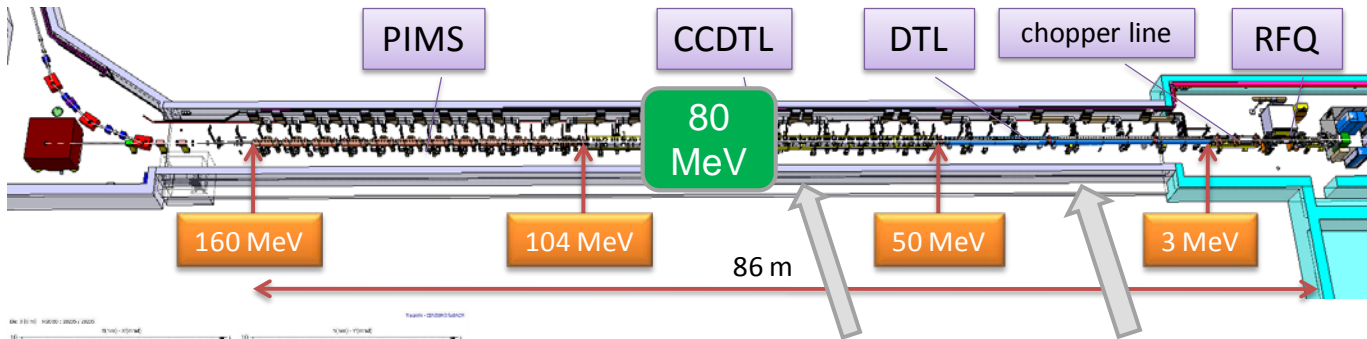
PS : Beam availability ~ 80 %

Main issues causing down time related to Main Power Converter

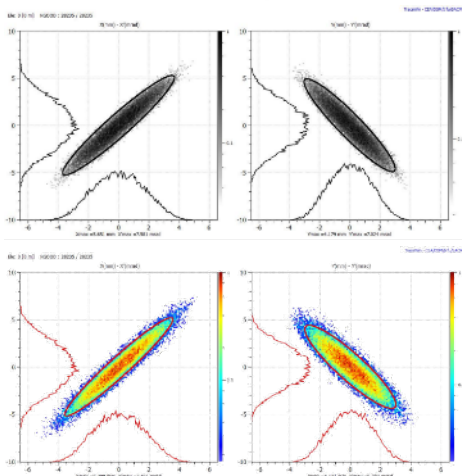
SPS : Reduced intensity and duty cycle for the SPS North Area fixed target beam due to SPS internal dump vacuum leak



Beam status of Linac4



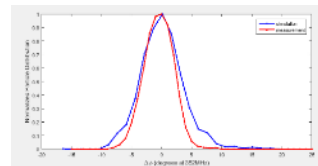
Beam commissioning completed up to **80 MeV energy** (DTL + 4 CCDTL tanks).



Simulated and measured beam emittances at 50 MeV



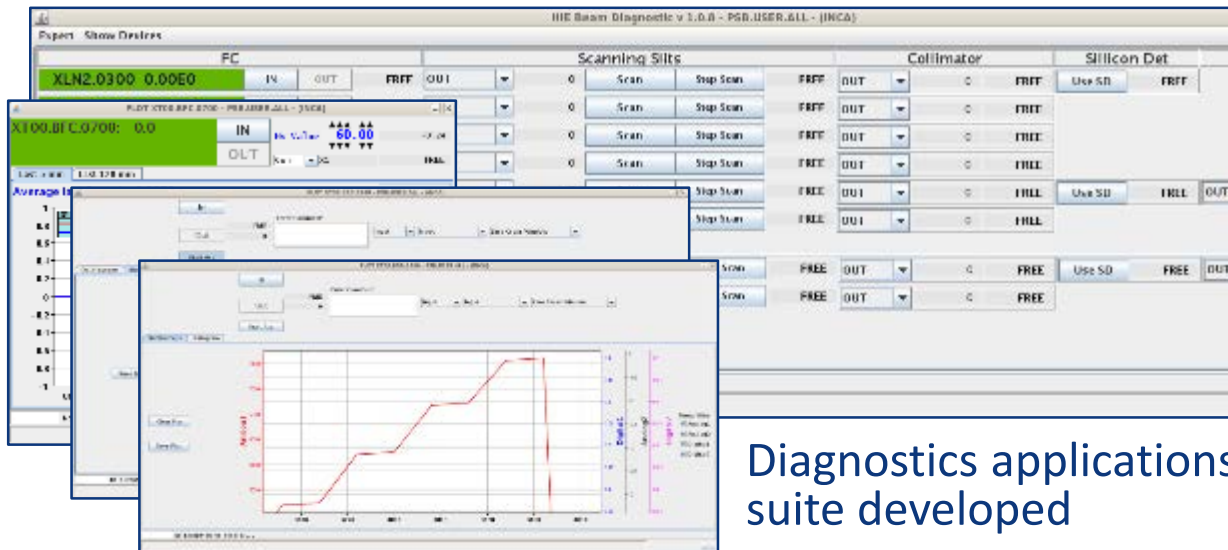
75% of the remaining structures (80-160 MeV) are installed.



50 MeV longitudinal beam profile (simulated and measured)

HIE - ISOLDE Status

- Installation of the two HIE-ISOLDE cryo-modules completed
- Cooling of cryo-modules on-going
- Conditioning of superconducting structures started

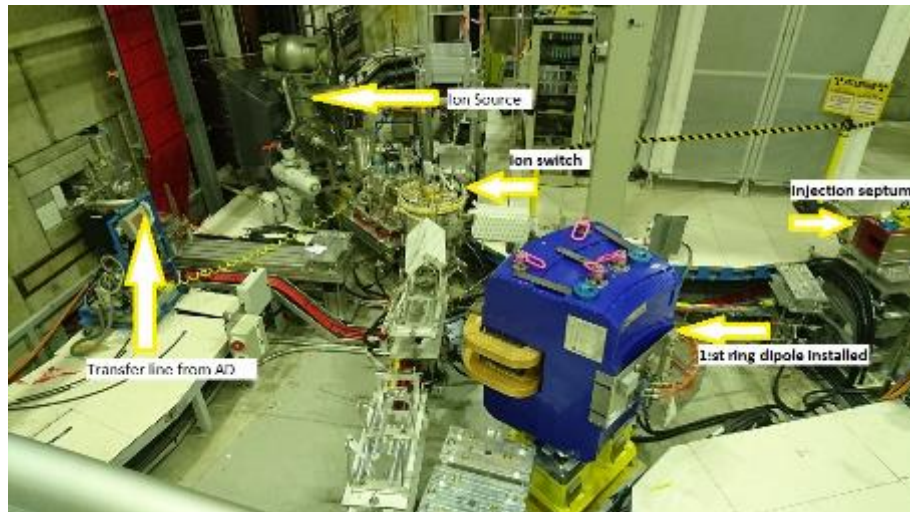


Main issues during the start-up, commissioning and first few months of operations:

- Minor delays cooling of cryomodules and starting up the RF systems
- Cycling hardware and software for the separators
- Some problems in the frontends (two vacuum leaks in targets, HV insulators replacement, clamping mechanism, extraction electrode)

AD: ELENA Status

- ELENA installation in progress
- 5 of the 6 main dipoles installed
- HW commissioning to start in July/August
- Delays with some components; but should be ok for beam commissioning to start later this year



ELENA beam transfer lines with 100 keV Ion source

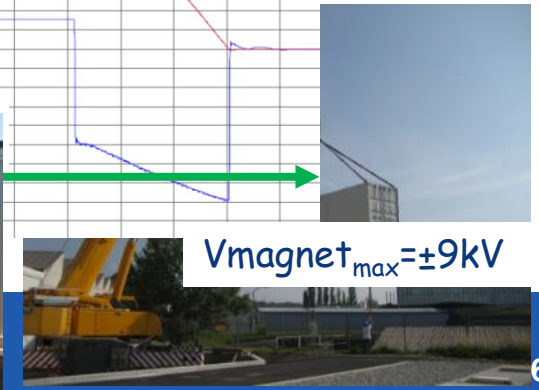
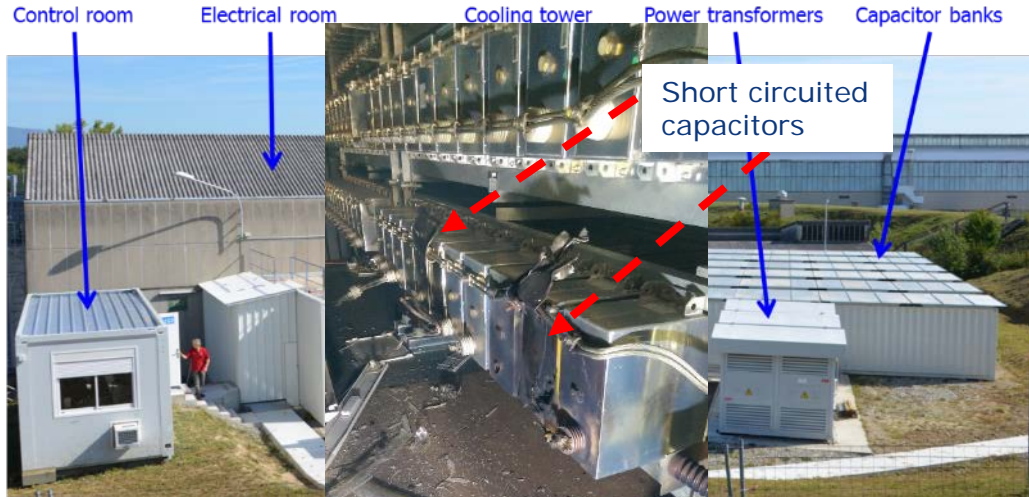
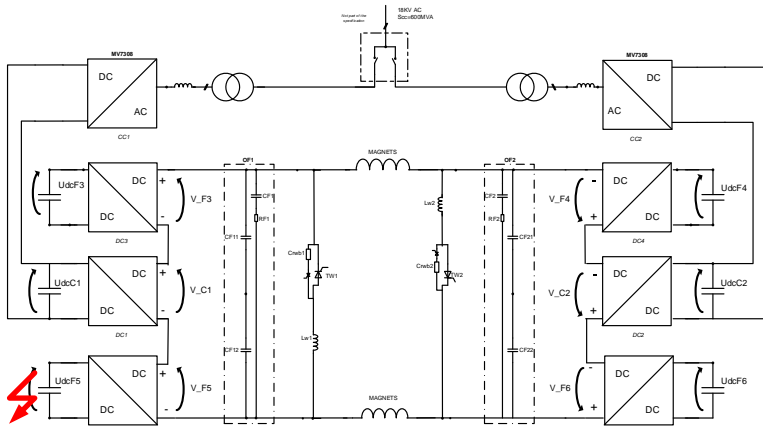


