

LHC Machine Status Report

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For the LHC team

Maximizing the Luminosity


Luminosity (round beams):

$$L = \frac{n_b \cdot N_{bunch1} \cdot N_{bunch2} \cdot f_{rev}}{4\pi \cdot \beta^* \cdot \varepsilon_n} \cdot R(\phi, \beta^*, \varepsilon_n, \sigma_s)$$

- ➔ 1) maximize bunch brightness [N_{bunch}/ε_n]
beam-beam limit and injector complex performance
- ➔ 2) minimize beam size [β^*] (constant beam power)
- ➔ 3) maximize number of bunches (beam power limit)
- ➔ 4) compensate for 'R'

Reminder of 2012 Priorities

1. The LHC machine **must** produce enough integrated luminosity to allow ATLAS and CMS to **independently** discover the Higgs before the start of LS1.
2. We must also prepare for the **proton-lead ion** run at the end of the year.
3. We must (in 2012) do the necessary machine experiments to allow high energy, **useful** high luminosity running after LS1.



Pile up and 25ns

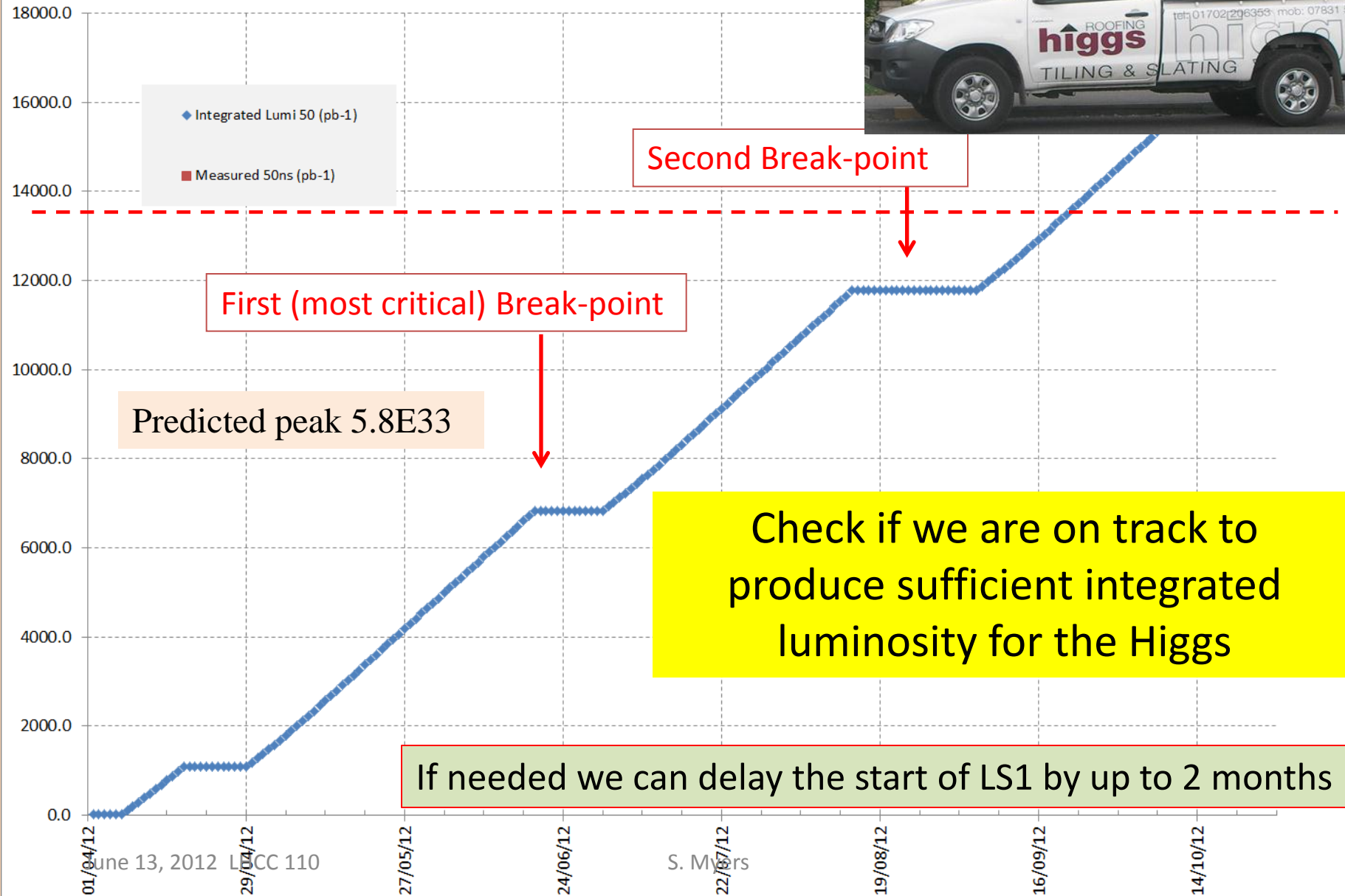
Integrated luminosity needed for Discovery of Higgs

Year	fb-1	signal (in σ)	Beam Energy	
2011	5	2.5	3.5	
2012	15	5	3.5	Needed
2012	11.5	5	4.0	Needed
2012	13.3	5	4.0	additional 15% for pile up and margin

