



CERN

Status and Future Plans



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June 6, 2011
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CERN



2011-2013: deciding years....

Experimental data will take the floor to drive the field to the next steps:

- LHC and Tevatron results
- θ_{13} (T2K, DChooz, etc..)
- Precision measurements, rare decays
- ν masses (Cuore, Gerda, Nemo...)
- Dark Matter searches
-



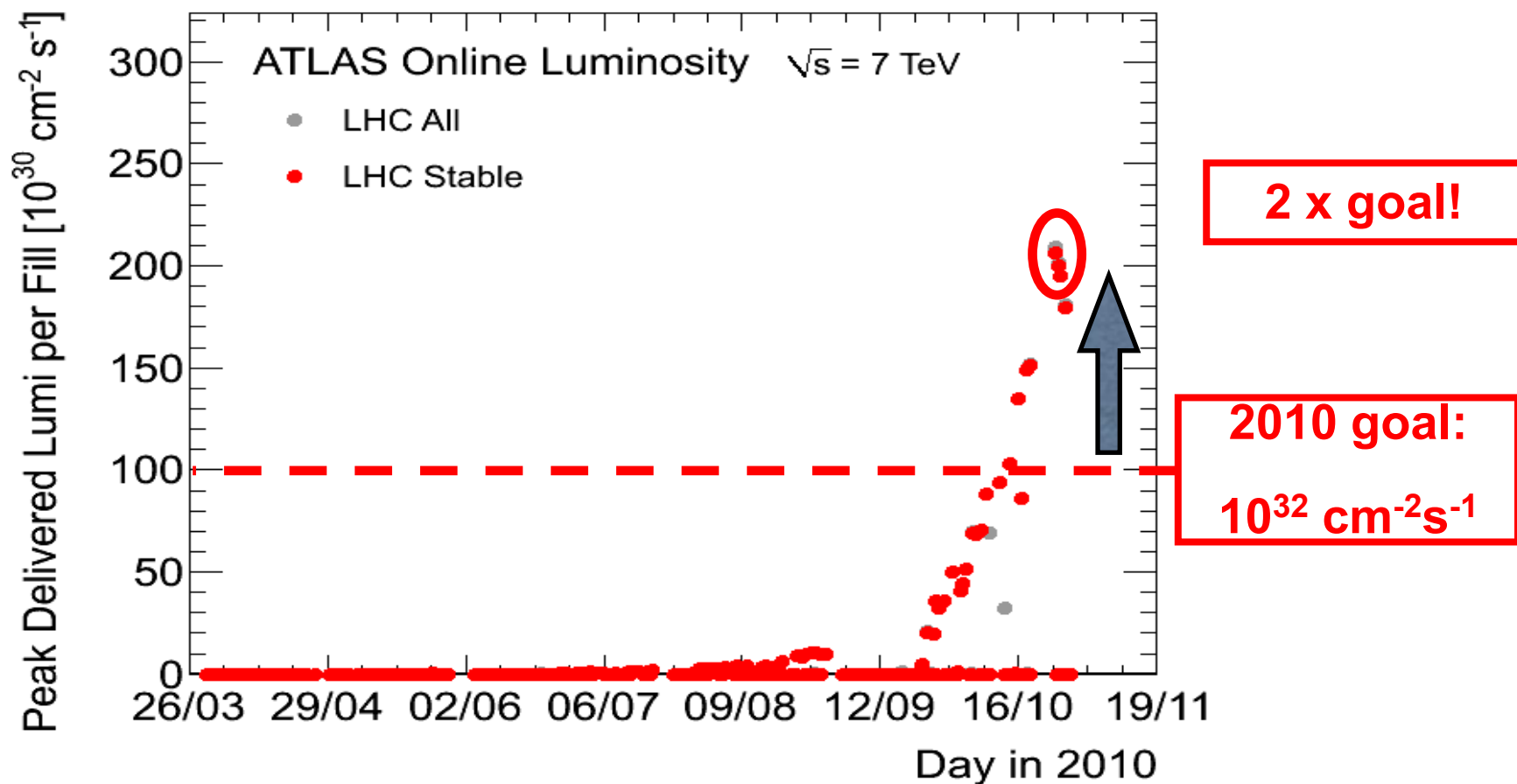
LHC: 2010 Summary

- Excellent single beam lifetime
- Ramp & squeeze essentially without loss
 - No quenches with beam above 450 GeV
 - Excellent performance of Machine Protection
- Optics close to model (and correctable)
- Excellent reproducibility
- Aperture (at least) as expected
- Better than nominal from injectors
 - Emittances, bunch intensity
- Beam-beam: can collide nominal bunch currents
 - With smaller than nominal emittances

And surprisingly good availability...



