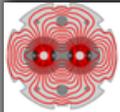


# Review of 2011 LHC run from the experiments perspective

- ❑ Overview of run,  $L$ ,  $L_{int}$ , etc
- ❑ Physics highlights
- ❑ Hübner factors, turn-around time, and all that...
- ❑ Special activities
- ❑ Wrap up

# A year ago ..... Chamonix 2011



## Luminosity projections for 2011

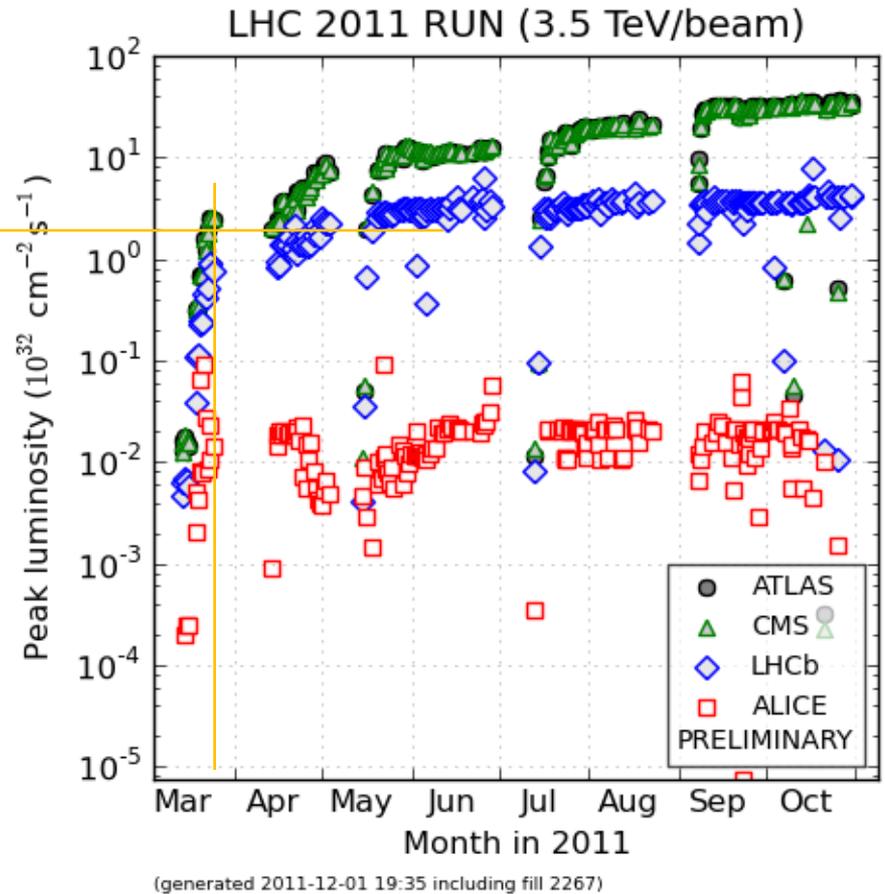
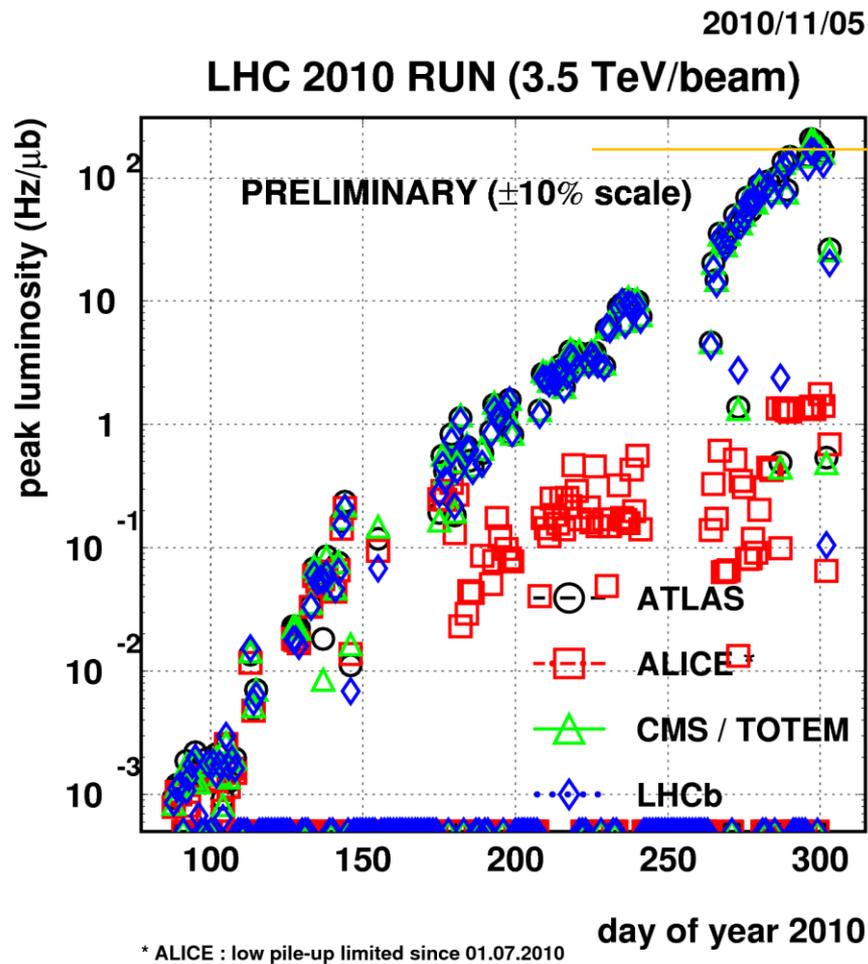
- Base:  $1 \text{ fb}^{-1}$
- Stretched:  $3 \text{ fb}^{-1}$
- Bob the builder “YesWeCan” coordinator special:  $5 \text{ fb}^{-1}$
- Super-duper stretched lino somewhere over the rainbow experiments’ special:  $10 \text{ fb}^{-1}$



Thanks to all the speakers for an excellent set of presentations

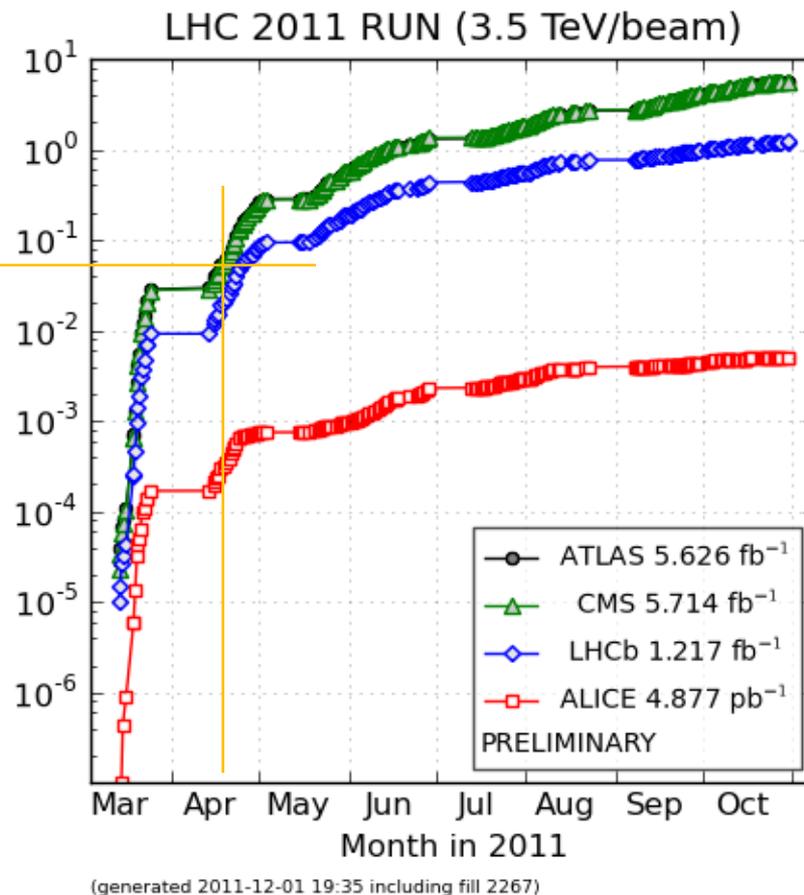
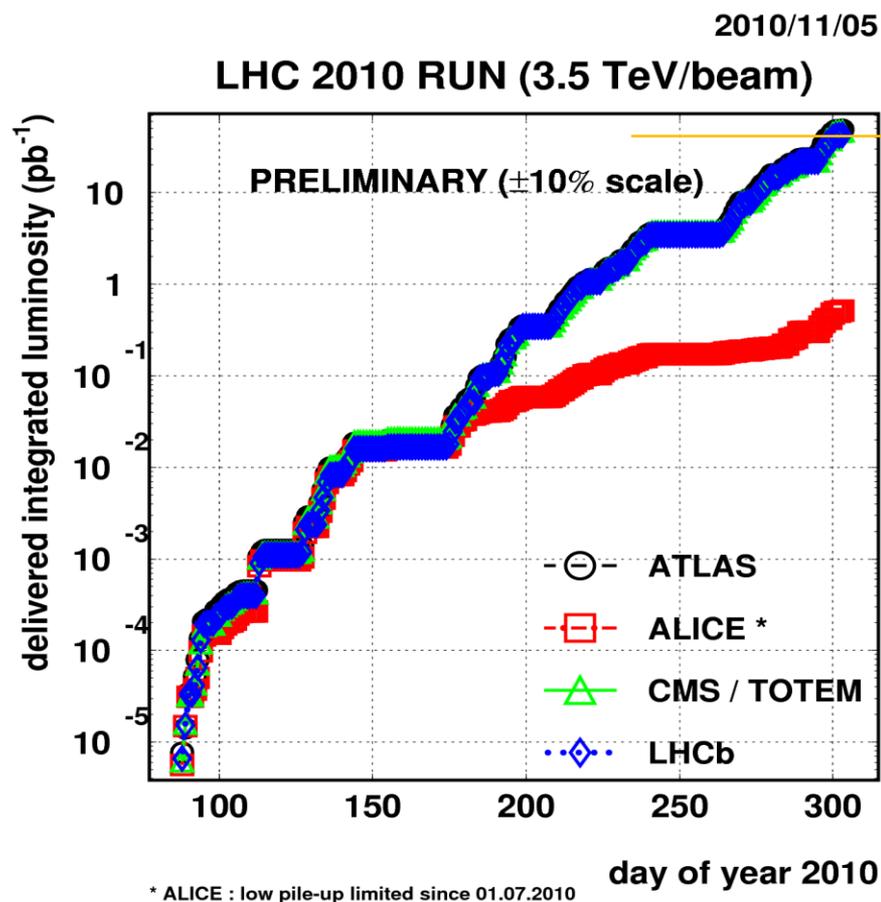
# Mean assertions...