Reminder 2012 run configuration

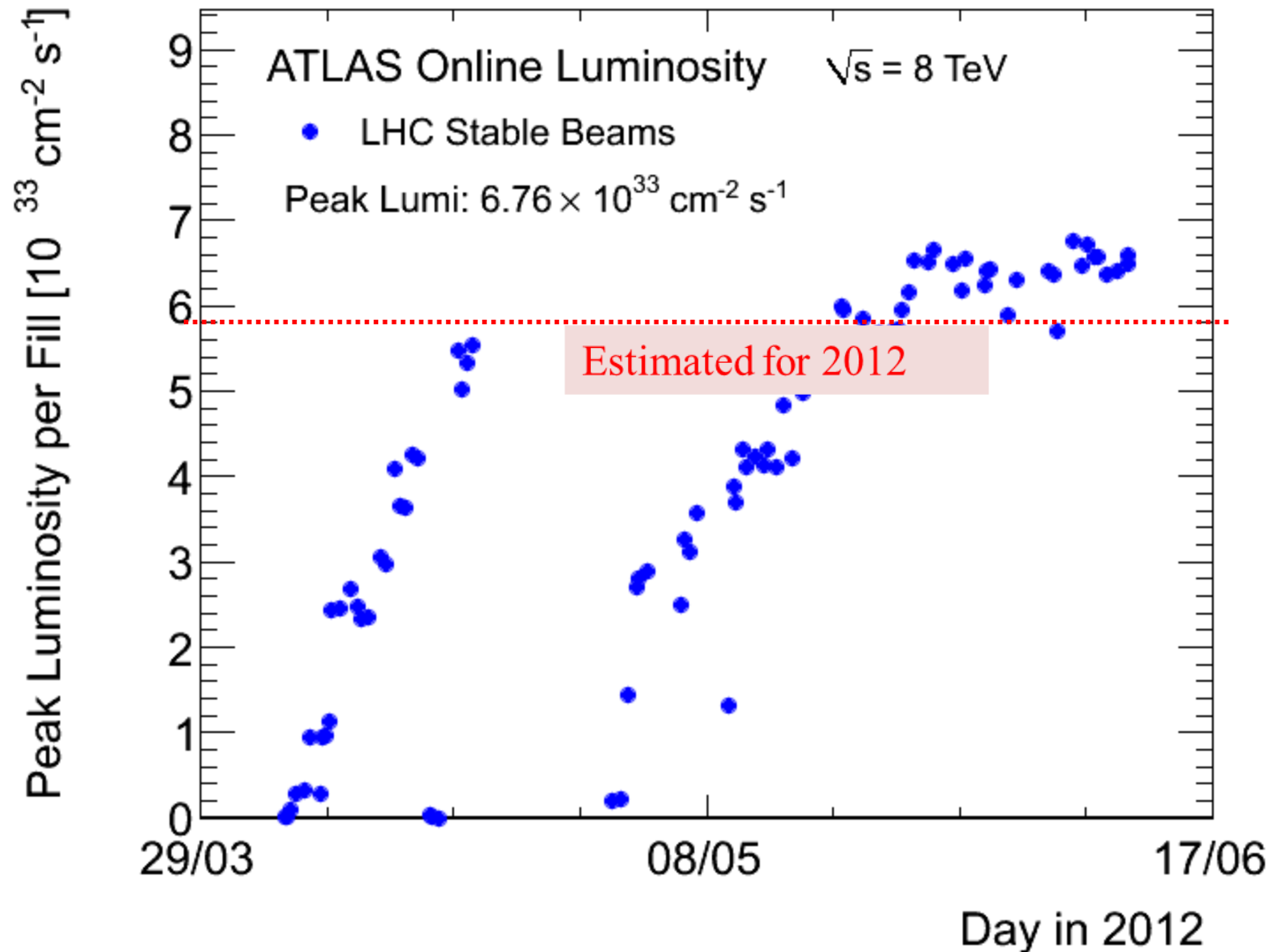
- Energy – 4 Real Challenge
 - 2 high luminosity experiments(ATLAS, CMS)
 - 1 mid-luminosity (LHCb) x20 lower
- Bunch spacing
 - 1 low-luminosity (ALICE) x10,000
 - Non colliding bunches to monitor background
 - Also TOTEM and ALFA
- Collimator settings – tight
- Atlas and CMS β^* - 60 cm
- Alice and LHCb β^* - 3 m
 - Natural satellites versus main bunches in Alice

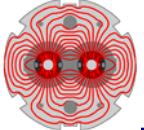
2012 Measured vs Predicted Integrated Luminosity



Present Performance

Peak Luminosity





7 Days of production (1.133fb^{-1}) (June 4—11)

LHC Efficiency - last 7 days

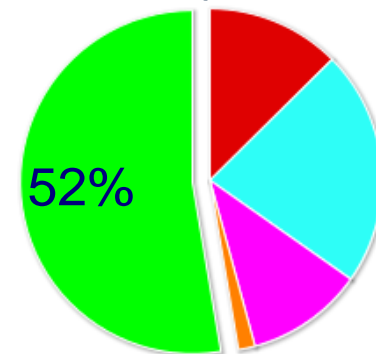
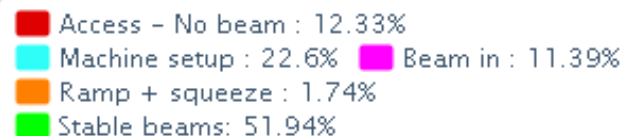
Mode: Proton Physics