Peak luminosity performance



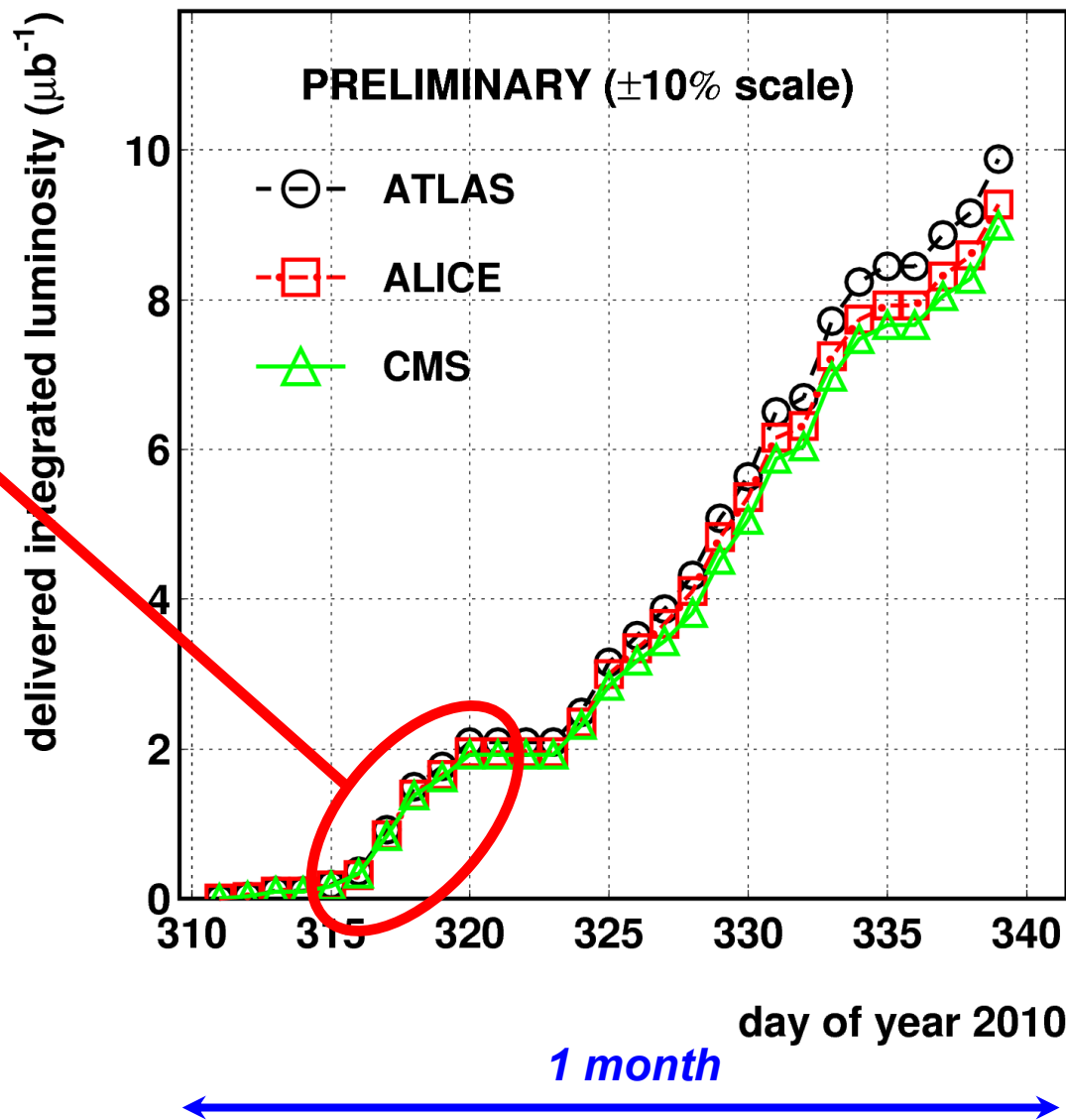
Main parameters: 368 bunches of 1.2×10^{11} protons.

Colliding beam sizes = 40 microns.



Ion luminosity performance

LHC 2010 HI RUN (3.5 Z TeV/beam)



Gained a factor 100 of peak luminosity in 6 days!

And the experiments?

Experiments have shown an astounding readiness in making use of the collected luminosity, due to:

- one year of cosmic rays (alignments, calibrations, people and systems training)
- excellent performances of the WLCG
- ~ 2500 greedy PhD students!

A very important discovery in 2010: experiments have a higher physics reach (for a given luminosity) than predicted by simulations!