ELENA ring magnets installation in progress

Power for PS (POPS)

The peak power needed for the main magnets is $\pm 40\text{MW}$ with a dynamic of 1MW per ms

April 27th : Capacitor failure in energy storage container



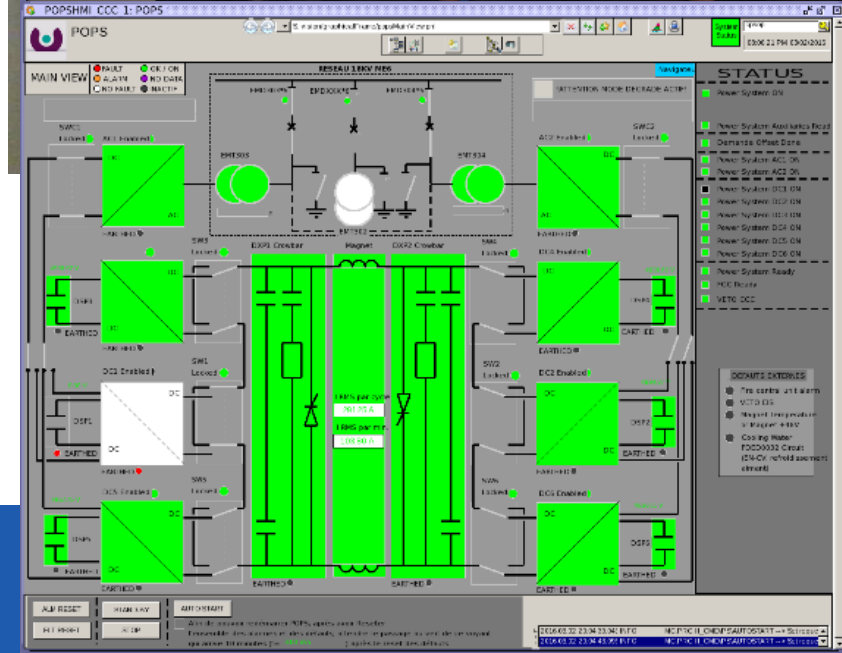
PS: "Old" Power System with rotating machine



May 20th : MPS High Power Switch burned

May 26th: Returning to POPS following partial repair and validation. **A sigh of relief !**

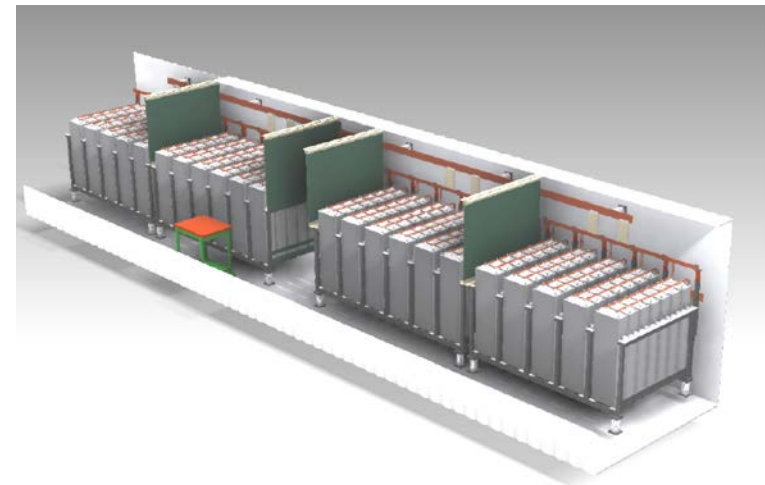
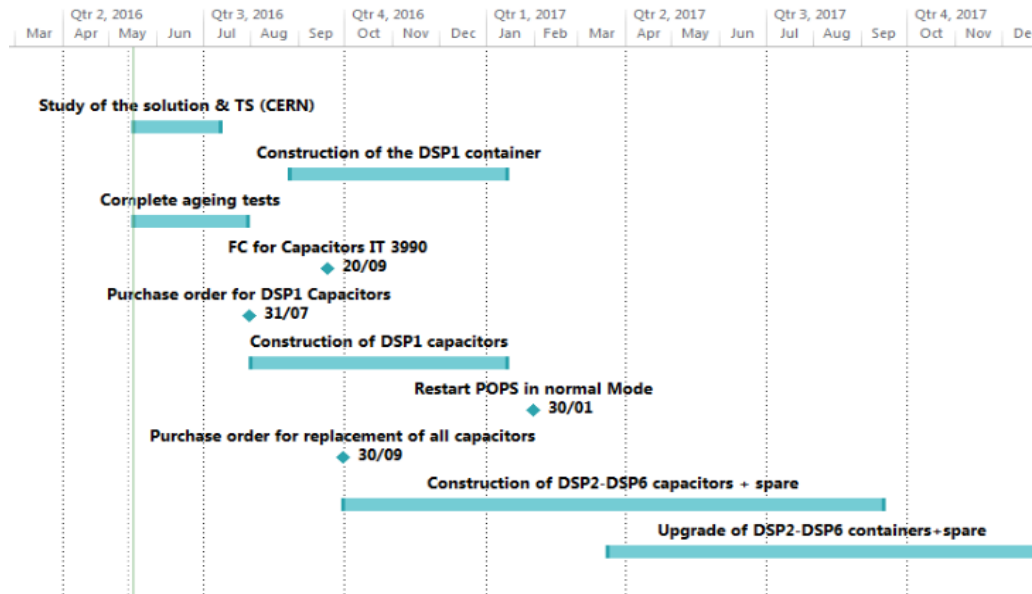
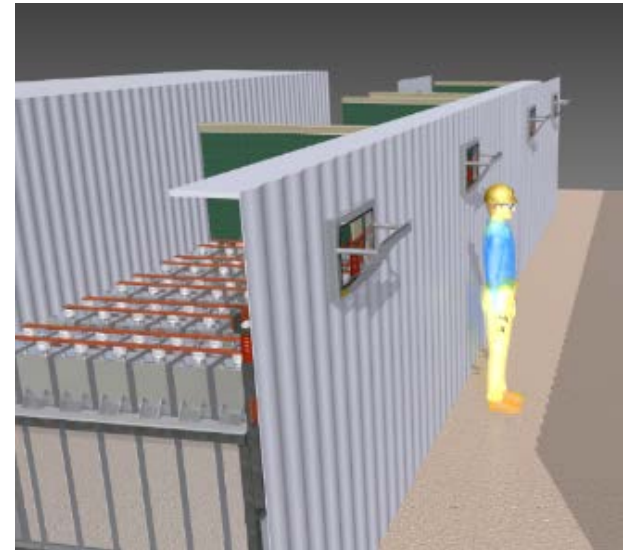
Running without redundancy mode but with full pulse capacity



PS: POPS recovery plan

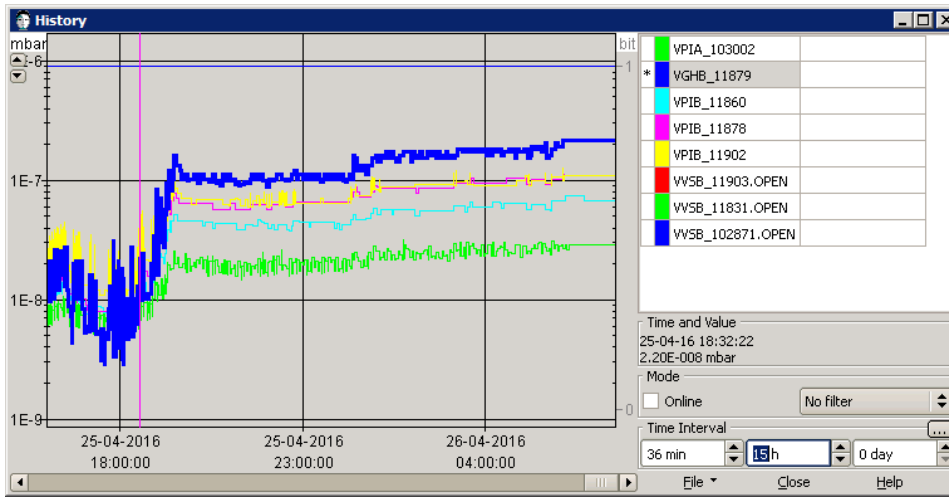
New capacitors are under final qualification.
 New containers are under design.
 More protections will be added to limit the impact of capacitor failure.

2 new fully equipped containers installed during next EYETS.
 Remaining containers replaced during YETS 2017-2018.

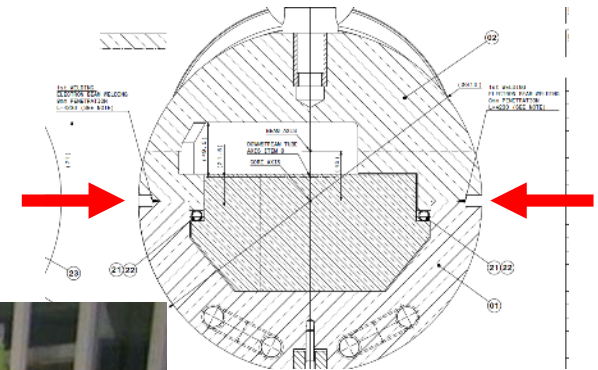


SPS status: during LHC scrubbing (25/04)...