Number of Fills: 28

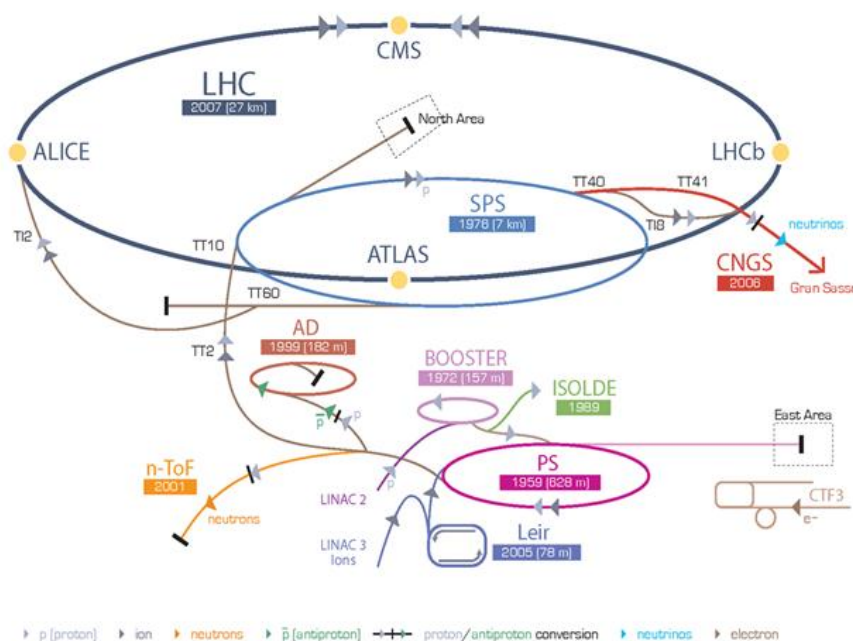
Time in SB: 4 days 19 hrs 10 mins

Intensity per bunch : $\sim 1.5\text{E}11$ p/b

Initial L : $6.2 - 6.7 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$



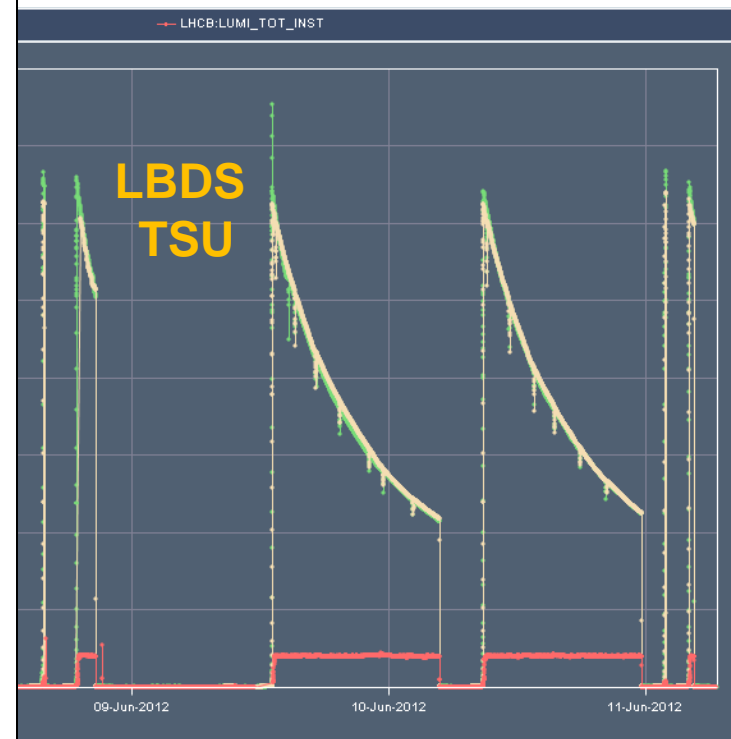
CERN Accelerator Complex



LHC Large Hadron Collider SPS Super Proton Synchrotron PS Proton Synchrotron

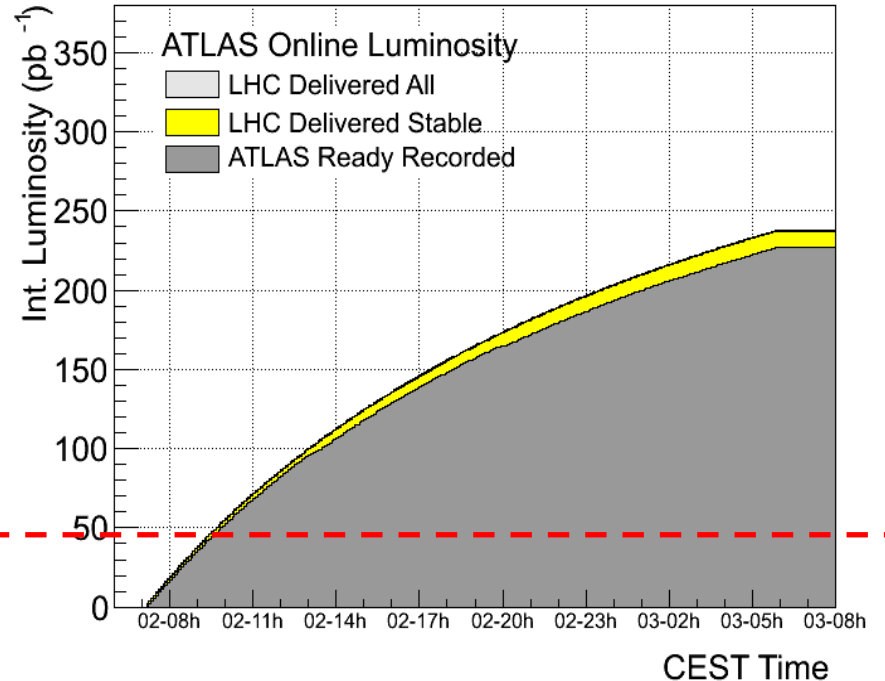
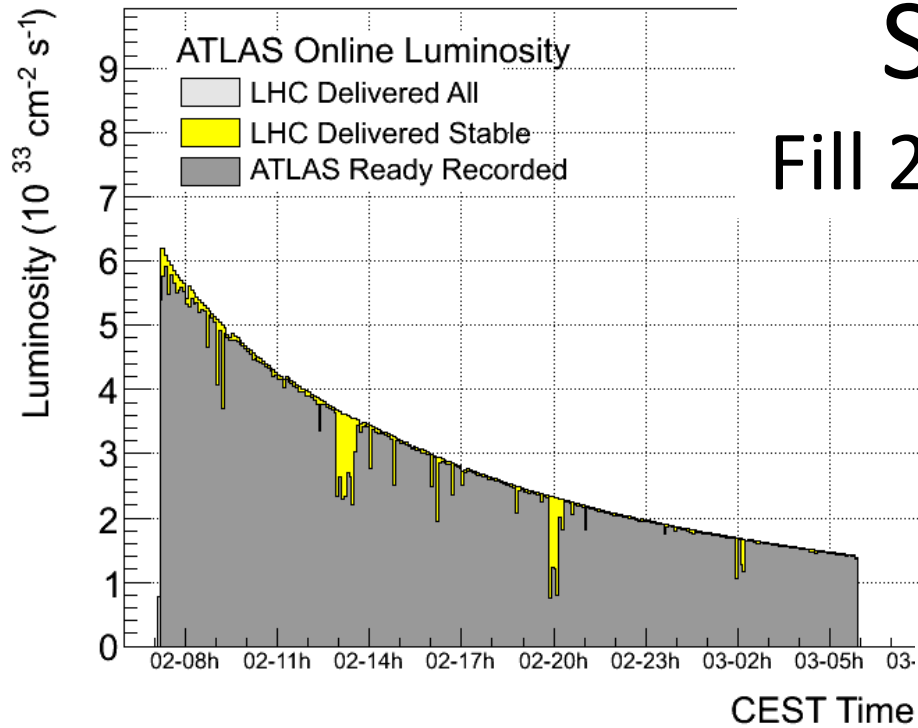
AD Antiproton Decelerator CTF3 CERN Test Facility CNGS CERN Neutrons to Gran Sasso ISOLDE Isotope Separator OnLine Device