# pp peak luminosity



- 2010 peak lumi re-established in 9 days of physics operation
- Will do even better in 2012!

# pp integrated luminosity



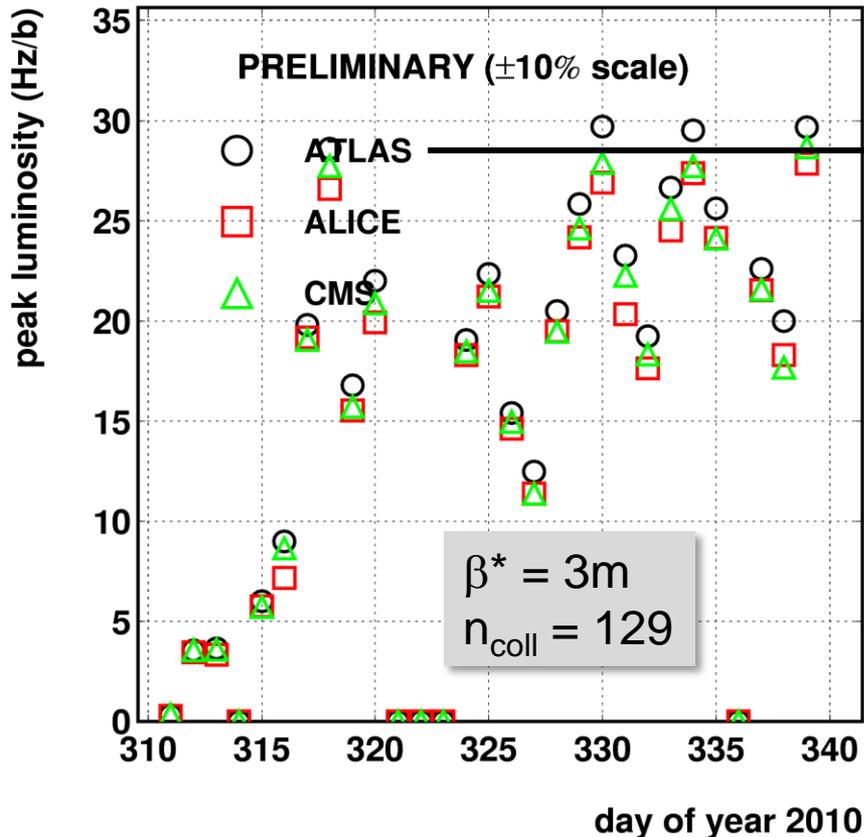
- About 1 month of physics to double 2010  $L_{\text{int}}$
- Do it again in 2012!!

# PbPb peak luminosity

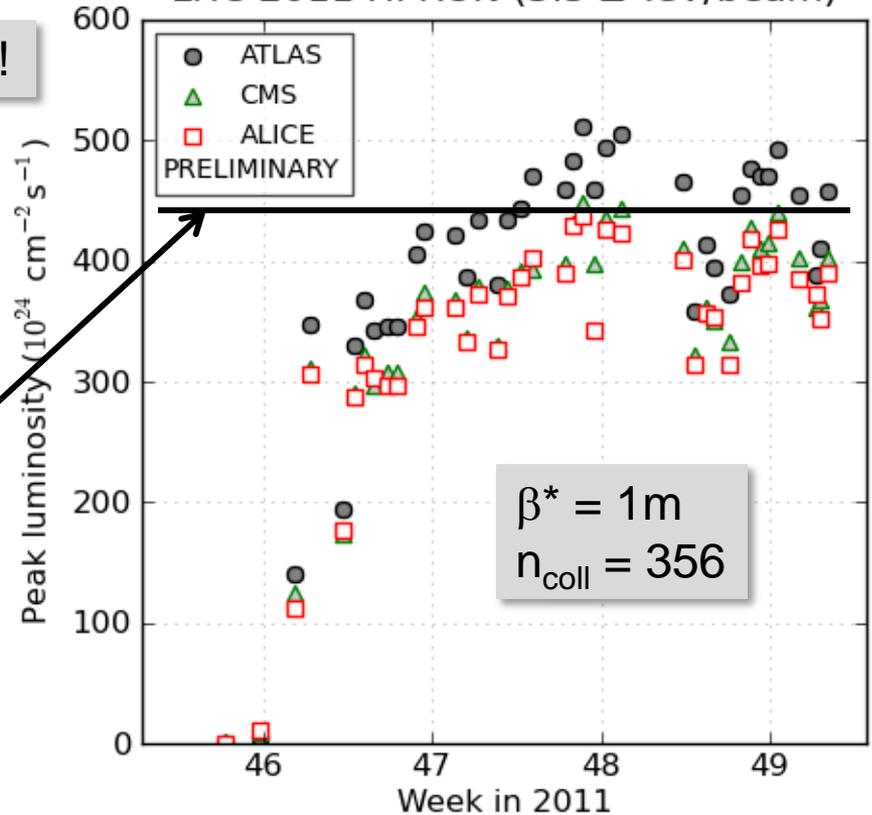
factor 16 improvement!

2010/12/06 21.3

LHC 2010 HI RUN (3.5 Z TeV/beam)



LHC 2011 HI RUN (3.5 Z TeV/beam)

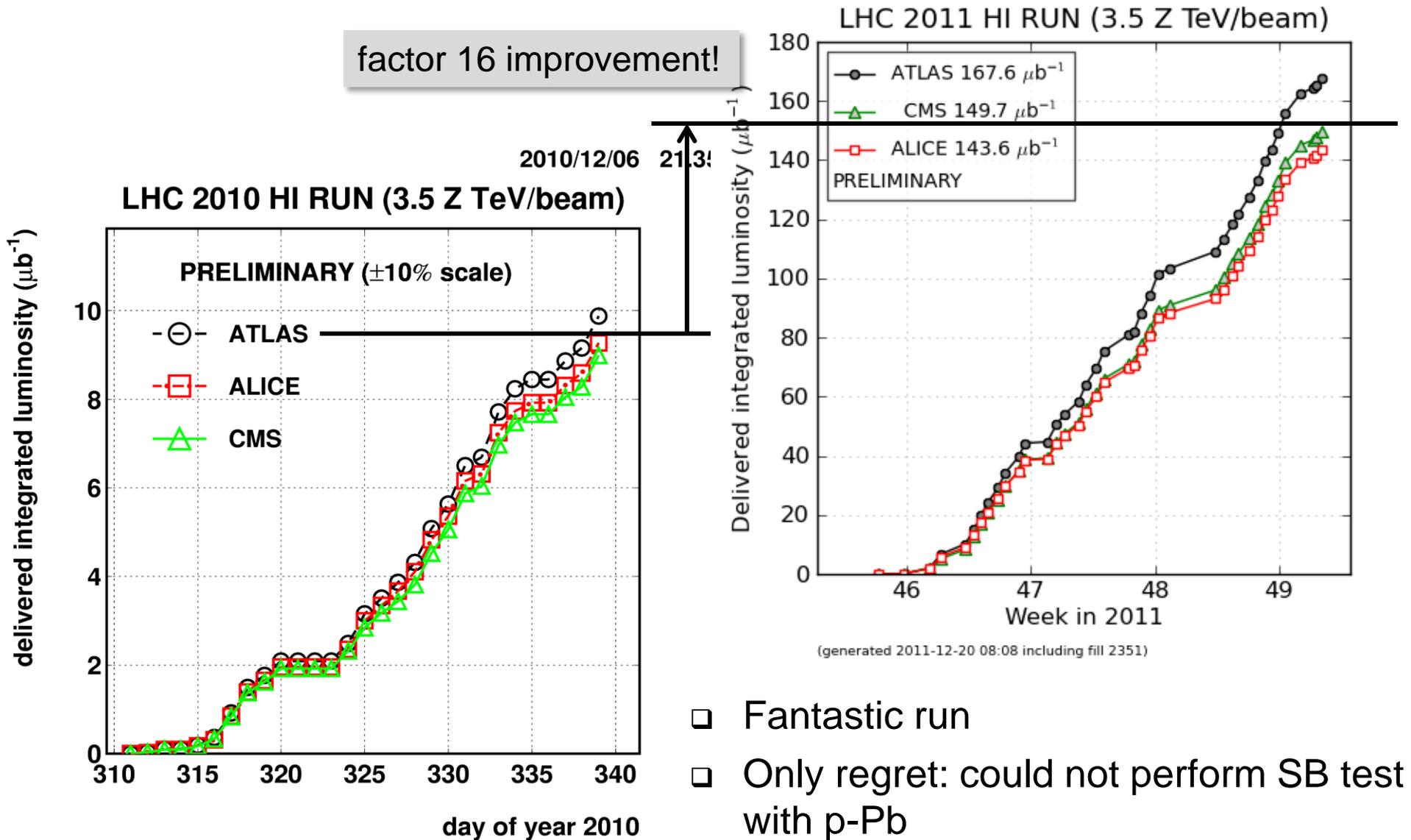


(generated 2011-12-20 08:08 including fill 2351)