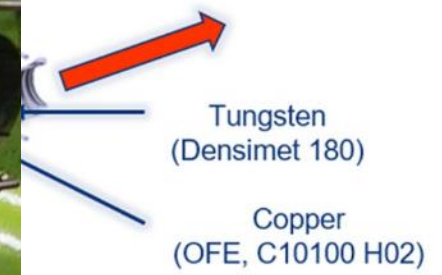
Sudden loss of vacuum conditions on the SPS internal beam dump (TIDVG) after repetitive dumping of high intensity beams in the SPS



Probable leak on the longitudinal welding

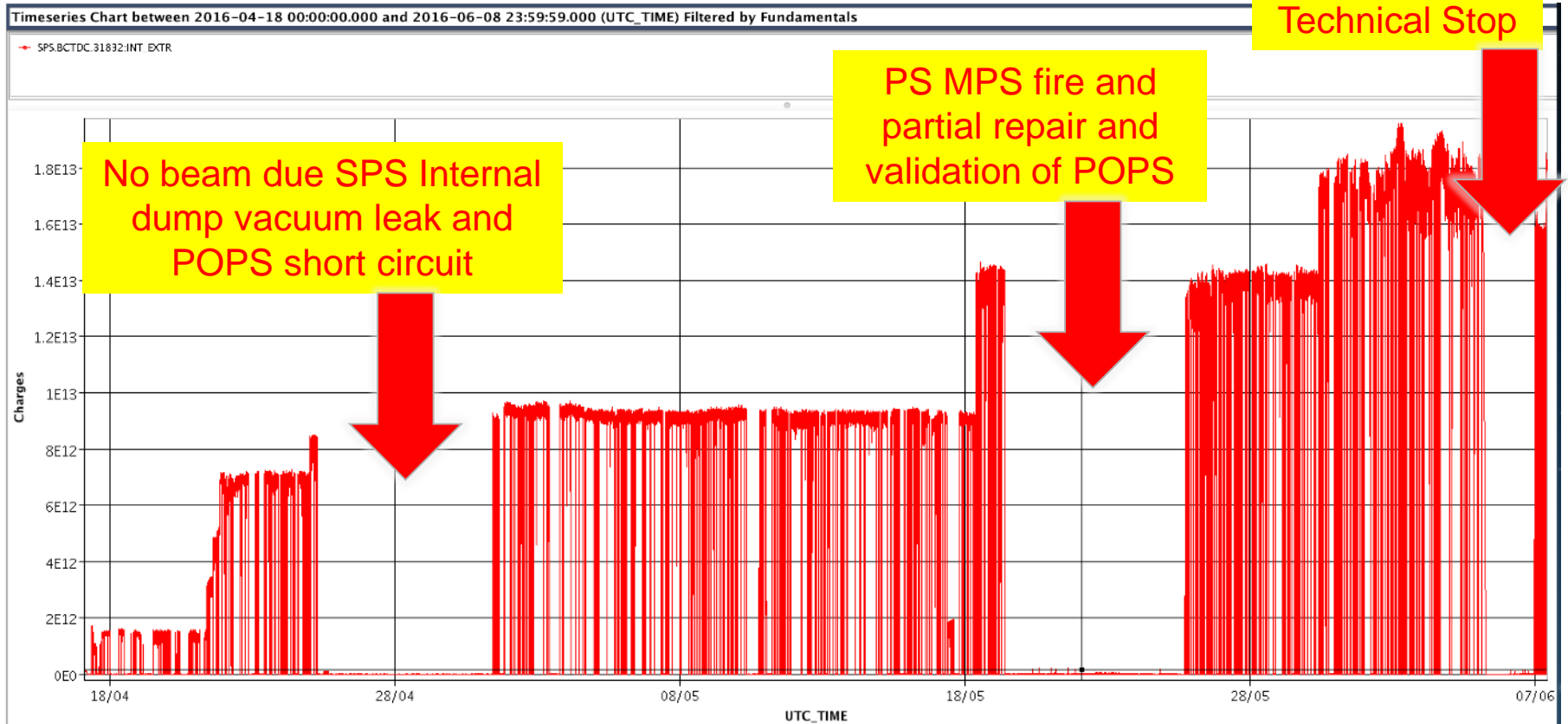


Leak detected inside the



SPS: Fixed Target Beam

Reduced intensity and duty cycle for the SPS North Area fixed target beam due to SPS internal dump vacuum leak

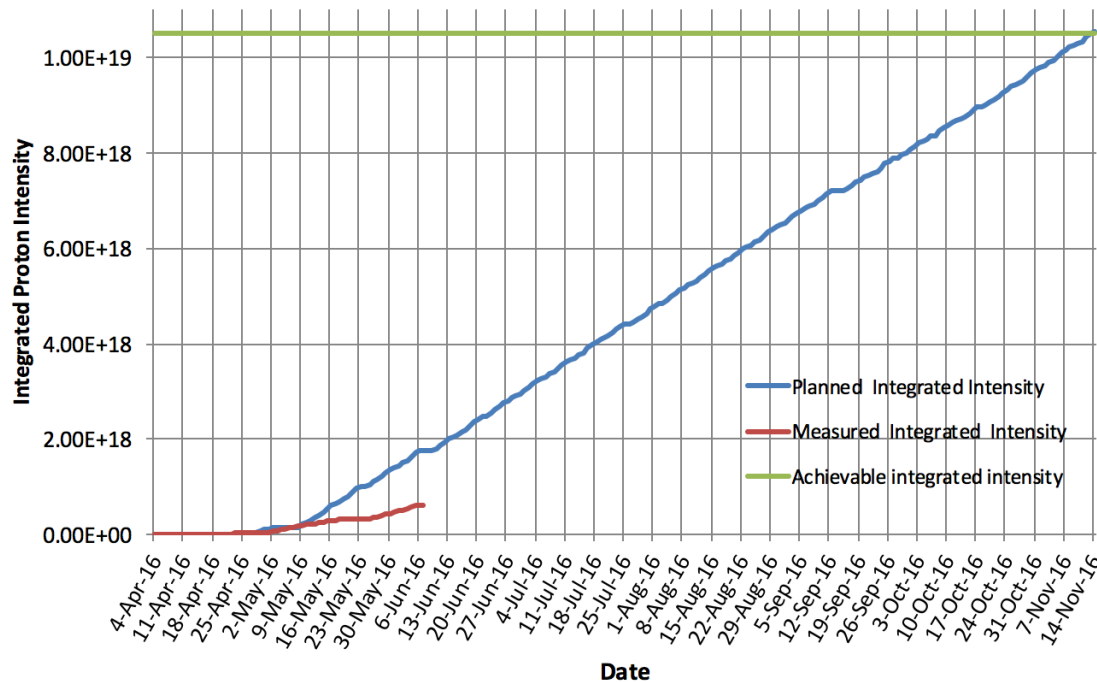


SPS: Fixed Target Beam Intensity

Severe reduction
due to Internal dump and PS POPS/MPS issues

Planned & Measured Integrated Intensity 2016 SPS extraction
for North Area Fixed Target Physics

($\sim 1.05 \times 10^{19}$ planned, based on 2016 injector schedule ver. 1.4)



Integrated proton
intensity at extraction,
status Tue. 07 June:

- Planned: 1.78×10^{18}
- Achieved: 6.13×10^{17}

This is 35% of what
was planned to date
and 6% of the total for
2016

Scheduling: SPS dump exchange (ALARA committee)

day:	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6
Stop SPS	depends on SPS use before stop													
Cooldown 1w	depends on SPS use before stop													
Consolidation of trenches								x						
Disconnections in SPS									x					
Move dump 2 OUT from LSS1 to BA3										x				
Move dump 3 IN from BA3 to LSS1										x				
Survey											x			
Reconnect vac, water, ctrl														
Pumpdown													x	

Eventual extra-cooling period
Beyond 4 days not so effective

Total calculated collective dose = 4.2 mSv
Maximum individual dose < 420 μSv

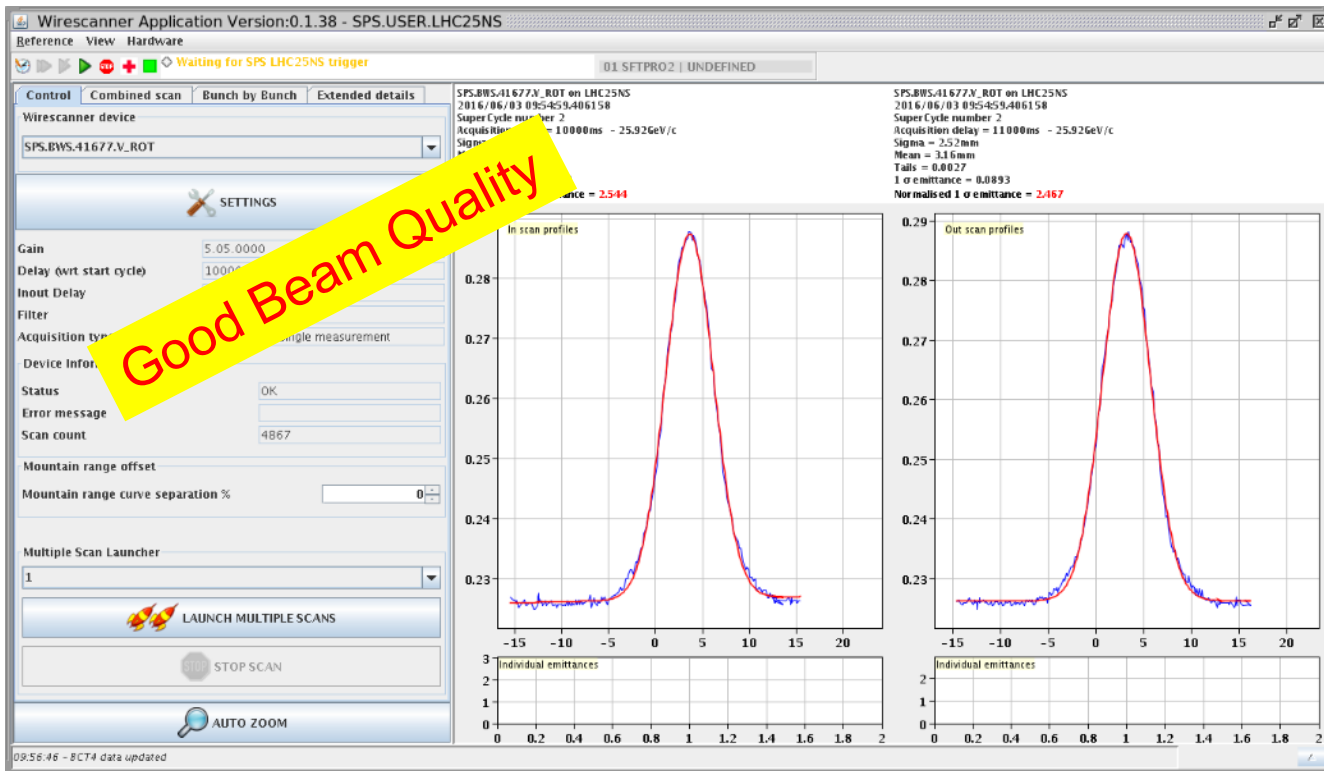


Training
with 1/1
mock-up

Courtesy Sven De Man

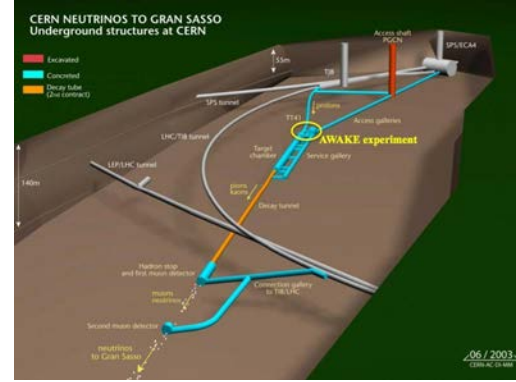
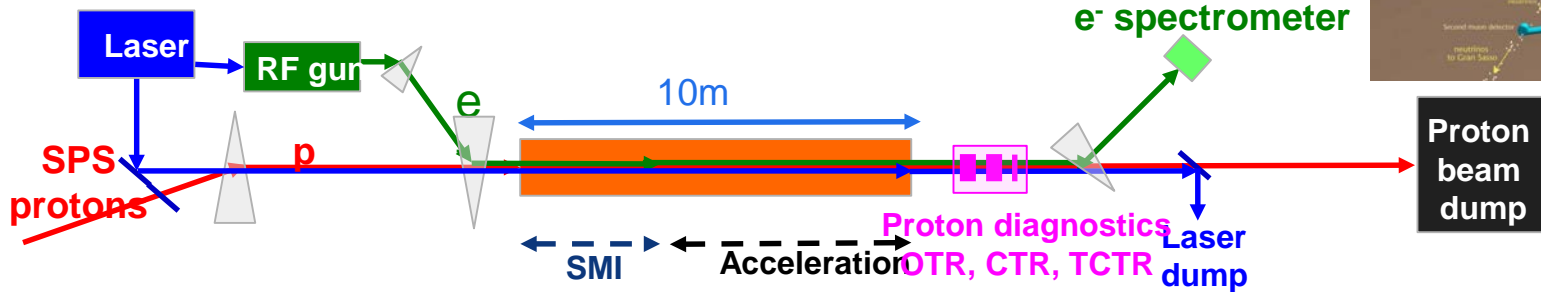
SPS: LHC Operational Beam with 72 bunches