LEIR Low Energy Ion Ring LINAC LiNear ACcelerator n-ToF Neutrons Time Of Flight



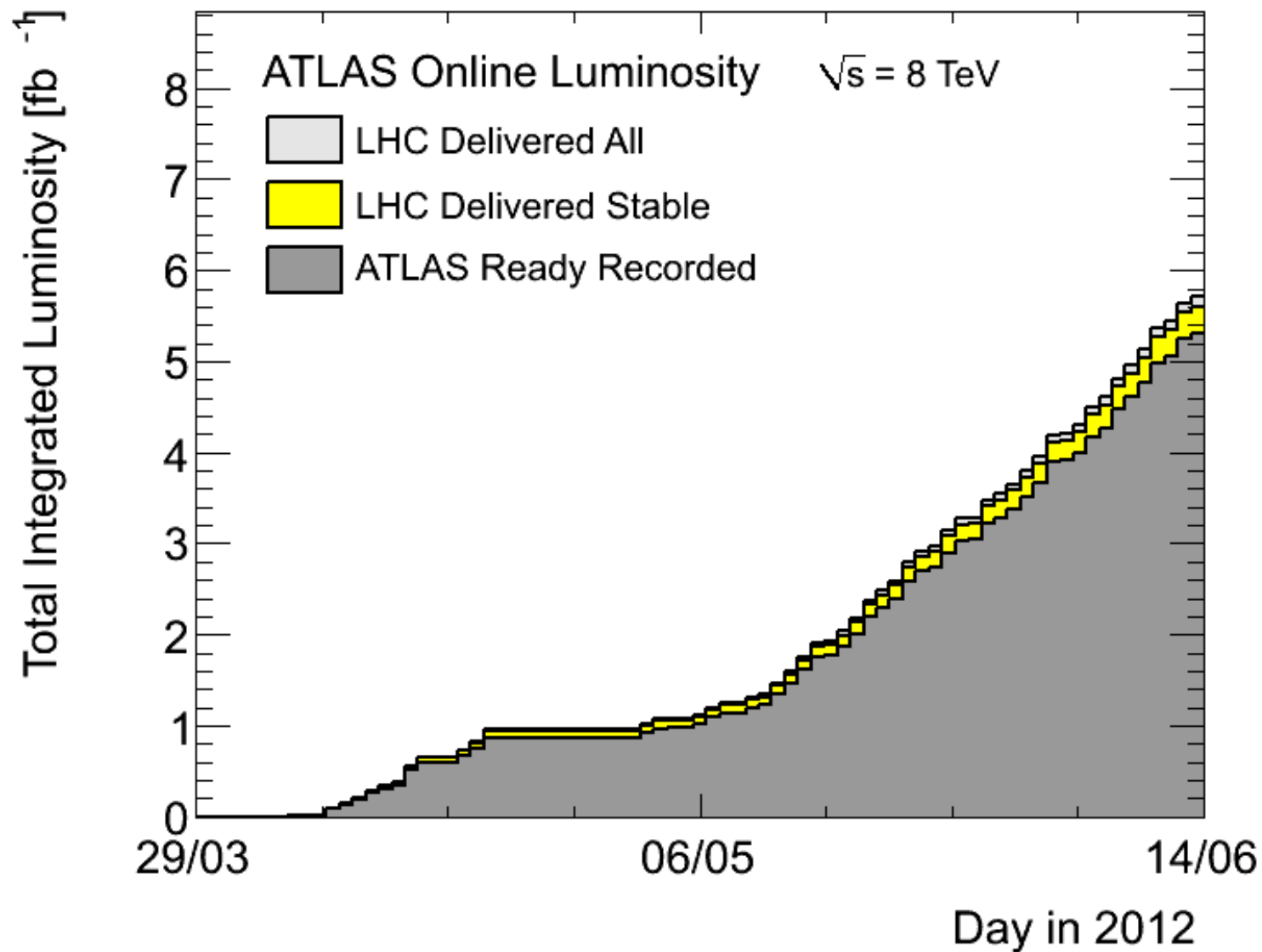
Saturday 2nd June

Fill 2692 (238pb-1 in 23 hours)