- $\beta^*$  x 3
- n of bunches x2.8
- the rest is brightness!! x1.9

# PbPb integrated luminosity

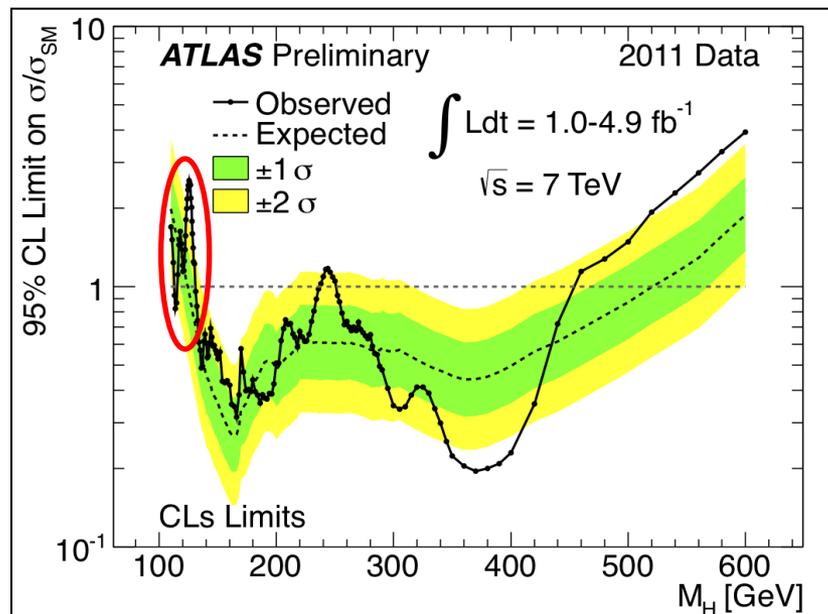
factor 16 improvement!



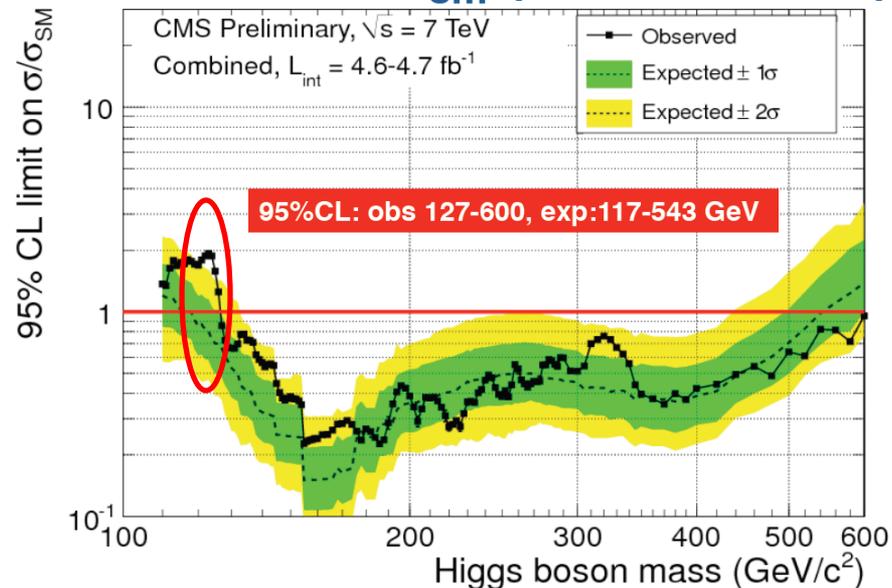
# Physics highlights

see F. Gianotti & G. Tonelli, CERN public seminar Tue 13 dec 2011

<http://indico.cern.ch/conferenceDisplay.py?confId=164890>



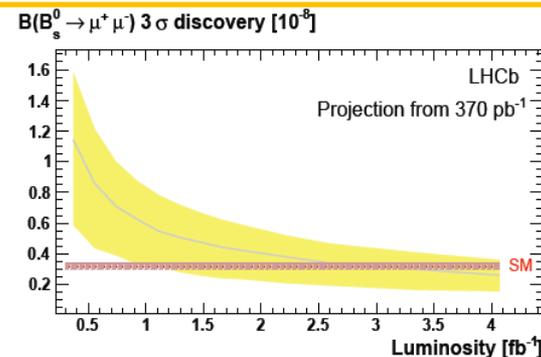
## Limits on $\sigma/\sigma_{SM}$ (CLs method)



LHCb search of Flavour Changing Neutral Currents:

$$\mathcal{B}(B_s^0 \rightarrow \mu^+ \mu^-) < 1.2 (1.4) \times 10^{-8} \text{ at } 90 \% (95 \%) \text{ CL,}$$

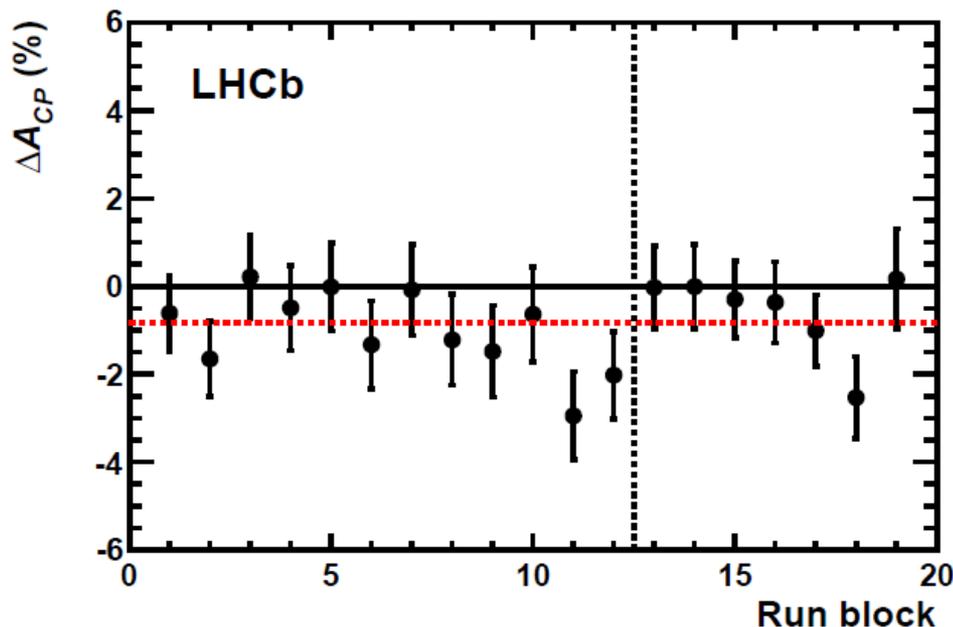
The SM predictions for the branching fraction  $(3.2 \pm 0.2) \times 10^{-9}$



# And a surprise in charm sector (CP violation)

- Evidence for CP violation in time-integrated  $D^0 \rightarrow h^- h^+$  decay rates

[arXiv:1112.0938v1](https://arxiv.org/abs/1112.0938v1) [hep-ex]