- Limited to 1 batch from PS due to SPS beam dump
- 1.15×10^{11} p+ per bunch, emittances $\sim 2.5 \mu\text{m}$



AWAKE commissioning

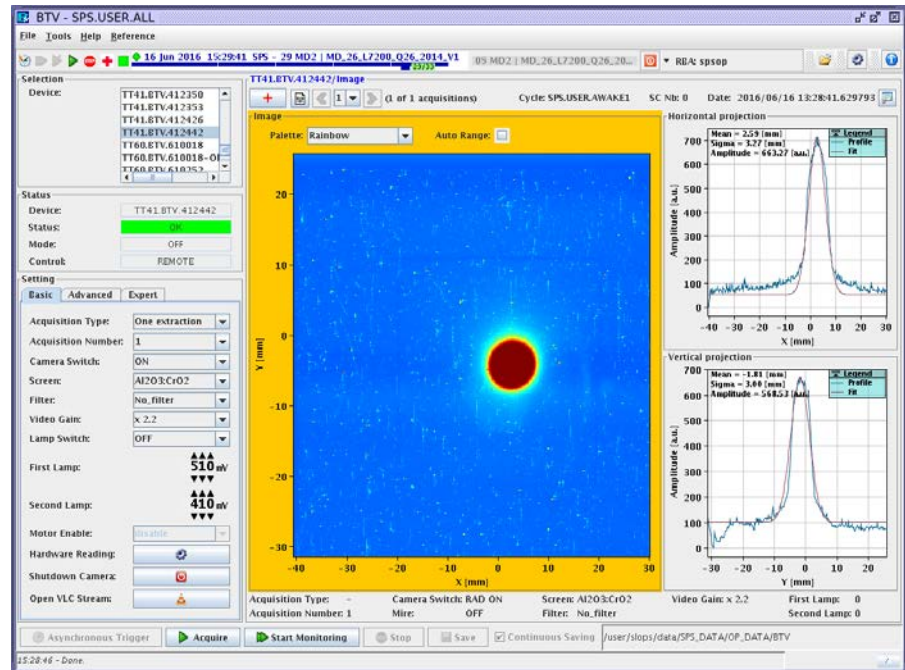
Proton Driven Plasma Wakefield Acceleration Experiment



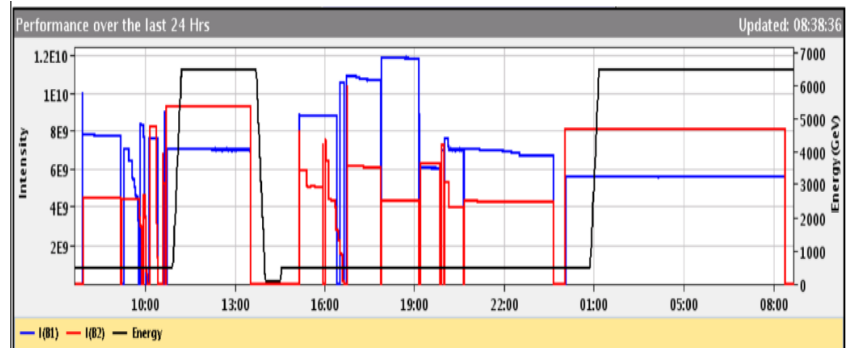
BREAKING NEWS

**Thursday 16 June 2016:
First AWAKE beam down
the proton line!**

Image of the last BTV screen
downstream the plasma cell.



LHC Start-up 2016



Friday 25 th March	First circulating beam
Saturday 26 th March	First ramp to 6.5 TeV
Sunday 27 th March	Squeeze to 0.4 m and optics measurements
Thursday 31 st March	Optics correction at 6.5 TeV (flat-top+squeeze)
Wednesday 6 th April	Nominal bunch to flat-top
Friday 8 th April	Nominal bunches into collisions
Tuesday 12 th April	Quiet beams
Sunday 17 th April	Aperture measurement (collision)
Thursday 21 st April	72 bunch injection to 444 bunches/beam
Friday 22 nd April	First Stable Beams – 3 bunches/beam

LHC April – May 2016

1668 1884

Mon 25 th April	Start scrubbing
Tues 26 th April	1668+1884 bunches
Weds 27 th April	Stable Beams 12 bunches.
Thu 28 th April	Beam back (PS on rotating machine)
Fri 29 th April	Stable Beams 49 bunches
Thu 5 th May	Beam back
Fri 20 th May	Stable Beams 1177 bunches
Sat 21 st May	Fill 4947 lost after 35.5 hours
Thu 26 th May	POPS back in action

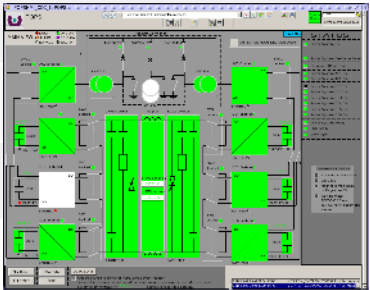
Vacuum leak on SPS dump

POPS – capacitor bank

Weasel Transformer Pt8

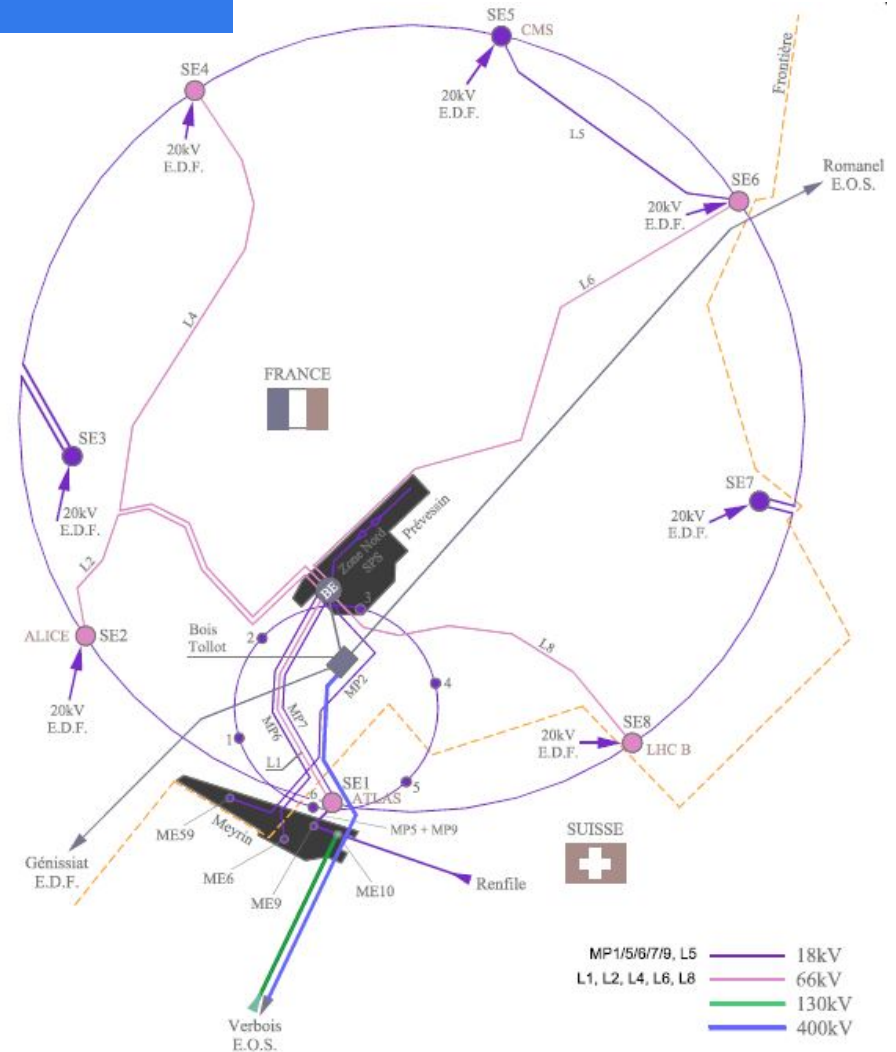


Rotating machine down



- **Lost around 2 weeks to technical faults**
- **Limitation number of injected bunches to avoid stressing SPS beam dump**

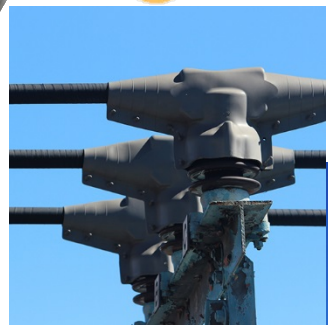
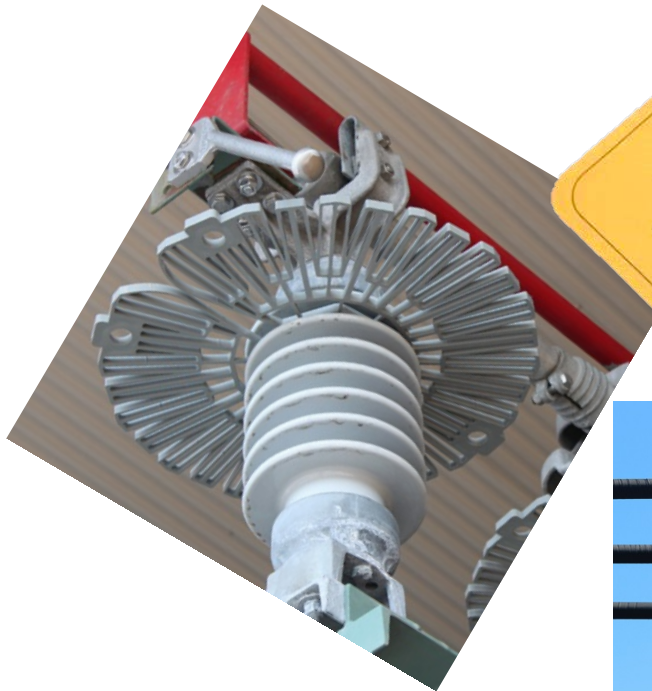
P8 Transformer 66 kV/18 kV





Tests divers

Eviter les dégâts de fouines



Contre les fouines avides de ronger, toute une panoplie de méthodes, plus ou moins efficaces, sont mises en oeuvre. Aucun moyen ne garantit une protection totale. Néanmoins, diverses recommandations vous montrent comment éloigner les fouines par des procédés simples.