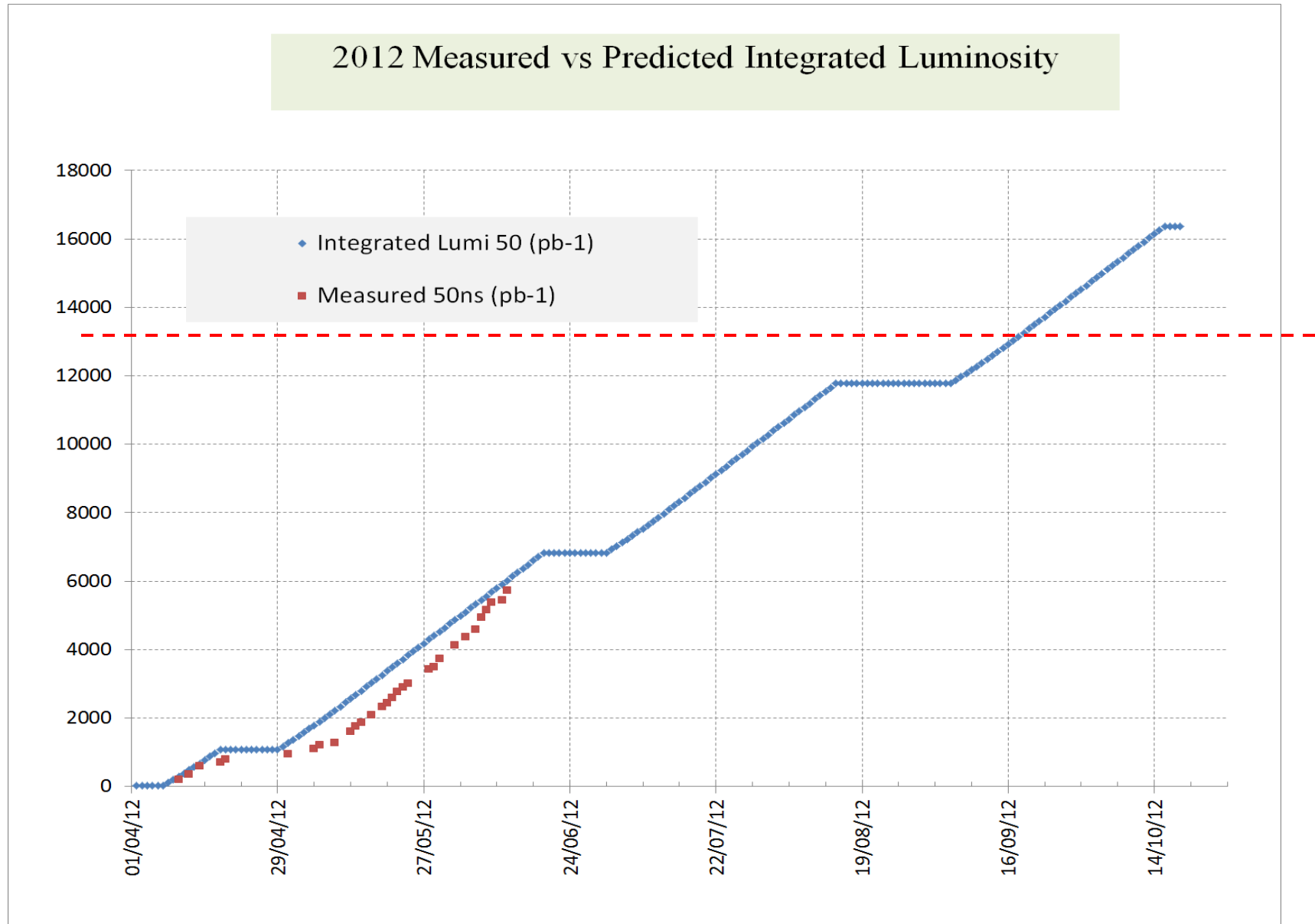


Integral of all of 2010
now 2.5 hours

Integrated from ATLAS



With Respect to estimates (as of Tuesday June 12)



Last 24 hours (260pb-1)

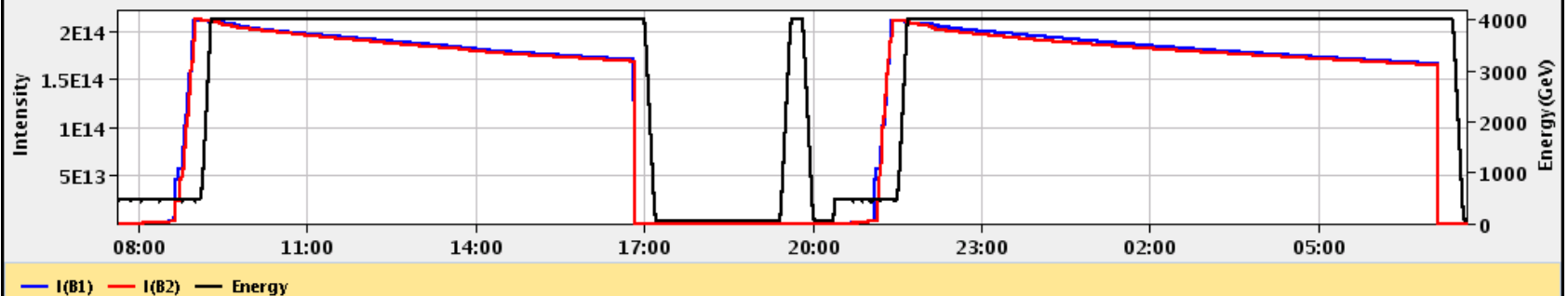
13-Jun-2012 07:37:26 Fill #: 2727 Energy: 59 GeV I(B1): 0.00e+00 I(B2): 0.00e+00

	ATLAS	ALICE	CMS	LHCb
Experiment Status	STANDBY	STANDBY	PHYSICS	STANDBY
Instantaneous Lumi [(ub.s) ⁻¹]	0.0	0.000	0.0	0.0
BRAN Luminosity [(ub.s) ⁻¹]	0.8	0.000	0.0	0.0
Fill Luminosity (nb) ⁻¹	142228.2	0.0	0.0	0.0
BKGD 1	0.003	0.163	0.001	0.141
BKGD 2	0.000	0.000	0.002	0.000
BKGD 3	0.348	1.654	0.434	0.056