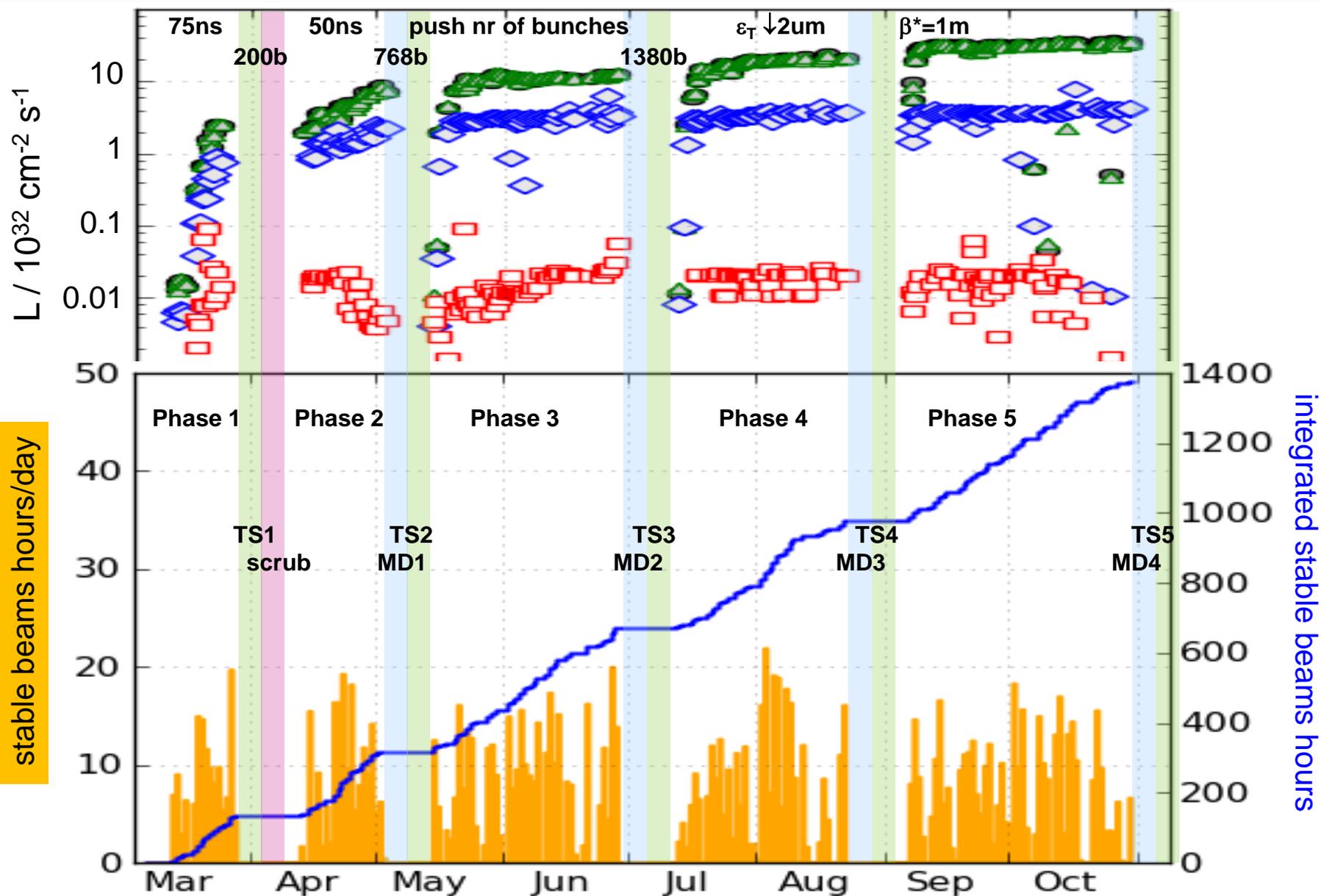
A tiny  $\mathcal{CP}$  asymmetry,  
yet too large an asymmetry

(The LHCb Collaboration)

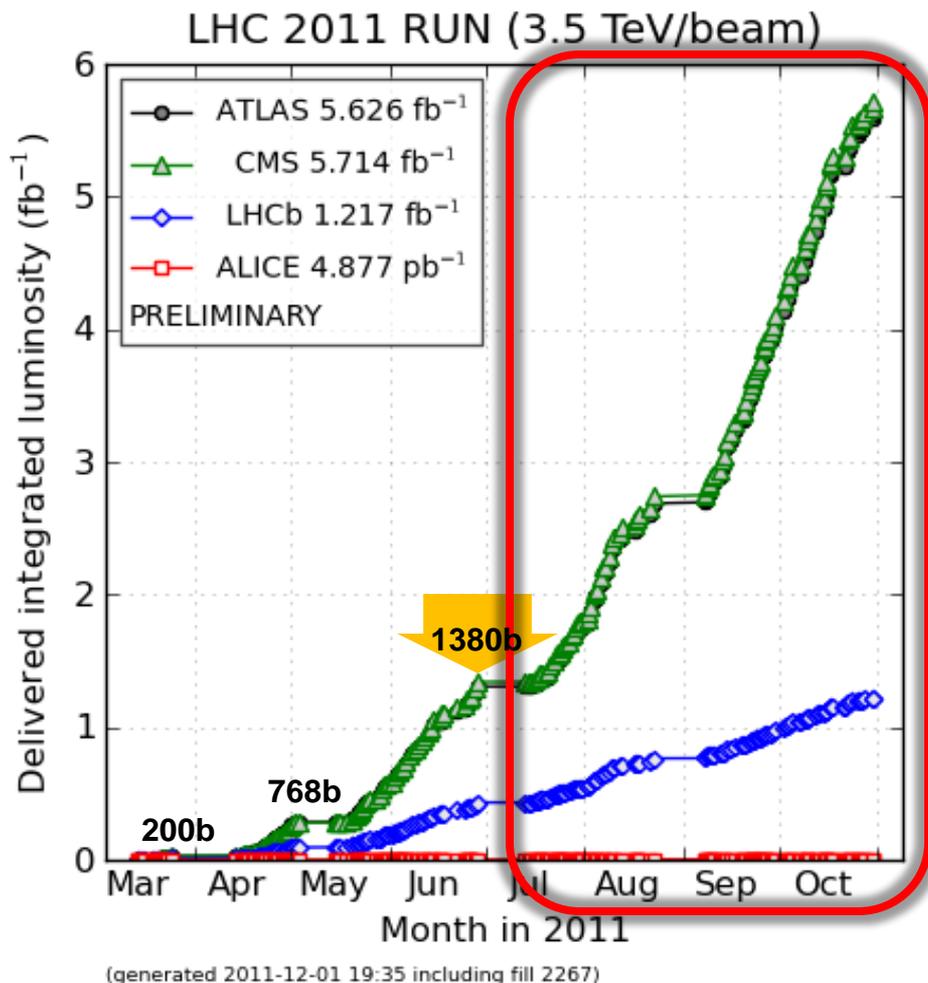
*Submitted to Phys. Rev. Lett.*

A search for time-integrated  $CP$  violation in  $D^0 \rightarrow h^- h^+$  ( $h = K, \pi$ ) decays is presented using  $0.62 \text{ fb}^{-1}$  of data collected by LHCb in 2011. The flavor of the charm meson is determined by the charge of the slow pion in the  $D^{*+} \rightarrow D^0 \pi^+$  and  $D^{*-} \rightarrow \bar{D}^0 \pi^-$  decay chains. The difference in  $CP$  asymmetry between  $D^0 \rightarrow K^- K^+$  and  $D^0 \rightarrow \pi^- \pi^+$ ,  $\Delta A_{CP} \equiv A_{CP}(K^- K^+) - A_{CP}(\pi^- \pi^+)$ , is measured to be  $[-0.82 \pm 0.21(\text{stat.}) \pm 0.11(\text{syst.})]\%$ . This differs from the hypothesis of  $CP$  conservation by 3.5 standard deviations.

# Pro memoria: overview of pp 2012



# Glorious summer & fall



2011:

- for ATLAS/CMS: 80% of integrated lumi comes from the last two periods

2012:

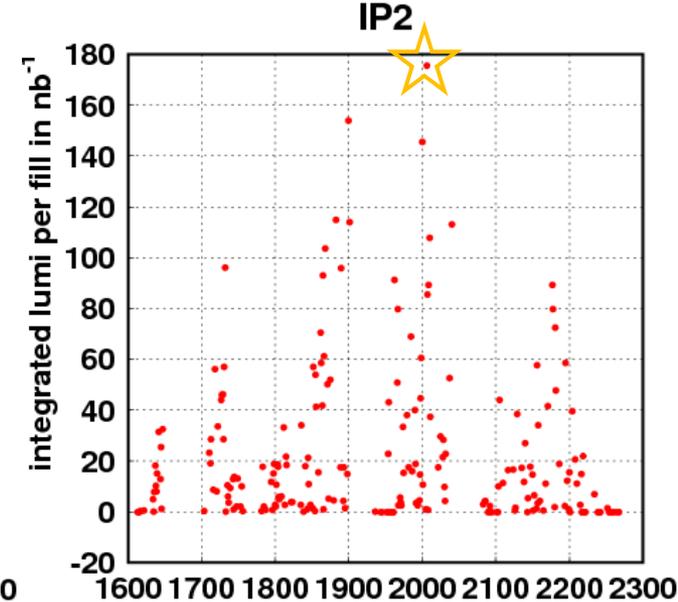
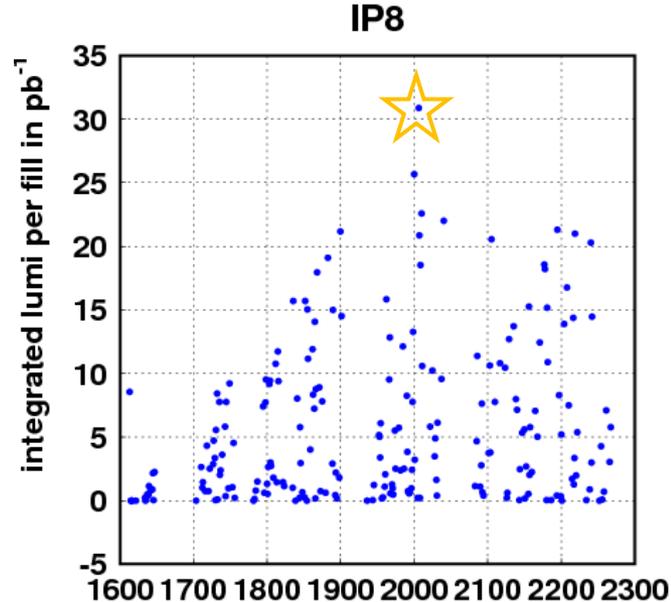
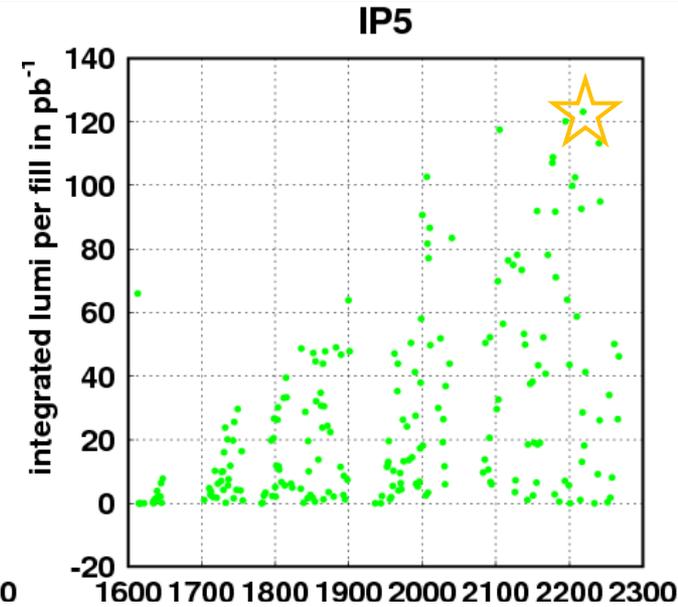
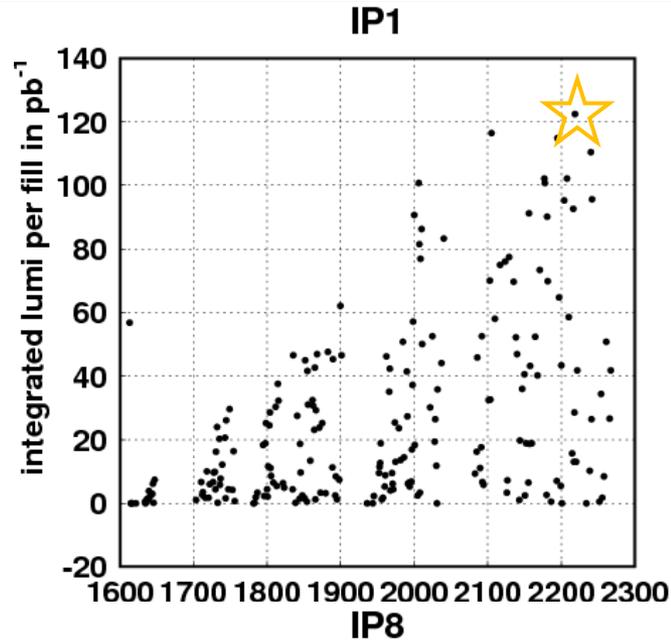
- no new developments associated with bunch spacing (50ns)
- no 'new territory' in terms of stored energy
- 2.5 years of operational experience

=> a glorious spring as well ?

# Integrated lumi per fill vs fill number

Best fills:

- 2219: 15.8 h SB
  - ATLAS  $122 \text{ pb}^{-1}$
  - CMS  $123 \text{ pb}^{-1}$
- 2006: 26 h SB
  - LHCb  $31 \text{ pb}^{-1}$
  - ALICE  $175 \text{ nb}^{-1}$



# Fill 2219

At start of fill, in IP1&5

$$3.5 \cdot 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$$

matches well with

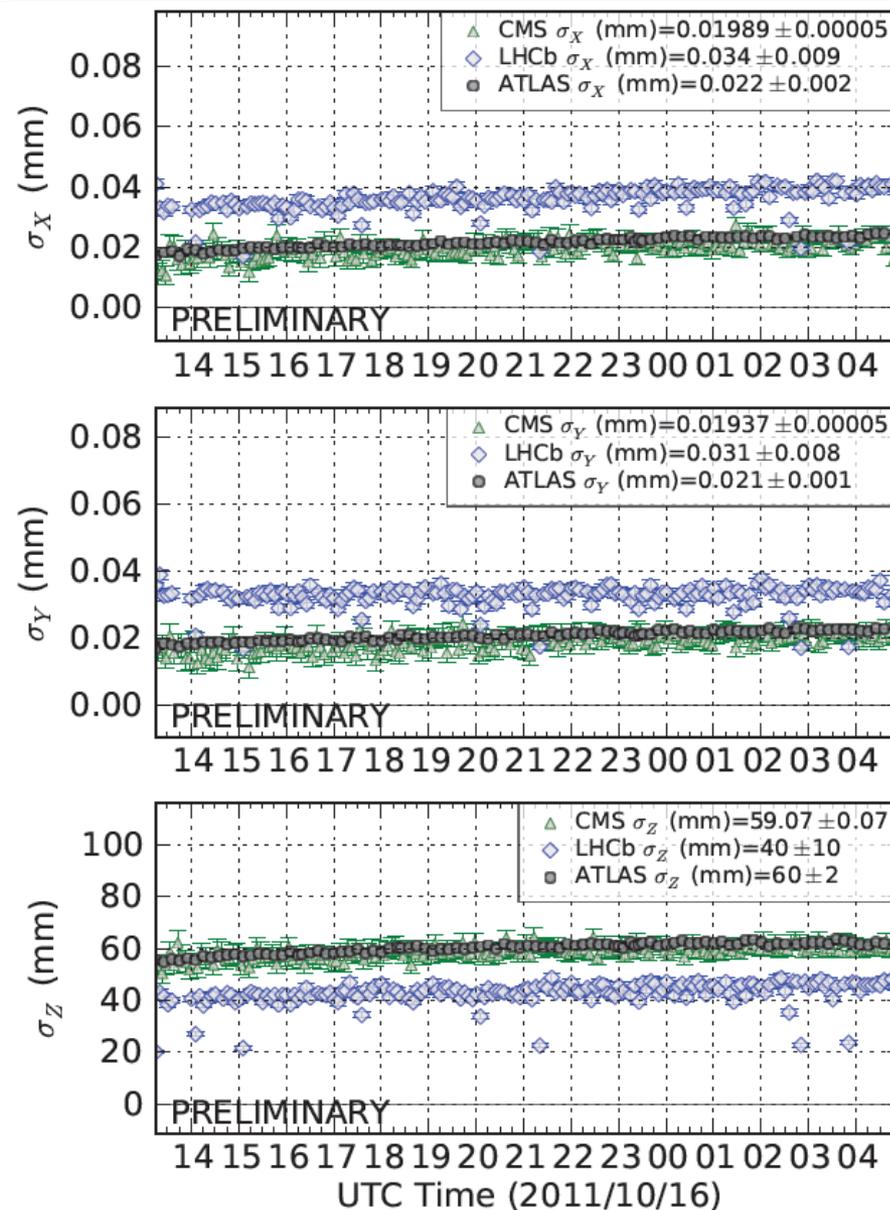
1331 coll. pairs

$$N = 1.43 \cdot 10^{11} \text{ p}$$

$$\varepsilon_T = 2.4 \text{ } \mu\text{m}$$

$$\beta^* = 1\text{m}$$

$$\left. \begin{array}{l} \varepsilon_T = 2.4 \text{ } \mu\text{m} \\ \beta^* = 1\text{m} \end{array} \right\} \sigma = 18 \text{ } \mu\text{m}$$

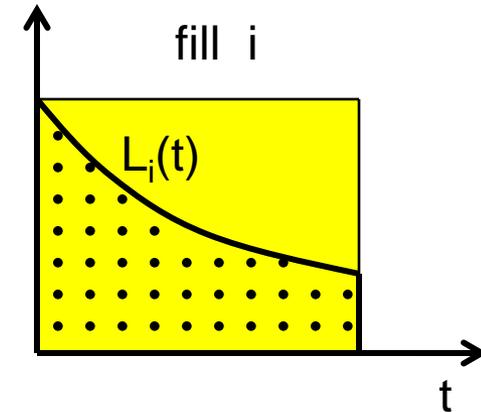


# "Hübner factor": definition

$$H = \frac{\sum_i \int L_i(t) \cdot dt}{L_{\text{peak,typical}} \cdot T_{\text{phys}}}$$

(sum over physics fills  $i=1, \dots$ )

$T_{\text{phys}}$  = total time scheduled for high-L physics  
(excluding TS, MD, special physics)



$$\varepsilon_{\text{SB}} = \frac{T_{\text{SB}}}{T_{\text{phys}}} = \frac{T_{\text{MA}}}{T_{\text{phys}}} \cdot \frac{T_{\text{SB}}}{T_{\text{MA}}}$$

$$\varepsilon_{\text{decay}} = \frac{\sum_i \int L_i(t) \cdot dt}{\sum_i L_{\text{peak},i} \cdot \Delta t_{\text{SB},i}} = \frac{\sum_i \boxed{\begin{array}{ccc} \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \end{array}}}{\sum_i \boxed{\text{yellow}}}$$