Les assurances sont mises à contribution
Certes, le nombre de cas annoncés diminue, mais pour les assurances, les frais demeurent, c'est-à-dire que le coût moyen par cas est toujours plus élevé. Chaque année, les compagnies d'assurances suisses doivent déboursier des dizaines de millions de francs à cause de dégâts de fouines.



Un iguane responsable d'un black out de 4h00 sur toute la Guyane

guyane

Plus d
4h00 a
Sinnai

Seattle Raccoon Killed 5,000

The raccoon did not survive

05/11/2016 06:01 pm ET

used by

offline for four hours.

Tweet Email 88

A "Squirrel" market? The Nasdaq's shutdowns

AUGUST 22, 2013 BY NICK WADDELL 0 COMMENTS

Share this: Tweet G+ 2 f L



On August 2nd, 1994 a squirrel chewed into a power line in Trumbull, Connecticut, where the Nasdaq's computer center is located, shutting down trading for 34 minutes. It was the second time it had happened.



Obsession

On August 2nd, 1994 a squirrel chewed into a power line in Trumbull, Connecticut, where the Nasdaq's computer center is located, shutting down trading for 34 minutes.



a transformer at Gitaru power station. Little did he know that millions of iriosity.

LHC April – June 2016

	Apr			Scrubbing	May			June					
Wk	14	15	16	17	18	19	20	21	22	23	24	25	26
Mo	4	11	18	25	2	9	Whit 16	23	30	6	13	20	27
Tu							VdM						
We		Injector TS (8 hours)		POPS						TS1			
Th					Ascension						beta* 2.5 km dev.		
Fr	Recommissioning with beam			WEASEL	May Day comp				MD 1				
Sa													
Su				1st May			PS						

- Scrubbing shortened – SPS dump
- POPS, WEASEL, ROTATING MACHINE plus recovery
- Intensity ramp-up seriously impacted



LHC April – June 2016: new schedule

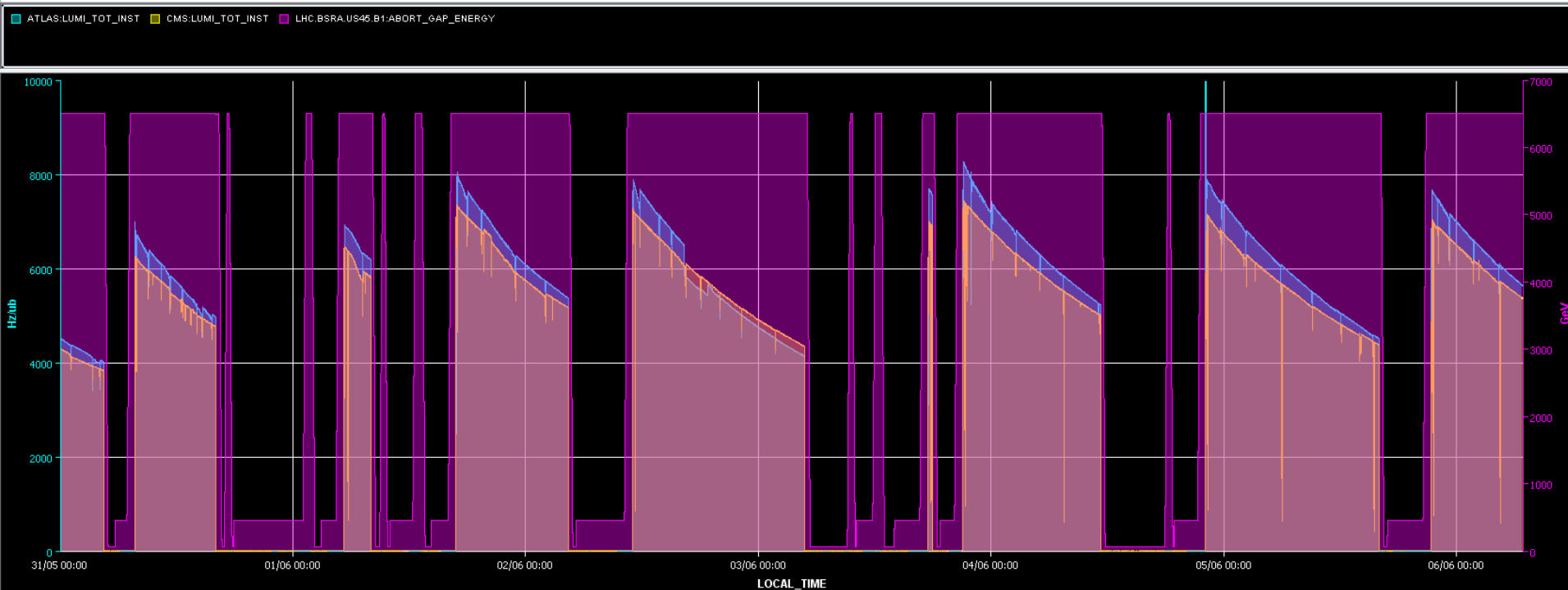
	Apr			Scrubbing	May			June					
Wk	14	15	16	17	18	19	20	21	22	23	24	25	26
Mo	4	11	18	25	2	9	Whit 16	23	30	6	13	20	27
Tu							VdM			TS1			
We		Injector TS (8 hours)											
Th					Ascension						beta* 2.5 km dev.		
Fr	Recommissioning with beam				May Day comp			VdM					
Sa													
Su				1st May									

- MD1 period postponed (5 days)
- TS1 shortened to 2.5 days – considerable amount done during extended stops for technical issues

After PS recovery and MD1 move a superb week

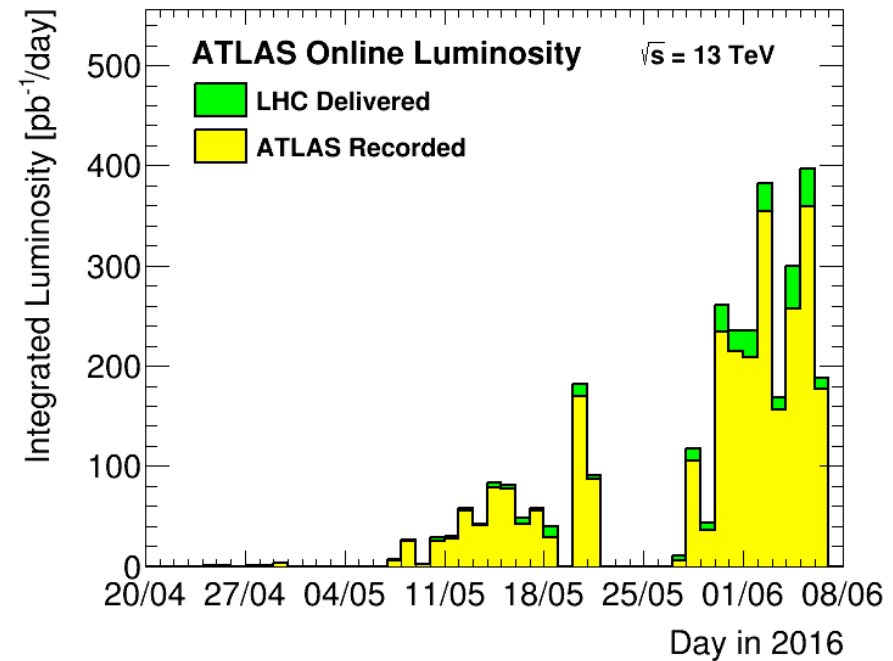
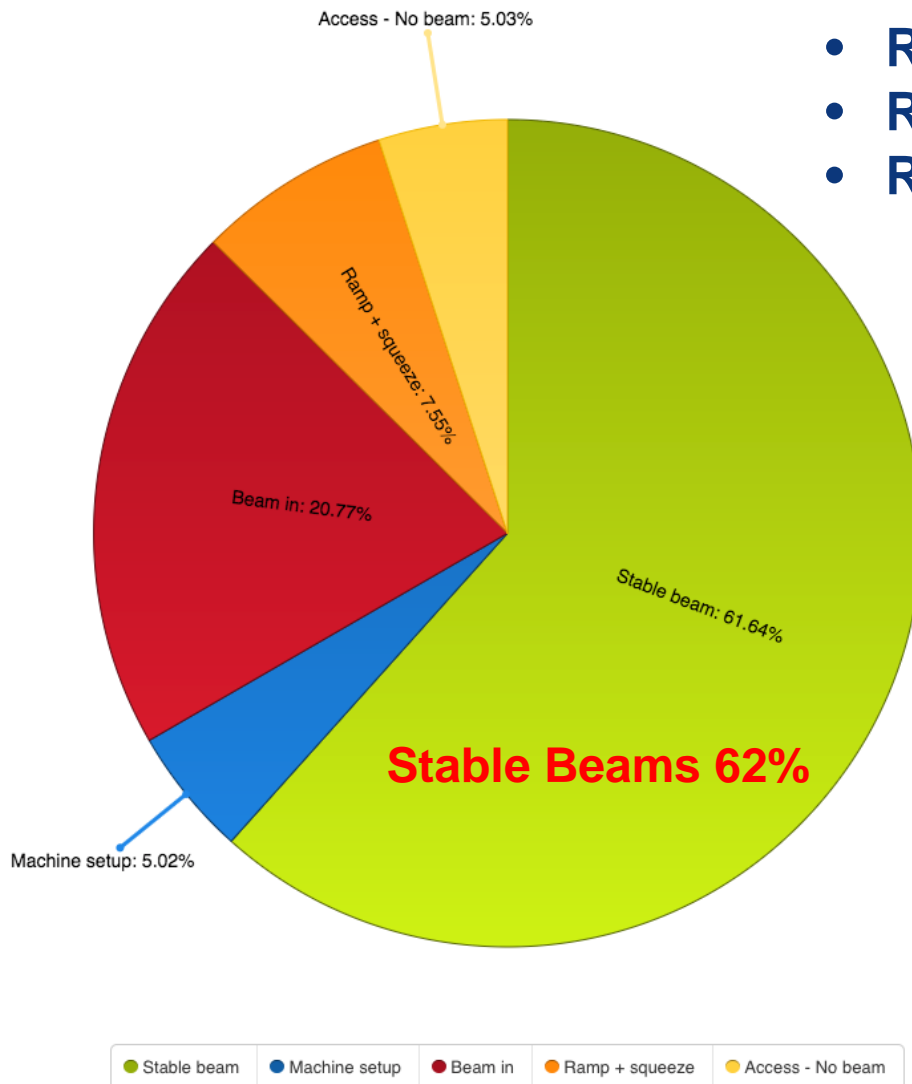
- Ramped up number of bunches to 2040 per beam
 - Maximum with 72 bunches per injection
 - Bunch population 1.1×10^{11}
- Peak luminosity $\sim 8 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$
- Excellent availability