LHCb VELO Position **OUT** Gap: 58.0 mm **RAMP DOWN** TOTEM: **STANDBY**

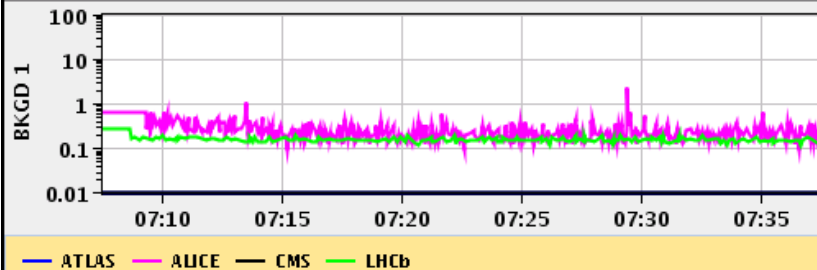
Performance over the last 24 Hrs

Updated: 07:37:24



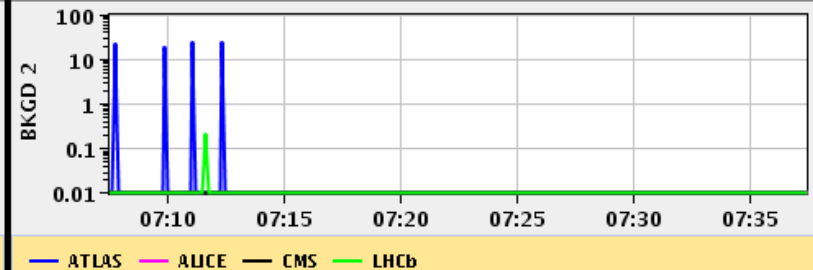
Background 1

Updated: 07:37:25



Background 2

Updated: 07:37:25



Records

Peak Stable Luminosity Delivered	$6.76 \times 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$	Fill 2710	12/06/06, 15:52
Maximum Luminosity Delivered in one fill	237.32 pb ⁻¹	Fill 2692	12/06/02, 01:55
Maximum Luminosity Delivered in one day	228.55 pb ⁻¹	Saturday 02 June, 2012	
Maximum Luminosity Delivered in 7 days	1133.3 pb ⁻¹	Monday 04 June, 2012 - Sunday 10 June, 2012	
Maximum Colliding Bunches	1380	Fill 2660	12/05/24, 13:17
Maximum Peak Events per Bunch Crossing	43.81	Fill 2479	12/04/06, 10:22
Maximum Average Events per Bunch Crossing	31.87	Fill 2710	12/06/06, 15:52
Longest Time in Stable Beams for one fill	22.8 hours	Fill 2692	12/06/02, 05:10
Longest Time in Stable Beams for one day	20.5 hours (85.6%)	Saturday 02 June, 2012	
Longest Time in Stable Beams for 7 days	79.0 hours (47.0%)	Monday 04 June, 2012 - Sunday 10 June, 2012	
Fastest Turnaround to Stable Beams	2.13 hours	Fill 2472	12/04/05, 15:46

Don't get the idea that it's easy!(1)

- Beam-beam
 - luminosity levelling by transverse separation,
 - crossing angle and separation schemes
 - bunches with a range of betatron tunes,
- Instabilities (TMCI, Head-tail, coherent instabilities, electron cloud) Collimators very close to beam
 - Transverse Damping
 - Landau damping octupoles,
 - Beam-beam stabilization
 - Solenoidal fields in warm regions
- Beam Induced Heating

Don't get the idea that it's easy!(2)