$T_{\text{SB}}$  = total time in stable beams

$T_{\text{MA}}$  = total "machine-available" time (not analysed here => see Alick's talk)

$$T_{\text{MA}} / T_{\text{phys}} = \sim 45\% ?$$

If  $L_{\text{peak},i}$  is reasonably flat over the "physics" run considered, then

$$H = \varepsilon_{\text{SB}} \varepsilon_{\text{decay}}$$

# "Hübner factors": actual

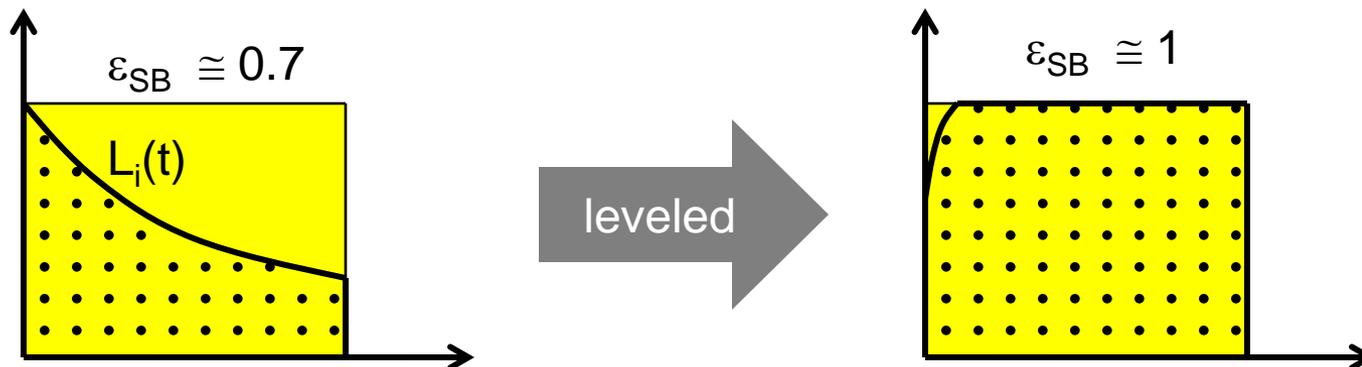
		Phase 4 (1936-2040)	Phase 5 (2083-2267)	units
Sched. physics time	$T_{\text{physics}}$	1080	1104*	h
Time in SB	$T_{\text{SB}}$	306	393	h
Integrated lumi	$\sum_i \int L_i(t) \cdot dt$	1.395 0.334	2.963 0.454	fb <sup>-1</sup>
SB fraction	$\epsilon_{\text{SB}}$	0.28	0.36	
Decay factor	$\epsilon_{\text{decay}}$	0.71 0.89	0.70 0.86	
Typical peak lumi	$L_{\text{peak,typ}}$	1.8 0.33	3.1 0.36	10 <sup>33</sup> cm <sup>-2</sup> s <sup>-1</sup>
"Hübner factor"	H	0.2 0.26	0.24 0.32	

ideally, should be 1

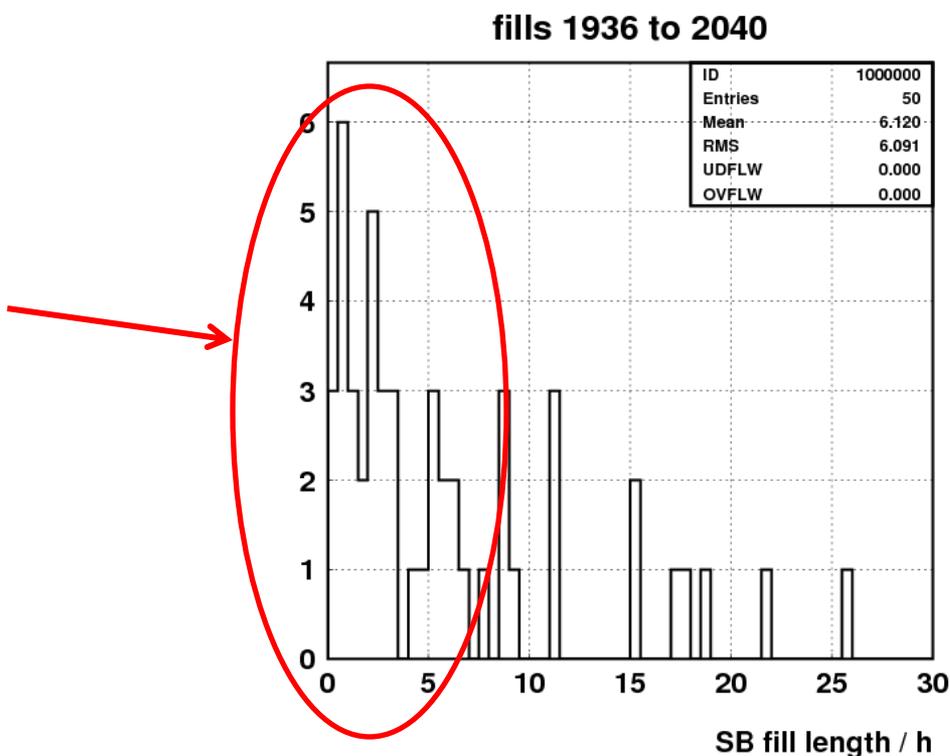
in black: IP1&5  
in green: IP8

\* removed 10 days of special physics and High PU + 25 ns tests

# pp STABLE BEAMS fill length



□ Many short physics fills...



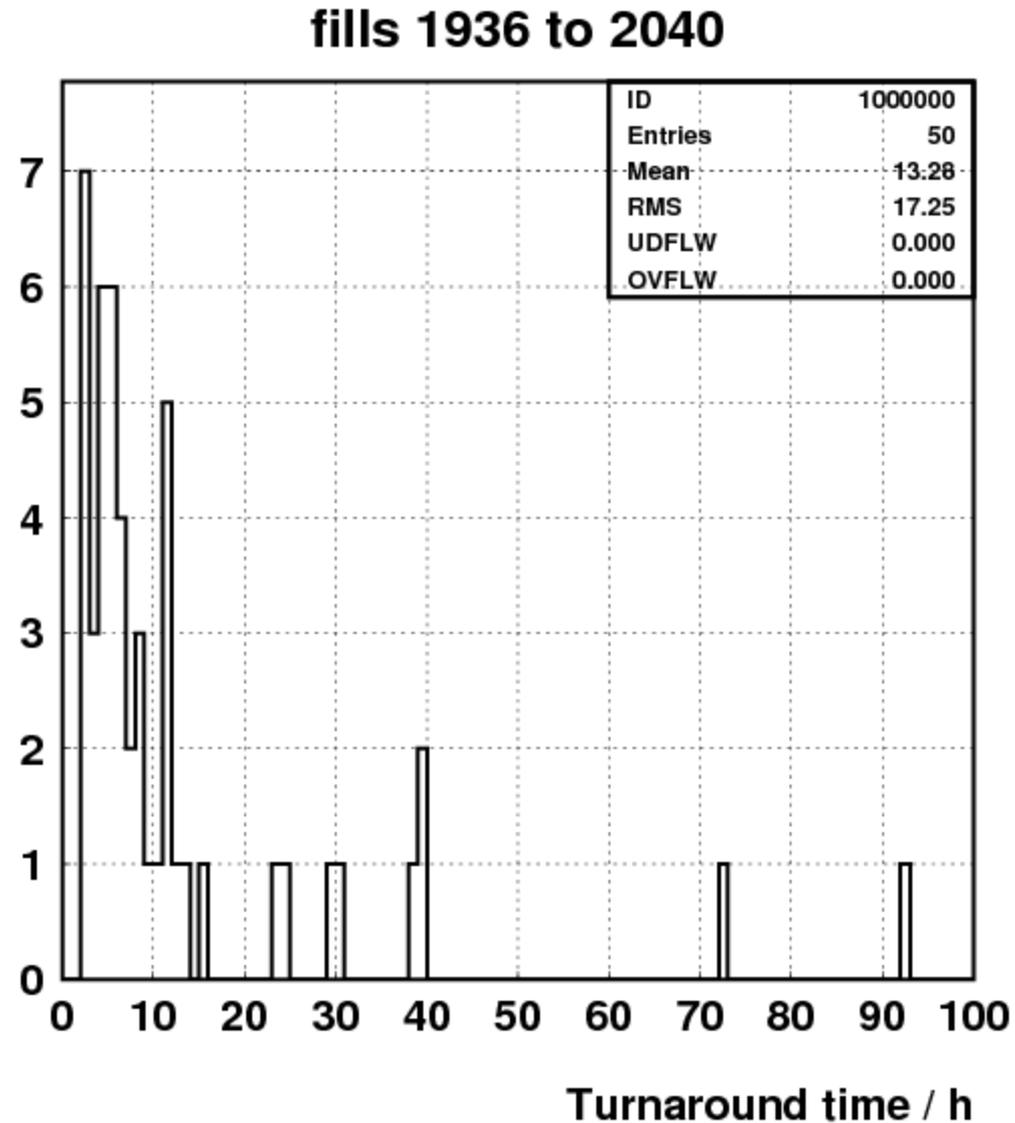
# Turn around time

Consider Phase 4 (summer)