Timeseries Chart between 2016-05-31 00:00:00.000 and 2016-06-06 06:50:14.976 (LOCAL_TIME)



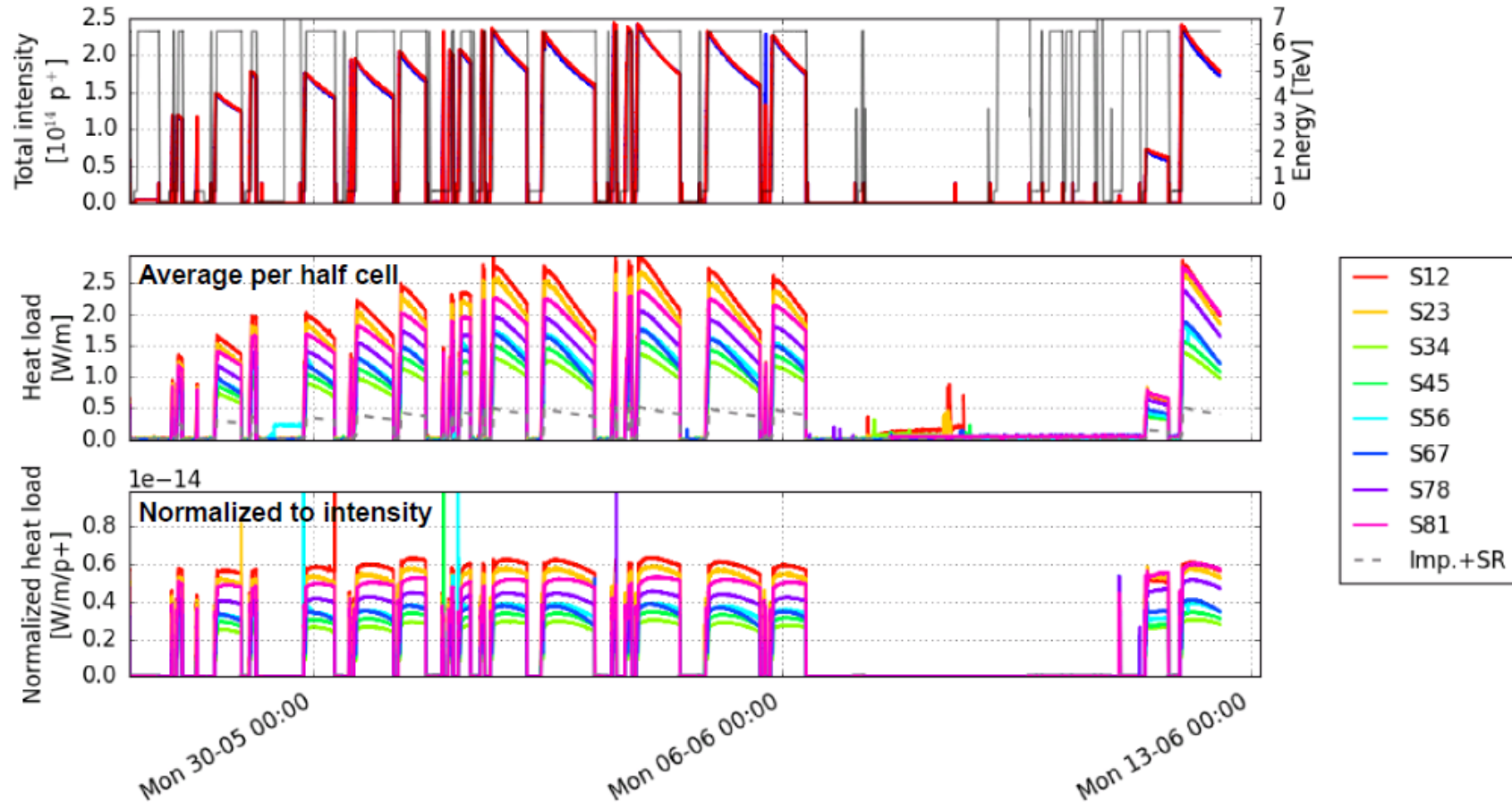
The golden week : Mon 30th May – Sun 5th June

- Record luminosity in fill: 380 pb⁻¹
- Record luminosity per day: 390 pb⁻¹
- Record luminosity per week: 1.98 fb⁻¹

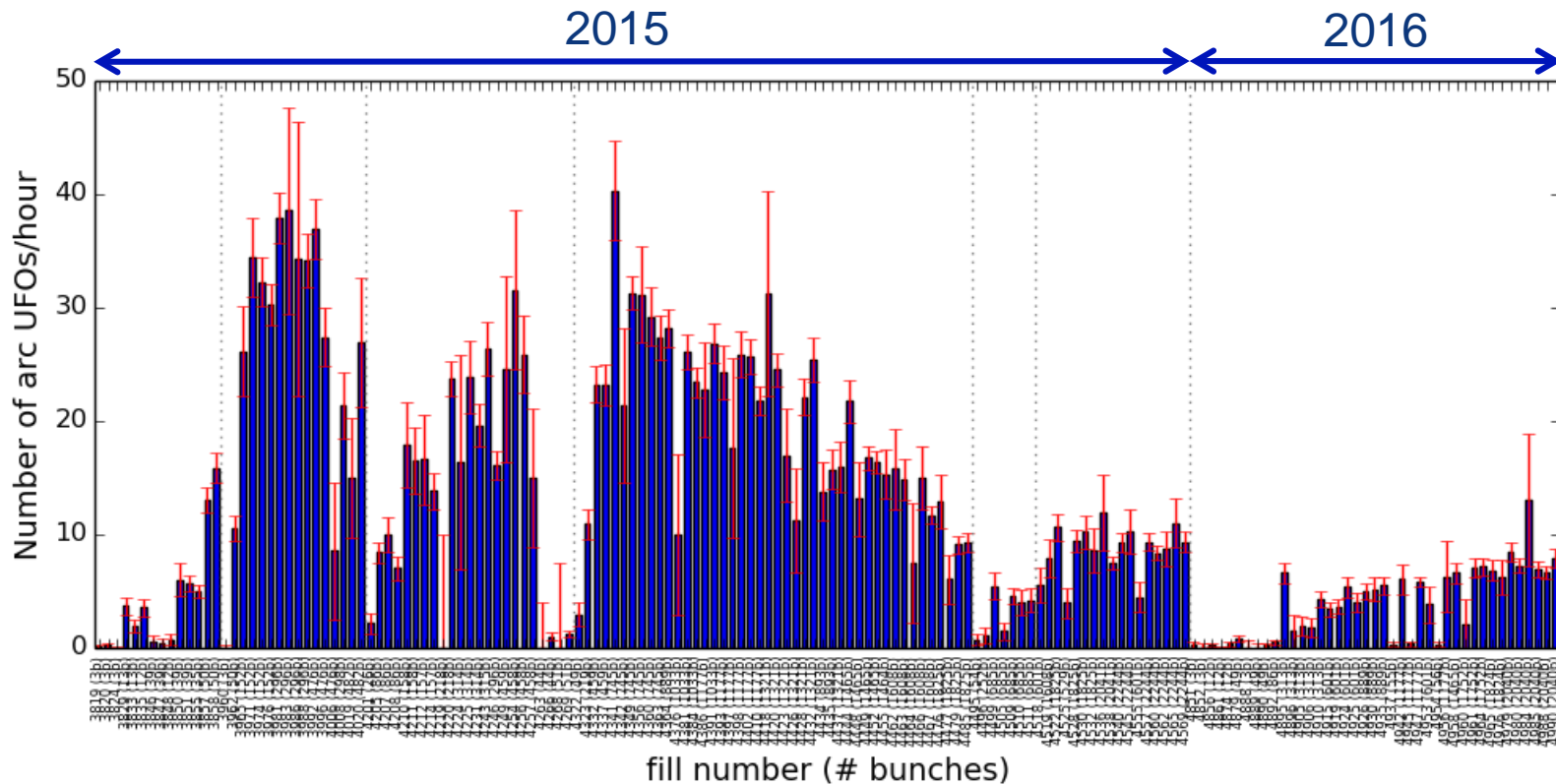


Electron cloud

- Still high electron cloud and high heat loads
- Within cryogenics limits and no more scrubbing (below the threshold)
- Beam parameters adjusted, stable operation