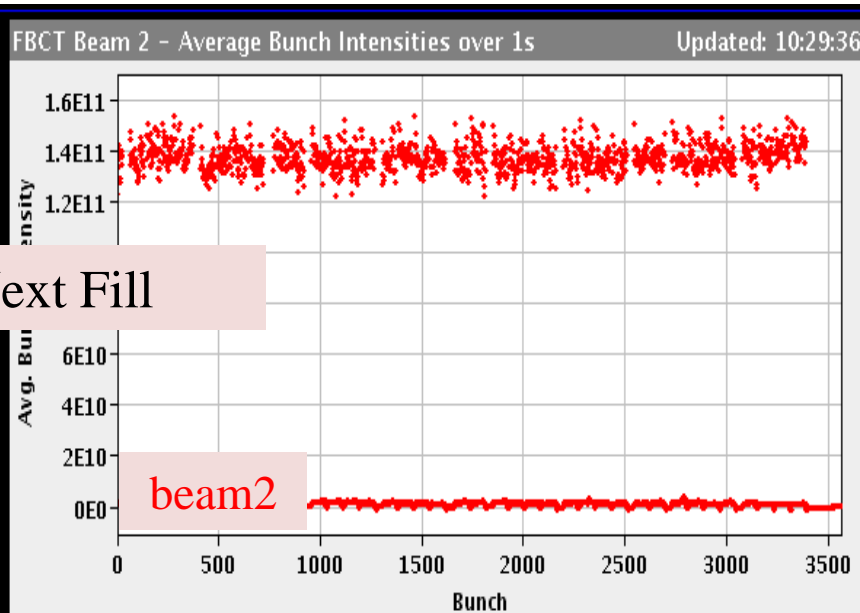
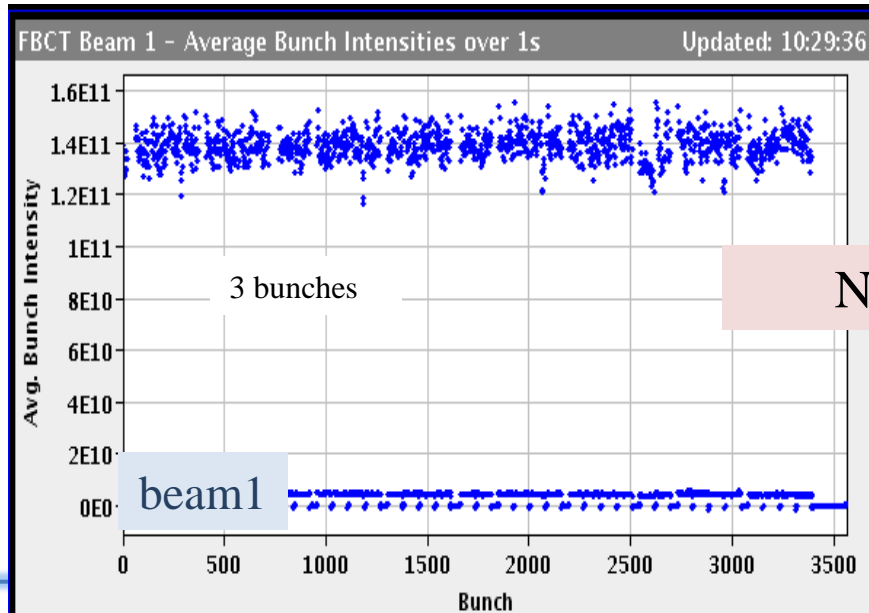
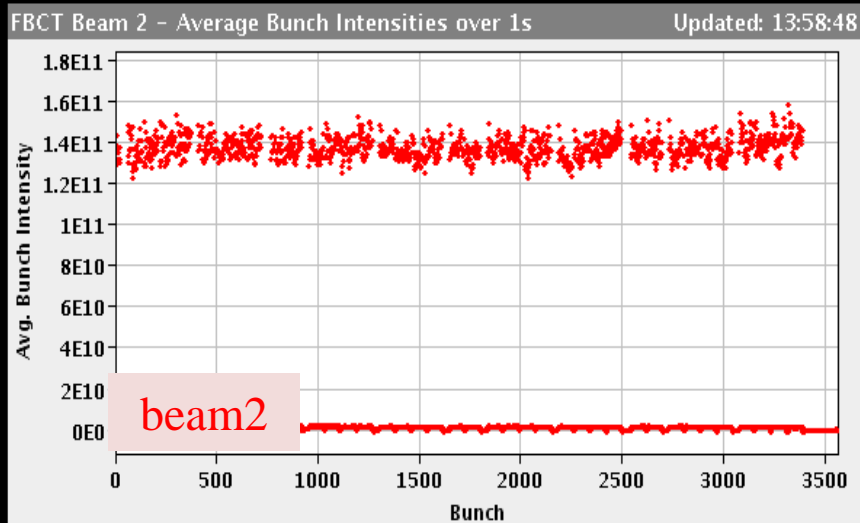
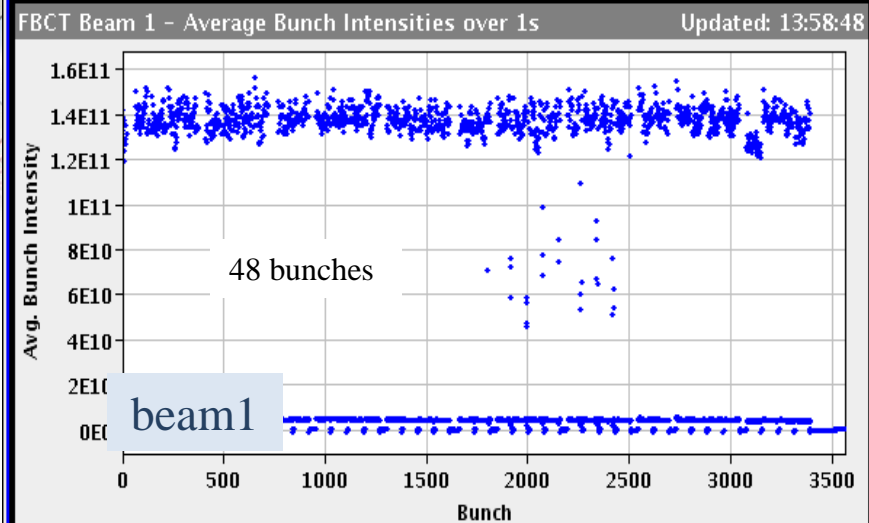
- Magnet measurement system (snapback, persistent currents..)
- Machine protection
 - Injection (protection devices, BLMS, injection interlocks..)
 - Ramp and squeeze (collimators, BLMS, orbit control...)
 - Collisions (idem, FCMM, UFOs...) electrical storms
- Emittance Control (longitudinal and transverse)
- Aperture

Don't get the idea that it's easy!(3)

- UFOs... dust particles
- R2E and Single Event Upsets(SEUs)
- Abort gap cleaning and Beam dump
- Beam feedback; orbit, tune, chromaticity
- Vacuum and electron cloud

Recent Example

Bunches used for background monitoring (only interact in LHCb) get lost and trigger the machine protection system to dump the beam



Next Fill

Summary

- A very successful first period in 2012
- However, we must remain extremely vigilant with respect to the protection of the machine (120MJ of stored energy) and hope that there are no “new” old “unexploded bombs” in the hardware!!
- In the absence of any major technical failure, the LHC machine WILL produce enough integrated luminosity in 2012 to allow the detectors to discover or exclude the Higgs Boson. EITHER DISCOVERY OR EXCLUSION WILL BE A MAJOR DISCOVERY!

Near Miss!