Define turnaround time as:

$$t_{TA} = t_{\text{startSB},i+1} - t_{\text{stopSB},i}$$

Mean value: 13.3 hours



# Special activities

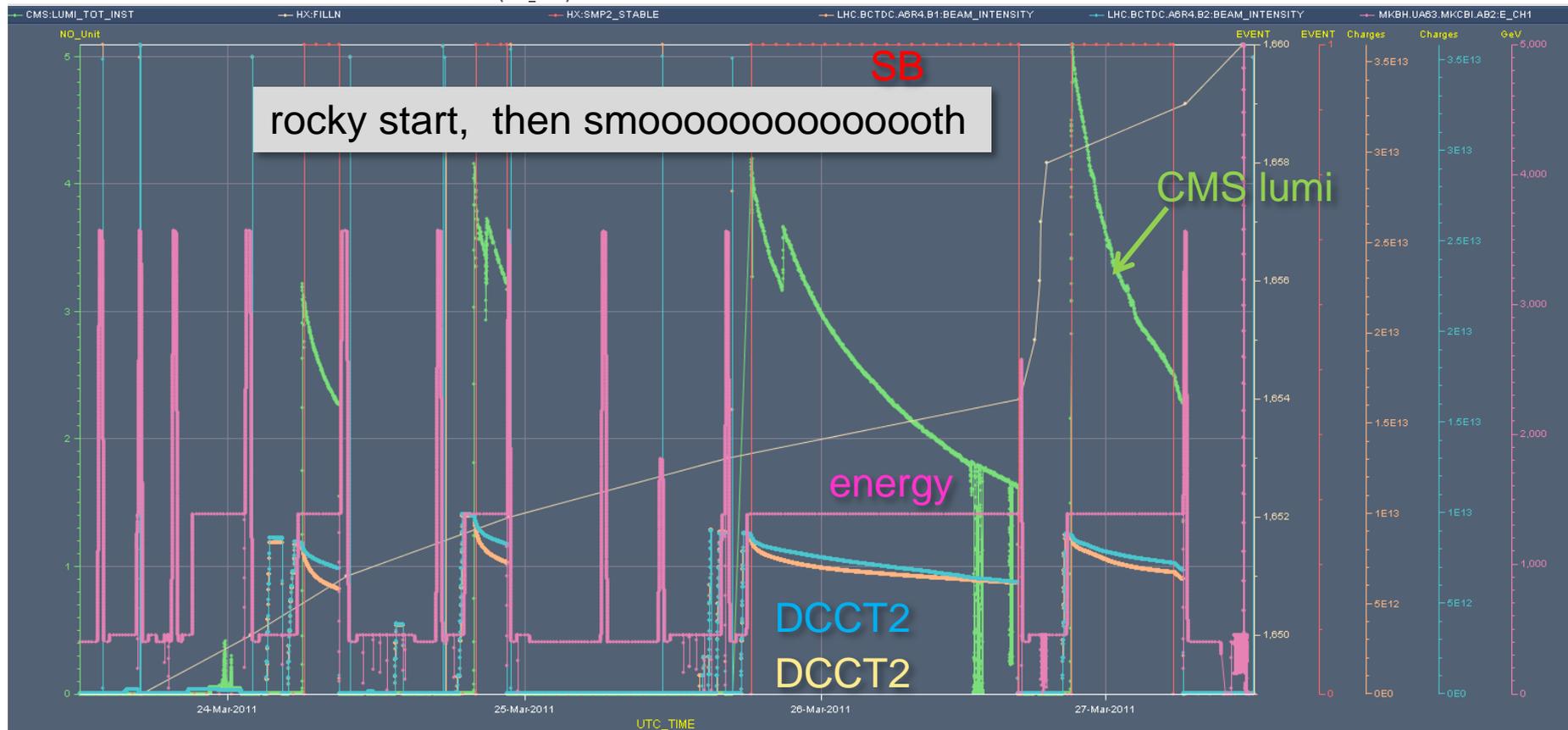
- ❑ Intermediate energy pp run
- ❑ Roman Pots and 90m optics
- ❑ Luminosity calibrations

**“An LHC year provides enough time  
to satisfy every experiment's need,  
but not every experiment's greed”**

Mahatma Massi

# E=1.38 TeV run

Timeseries Chart between 2011-03-24 11:00:00.000 and 2011-03-28 10:00:00.000 (UTC\_TIME)



- ❑ About 4 calendar days
- ❑ 90h of machine-available time
- ❑ 35h of SB

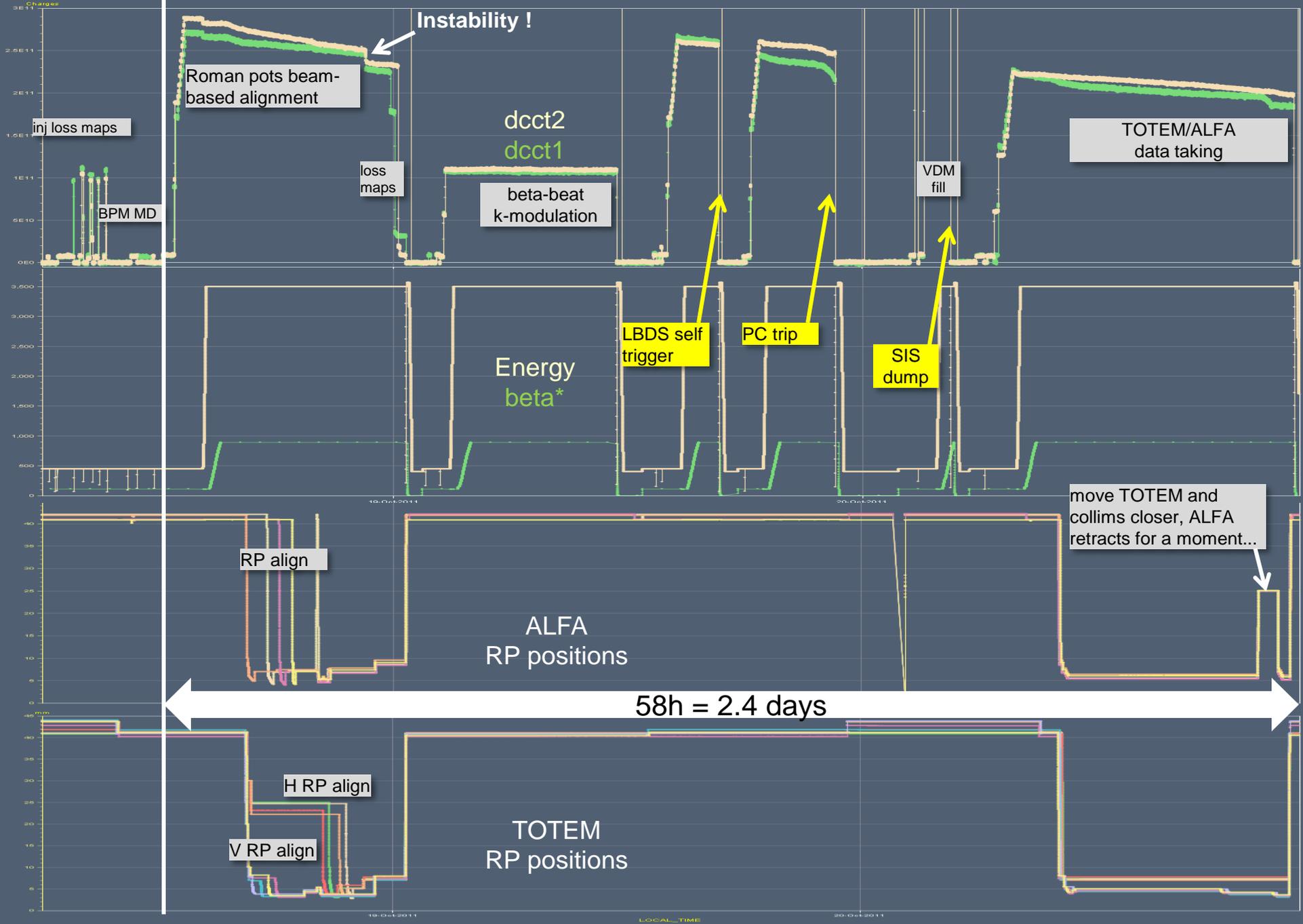
- ❑ **STUDY 1 IN MAY 2011, SEE MD NOTE**
  - Used one probe bunch per beam (1.2e10).
  - Established feasibility of 90m optics in IP1/5, performed first optics measurements.
- ❑ **STUDY 2 IN JUNE 2011, SEE MD NOTE**
  - Used two probe bunches per beam (~1e10 and ~2e10 p/bunch).
  - Operational sequence tested.
  - Implemented optics corrections from Study 1.
  - Went to collisions in IP1 and IP5.
  - Took data with RPs at intermediate distance,  $> 10 \sigma_{\text{nom}}$  (in ADJUST).
- ❑ **STUDY 3 IN AUGUST 2011, SEE MD NOTE**
  - Used 3 bunches of ~7e10 p/bunch and ~3um transverse emittance (the last bunch with a bit lower emittance by removing one screen in SPS).
  - Iterated operational sequence and established collisions in all IPs.
  - Performed beam-based alignment of the 8 verticals RPs of TOTEM.
  - Performed beam-based alignment of TCTs at IP1, IP5 and IP8.