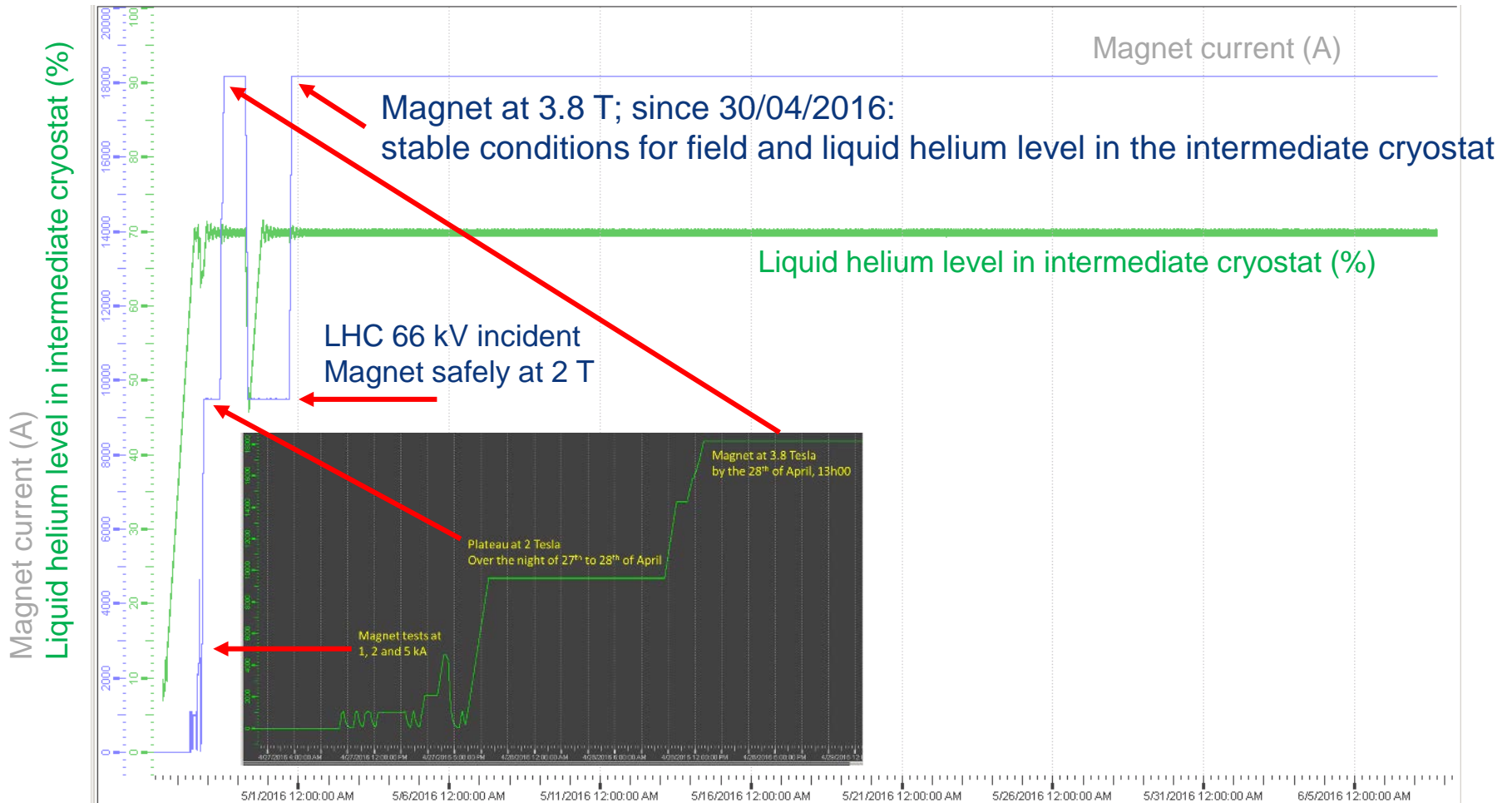


UFOs - Run 2 so far



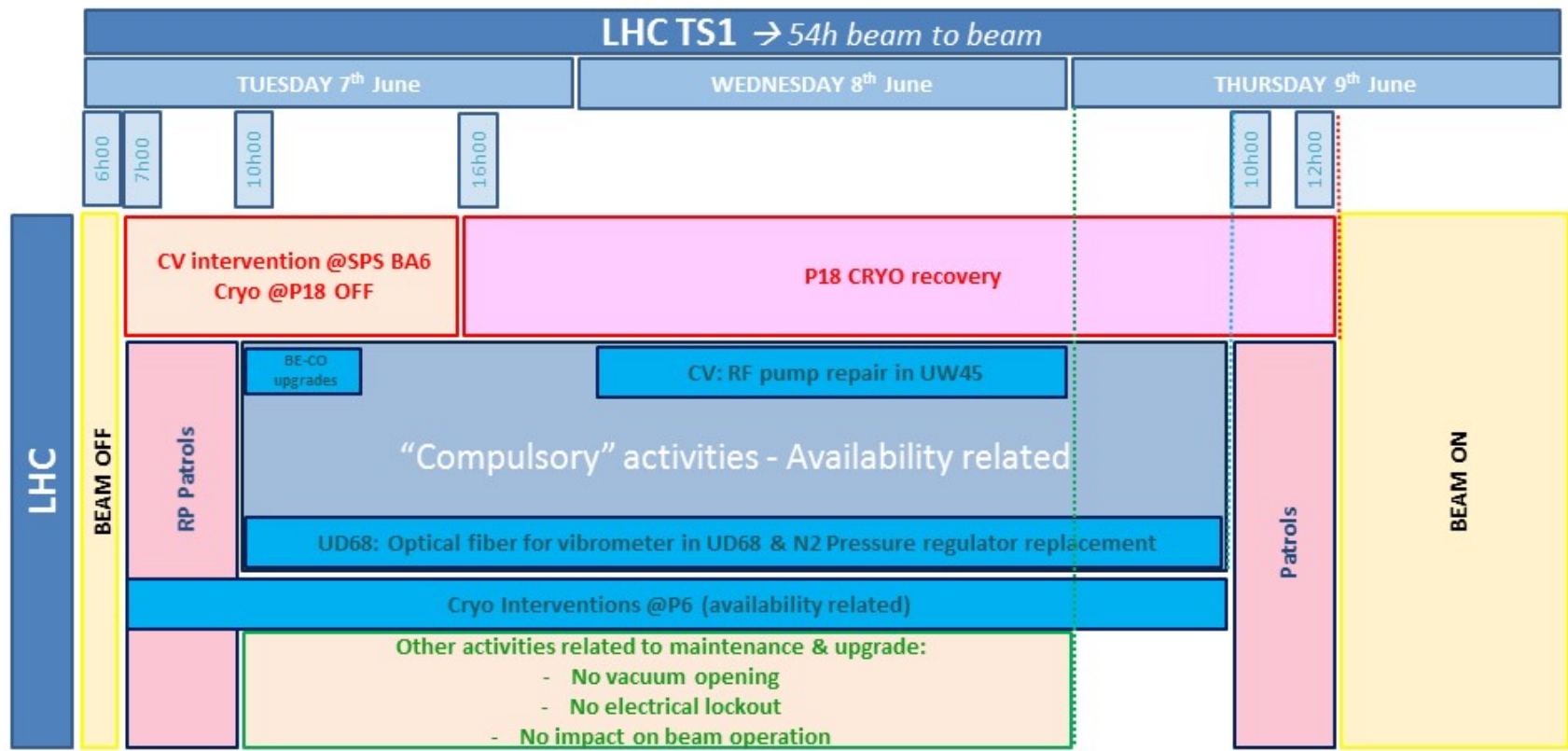
Arc UFOs : rates similar to end of 2015
- did not lose conditioning over the YETS stop

A good news: CMS Magnet at 3.8 T



Technical Stop Overview

- Original schedule → 5 days
- Following the unexpected stops of LHC & Injectors:
 - The activities have been anticipated during the available time
 - The duration of TS1 for LHC was reduced to 2.5 days, to solve only critical items
 - *The duration of TS2 for Injectors was reduced from 36h to 8h*



Activity on the critical path SPS Primary water leak

- 8th of May level 3 alarm: flooding in building 863
- Sumps was installed to re-inject water in the basin of the cooling towers
- 9th of May the leak was reduced with a temporary repair
- Water circuit impacting the LHC cryo cooling circuit in P18 – Sector 12
- Leak permanently repaired during the LHC-TS1
- Cryo recovery time in LHC ~ 40h



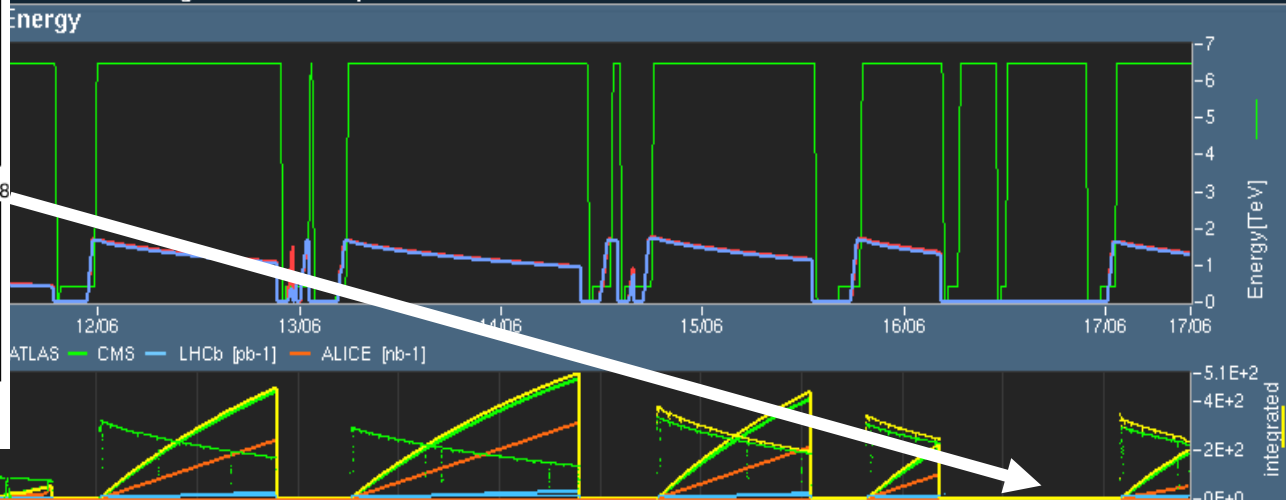
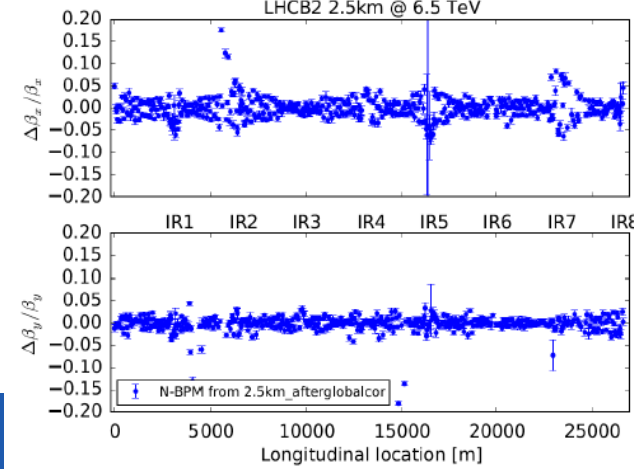
LHC April – June 2016: new schedule

		Scrubbing													
		Apr				May				June					
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Mo		4	11	18	25	2	9	Whit	16	23	30	6	13	20	27
Tu								VdM			TS1				
We			Injector TS (8 hours)												
Th						Ascension						beta* 2.5 km dev.			
Fr						May Day comp			VdM						
Sa		Recommissioning with beam													
Su					1st May										

- MD1 period postponed (5 days)
- TS1 shortened to 2.5 days – considerable amount done during extended stops for technical issues
- Physics 600 bunches Sat. (9h) and 2040 bunches back Sat. around midnight