Preparing for a review on “LBDS powering” on 20 June ...
(triggered by asynch. dump)

Identified an error source on the test bed which would (if this error would occur) render the LBDS inoperable (→ NO dump when requested)

Trigger Synchronization Units (redundant TSUs, powered by redundant PS) in one crate

Loss of +12 V, e.g. by short circuit on a card, would make all output stages unusable

Power failure will be detected but, due to the loss of 12 V, not be transmitted further down into the LBDS (power triggers/pulse generators)

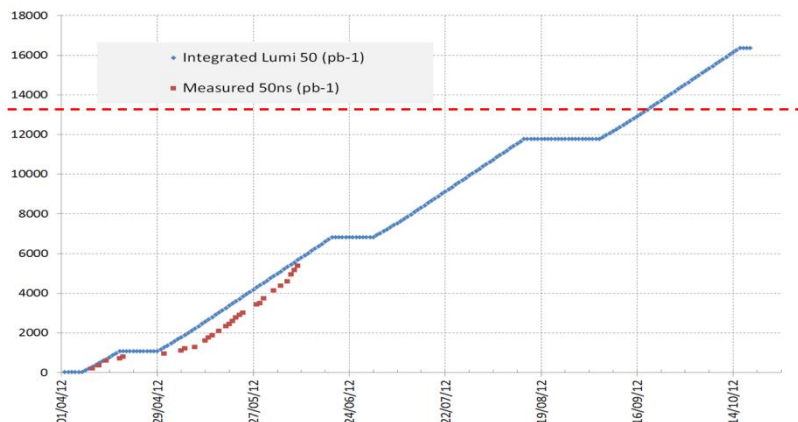
Disaster, nightmare, Armageddon

Summary

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- However, we must remain extremely vigilant for the protection of the machine (120MJ of stored energy) as there are no “new” old “unexploded bombs”
- In the absence of any major technical failures, the LHC WILL produce enough integrated luminosity to discover or exclude the Higgs boson. EITHER DISCOVERY OR EXCLUSION WILL BE A MAJOR DISCOVERY!



2012 Measured vs Predicted Integrated Luminosity

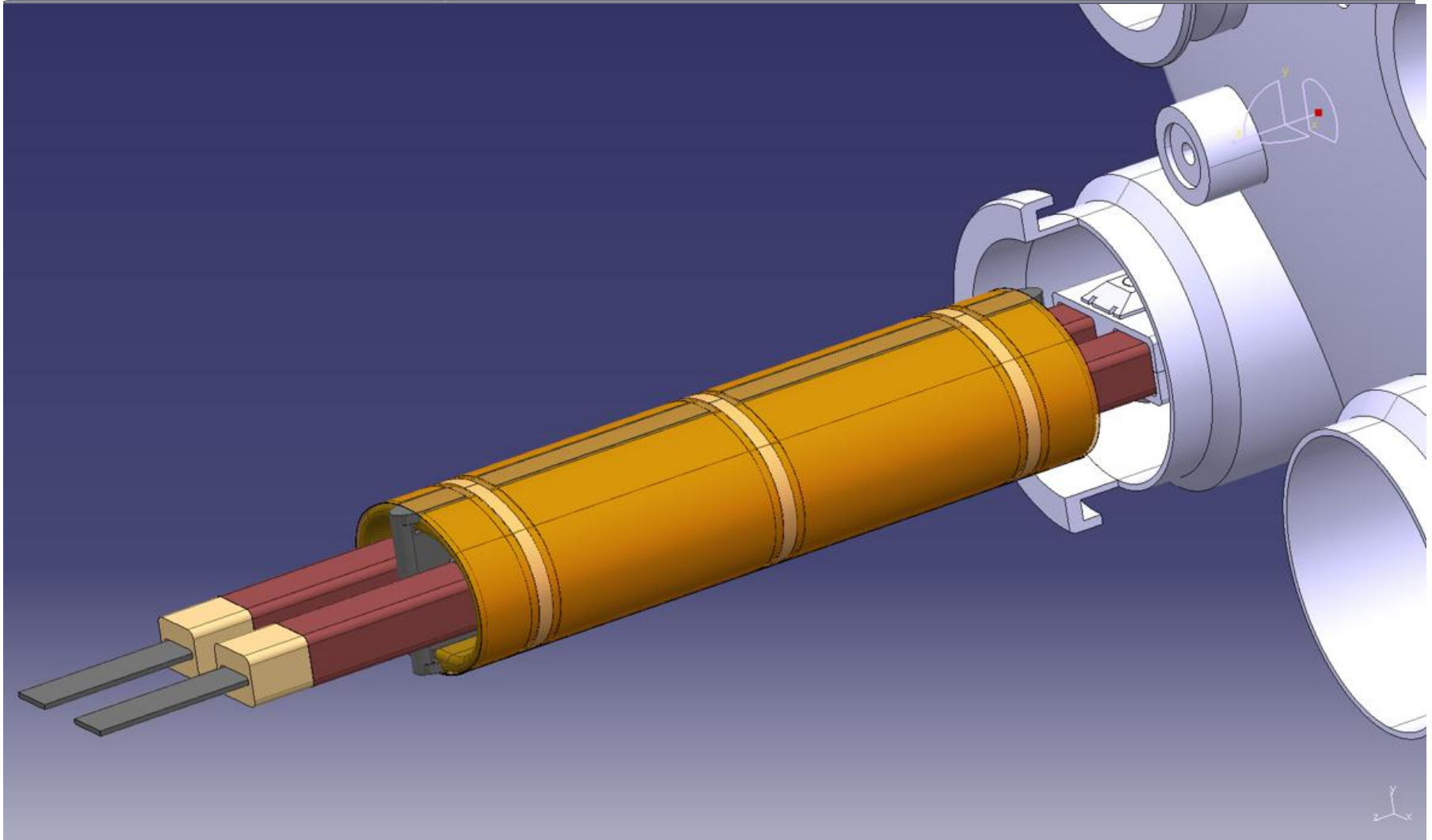


Thank you for your attention

Main LS1 Work

- Repair defectuous interconnects
- Consolidate all interconnects with new design
- Finish off pressure release valves (DN200)
- Bring all necessary equipment up to the level needed for 7TeV/beam

LHC MB circuit splice consolidation proposal



Phase III

Insulation between bus bar and to ground, Lorentz force clamping

7 Days of production (1.133fb^{-1}) (June 4—11)