## ❑ **STUDY 4 ON 30 SEP 2011**

- Four ramps (2172-2175) lost due to various issues (stuck collimator, LVDT intlk limit on an ALFA pot, OFB, UPS trip)
- Cut by VIP visit (Sat morning Oct 1).
- Consumed 24h.

## ❑ **STUDY 5 ON 18-20 OCT 2011**

- Successfully aligned all TOTEM220m pots and ALFA pots
- Took data
- TOTEM pots all the way down to  $\sim 4.8$  sigmas
- Issues with bkg (for the non-coinc triggers)
- Consumed about 2 days



2%

special thanks to: BE-BI, BE-OP, BCNWG and **Colin Barschel** (Phd student)

# Luminosity calibration

## LHC Lumi Days 2012

from 29 February 2012 to 01 March 2012 (Europe/Zurich) CERN  
Europe/Zurich timezone

Sign up!  
Everybody  
is welcome

### Overview

Timetable

Registration

↳ Registration Form

List of registrants

Following the successful [2011 meeting](#), and in view of the progress made in 2011 both in the determination of the LHC luminosity, and in successfully exploiting this increased accuracy in physics analysis, we propose a new edition of LHC lumidays.

A list of useful references and documents of relevance for the workshop can be found [here](#), and the proceedings of the first edition are available from <http://cdsweb.cern.ch/record/1347440>

To subscribe to the workshop mailing list, go to

<https://simba3.web.cern.ch/simba3/SelfSubscription.aspx>

and request to join the mailing list [lhc-lumi-days@cern.ch](mailto:lhc-lumi-days@cern.ch)

Information on accommodation, access to CERN and laptop registration is available from <http://lpcc.web.cern.ch/LPCC/index.php?page=visit>

Scientific Secretary: Alick Macpherson

**Dates:** from 29 February 2012 09:00 to 01 March 2012 18:00

**Timezone:** Europe/Zurich

**Location:** CERN

Room: TH Theory Conference Room

**Chairs:** Burkhardt, Helmut  
Ferro-Luzzi, Massimiliano  
Mangano, Michelangelo  
Dr. Gorini, Benedetto  
Meschi, Emilio

<http://indico.cern.ch/conferenceDisplay.py?confId=162948>

# Data exchange / lumi application

New specs under discussion for upgrade of

- ❑ IP trim sequence application (lumi scans, length scale scans)

<https://edms.cern.ch/document/1184480/1>

- ❑ Experiments' offline data on lumi and lumi region

<https://edms.cern.ch/document/1181952/1>

# Main-satellite collisions

Thank you Steve Hancock,  
Thomas Bohl, et al

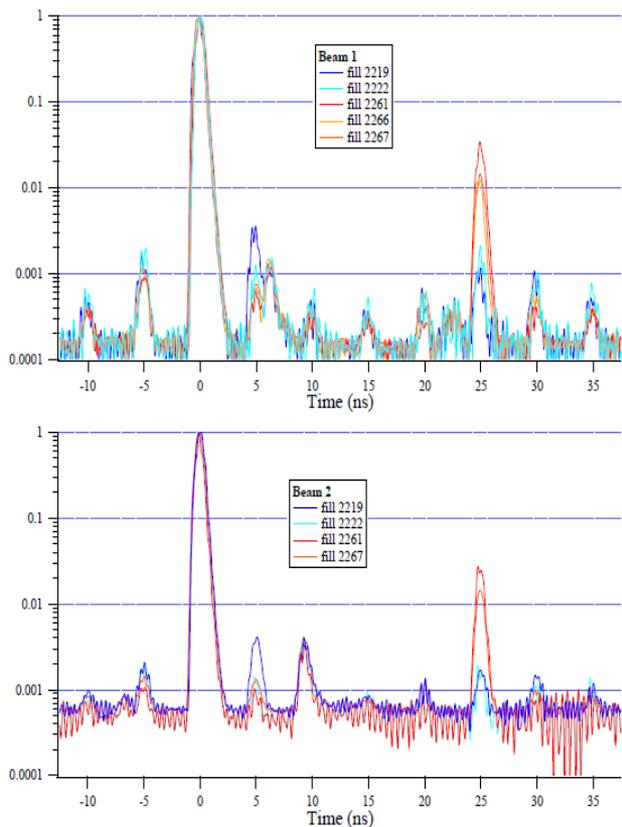
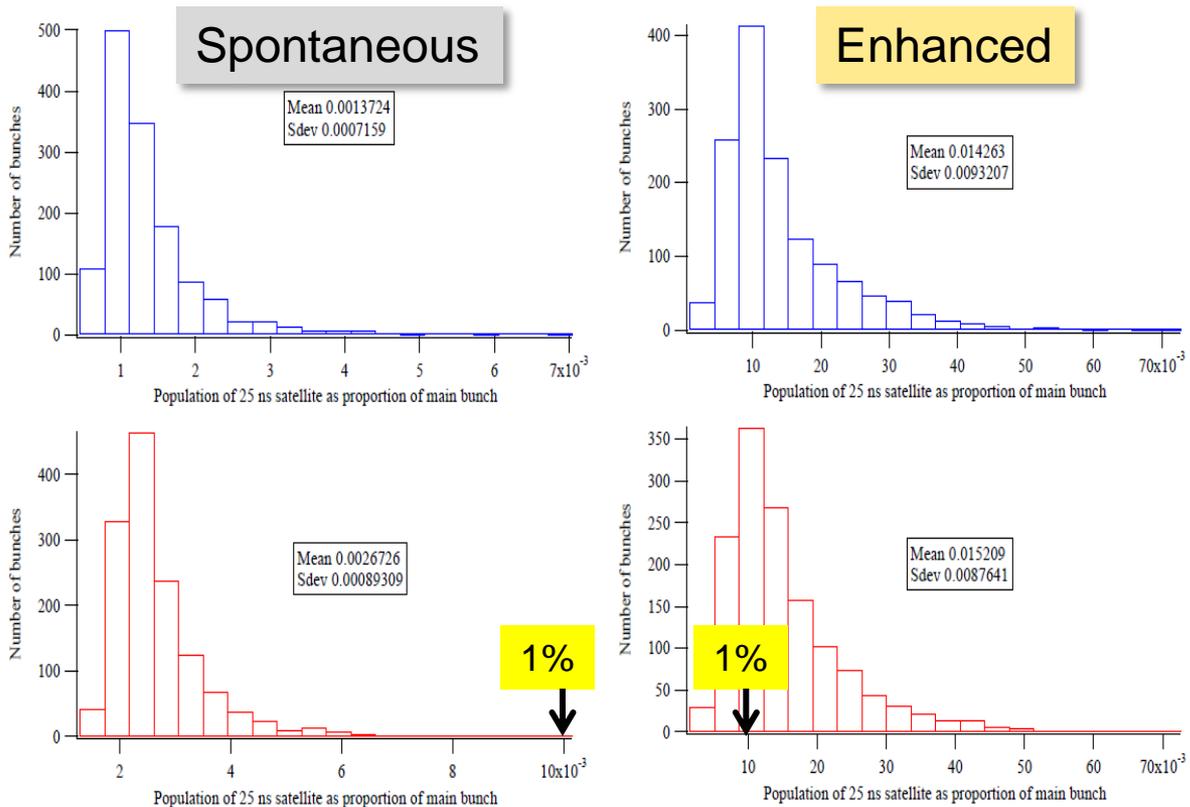


Figure 4: Population of the 25 ns satellites relative to the 50 ns nominally filled bucket populations for fill 2219 (spontaneous satellites). Top: beam1, bottom: beam2. Courtesy of Adam Jeff.

fill 2219

Figure 8: Population of the 25 ns satellites relative to the 50 ns nominally filled bucket populations for fill 2267 (enhanced satellites). Top: beam1, bottom: beam2. Courtesy of Adam Jeff.

fill 2267

Figure 9: Longitudinal charge distribution within  $[-12.5, +37.5]$  ns of a nominally filled slot, averaged over all filled slots, for fills 2219 and 2222 (spontaneous satellites) and fills 2261, 2266 and 2267 (enhanced satellites). Top: beam1, bottom: beam2 (2266 missing). Courtesy of Adam Jeff.

# Overview of the whole year (pp and PbPb)

Activity	cal. days	MA time (h)	SB (h)
TS days	23		
TS recovery	5		
MD	22		
Setup pp	24		
Scrub	7		
pp intensity ramp-up	76		585
75 ns, to 200b	10		
50ns, to 768b	15		
50ns, to 1380b	40		
pots-TS ramp-up	11		
1380b pp physics	86		710
Other physics		276	60
RP + 90m		145 (+8 in MD)	0
E=1.38TeV		90	35
VDM		30	19
Hi PU & 25ns		16 (+8 in MD)	6 (+4 in MD)
Setup ions	4		
Ion Physics	24		204
Total pp physics	181		1355
Total protons	262		
Total days	290		

This talk could have been titled

"La Revanche de Bob le Bildeur"

**You gave me  
more than  
five, Mike!**



and next time,  
at least,  
don't pick a  
handycapped figure...

(handyquattred ?)

# Mike's preferred 2012 mascotte



6 fb<sup>-1</sup>

6 quarks and 6 leptons

6 years of Lhc Programme Coordination



**It has been**

**a very pleasant**

**a very exciting**

**a very enriching experience.**

**I sincerely wish to thank you all**