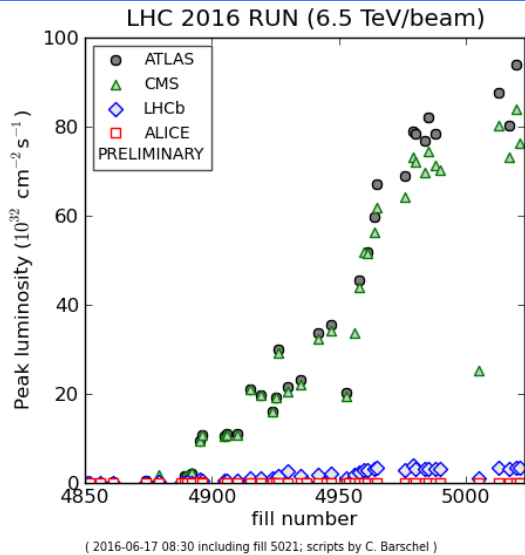
FILL NUMBER: 5024 STABLE BEAMS SINCE 08h 05m					Beam	Intensity	Stored E	Particle	Bunches	Beam Energy	17-06-2016 10:10:03
PROTON PHYSICS					1	1.83E+14	190 MJ	Proton	2040	6.50 TeV	
1697_1712_72bpi_30inj					2	1.88E+14	196 MJ	Proton	2040		

20 bunches longitudinal blow up test finished, mini scan in CMS

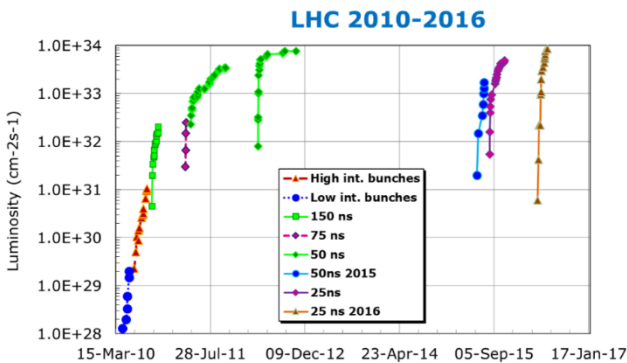
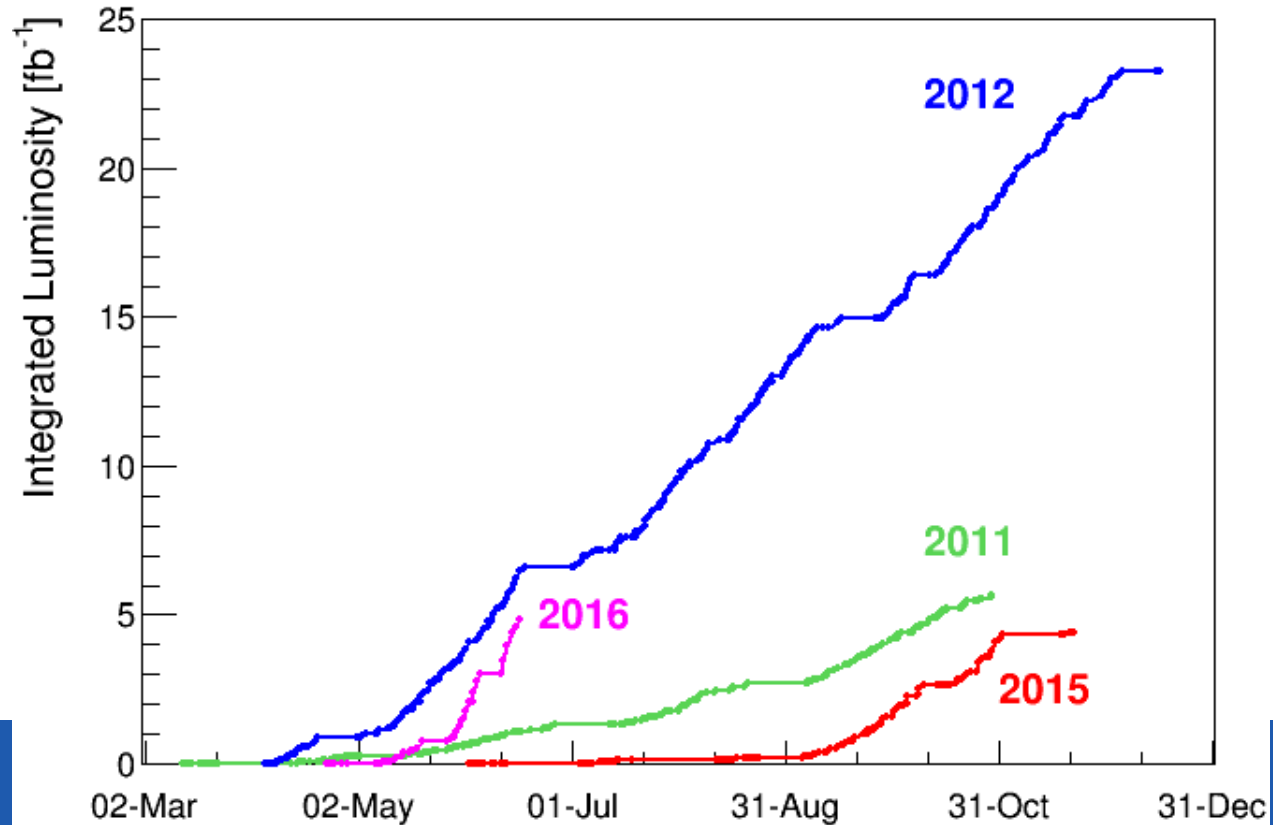


Frederick
17 June 2016

Peak and Integrated luminosity overview

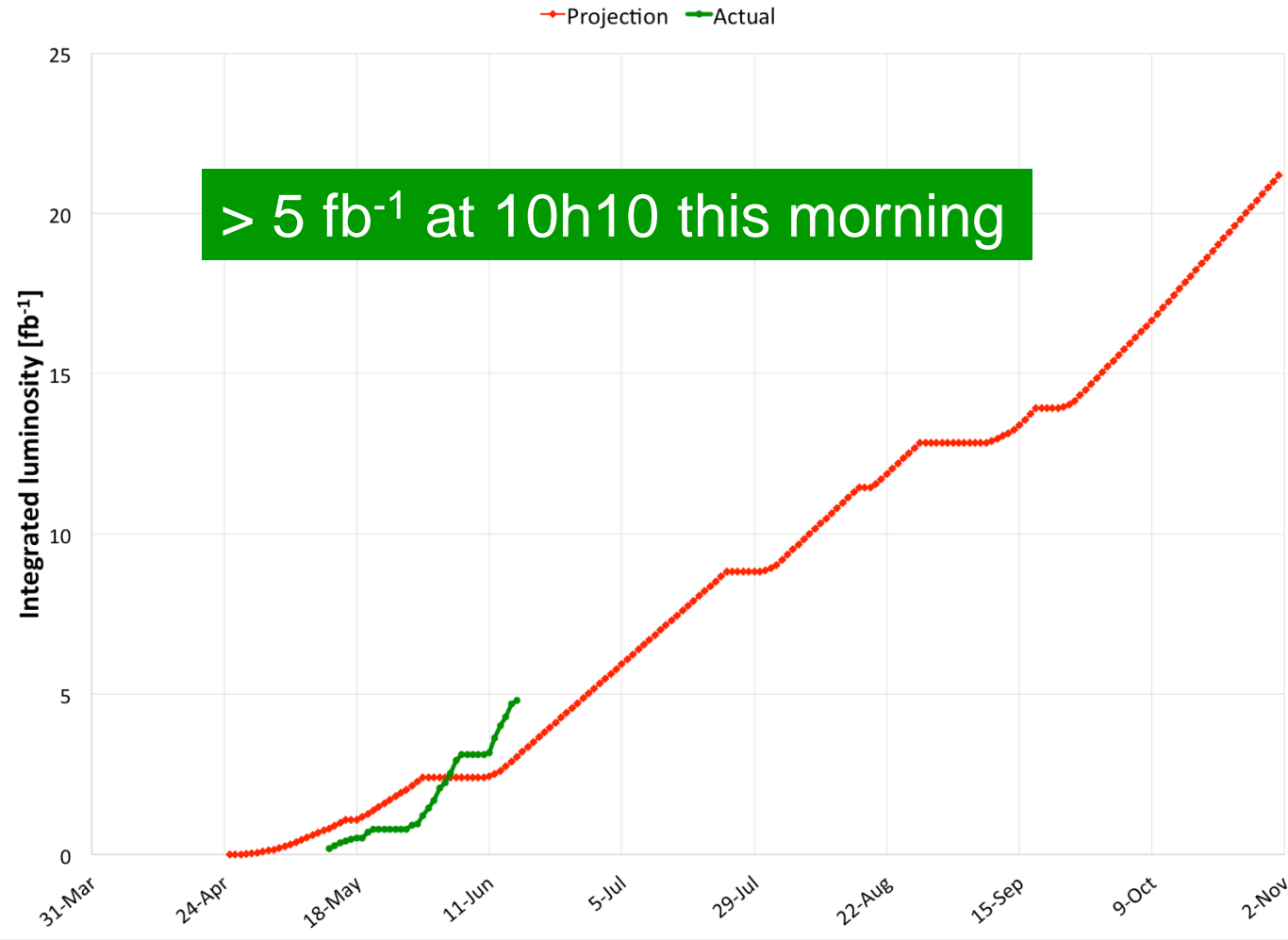


Peak luminosity: $9 \cdot 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$



Integrated luminosity: achieved % projected (Chamonix Jan. 2016)

2016 Integrated Luminosity Projection (40 cm β^* - 2100 bunches)



Hat's off to QPS, power converters, R2E, cryogenics, Infrastructures, etc ... all equipment teams ... and operation crew

Impossible without a terrific team spirit

LHC schedule

- ICHEP cut-off 20th July
- sustained production over the summer
- 2 days floating MD cut
- MD dates to be confirmed

	Apr				May				June				
Wk	14	15	16	17	18	19	20	21	22	23	24	25	26
Mo	4	11	18	25	2	9	Whit	16	23	30	6	13	20
Tu							VoM			TS1			
We		Injector TS (8 hours)											
Th					Ascension							beta* 2.5 km dev.	
Fr					May Day comp			VoM					
Sa	Recommissioning with beam												
Su				1st May									

	July			Aug				Sep					
Wk	27	28	29	30	31	32	33	34	35	36	37	38	39
Mo	4	11	18	25	1	8	15	22	29	5	12	19	26
Tu													
We				MD 1							TS2		
Th			beta* 2.5 km dev.							Jeune G		beta* = 2.5 km data taking	
Fr													
Sa										MD 2			
Su													

	Oct			Nov			Dec						
Wk	40	41	42	43	44	45	46	47	48	49	50	51	52
Mo	3	10	17	24	31	7	14	21	28	5	12	19	26
Tu													
We	MD 3					TS3	ions setup					Extended year end technical stop	
Th									Ion run (p-Pb)			Lab closed	
Fr					MD 4								
Sa													
Su										Pb MD		Xmas	New Year

2016:
production year



KEEP CALM AND FINGERS CROSSED



Thanks for your attention



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