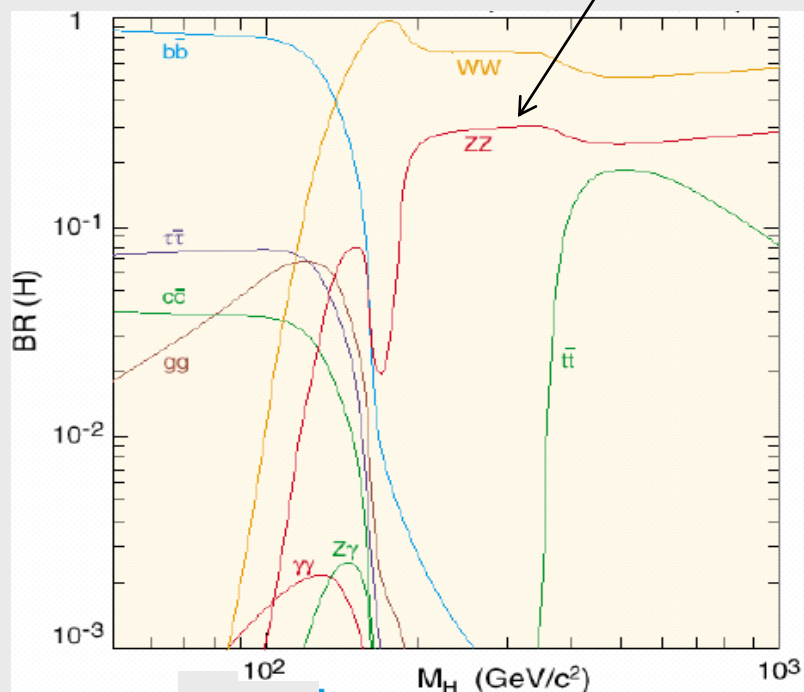
An example

Prospects for the Higgs Boson at 7 TeV

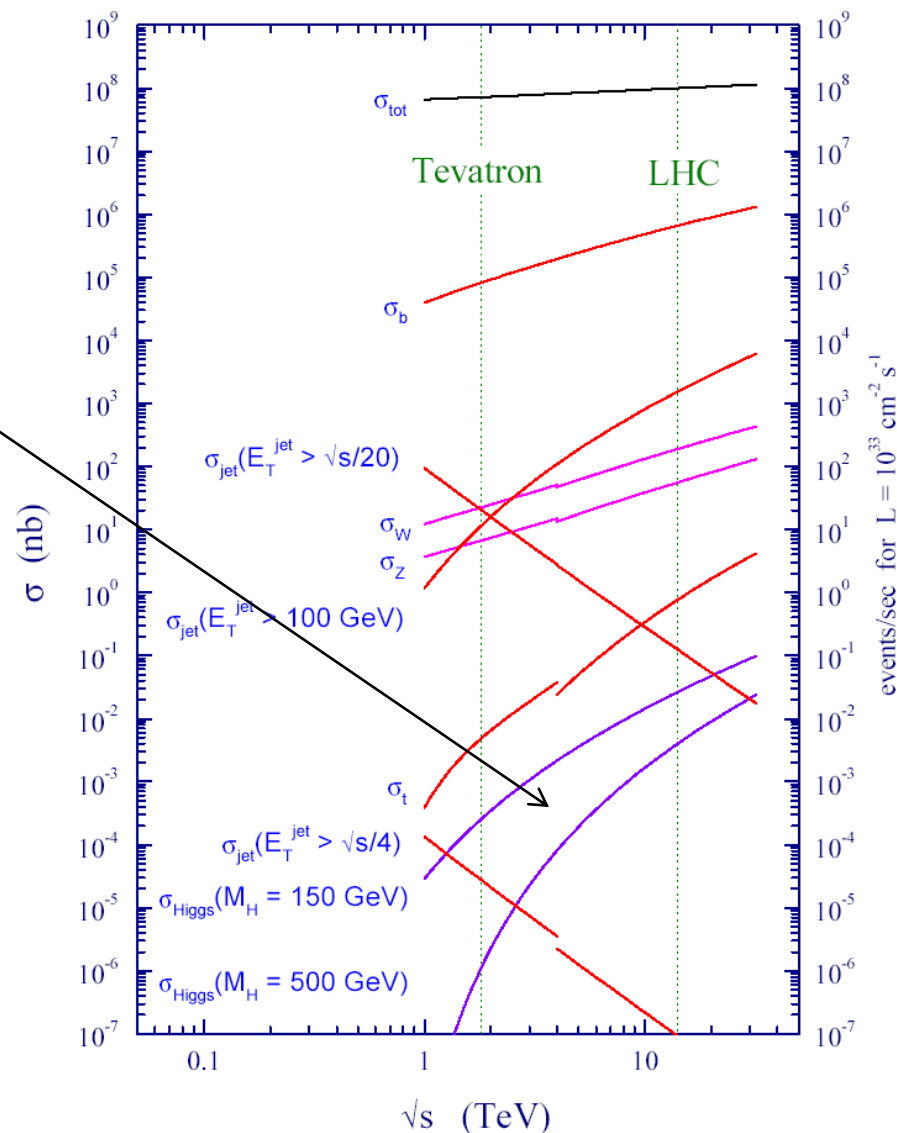
Search for the Higgs-Boson at the LHC

Production rate of the Higgs-Bosons depends on its mass

as well as its decay possibilities ("Signature (or picture)" as seen in the detector)

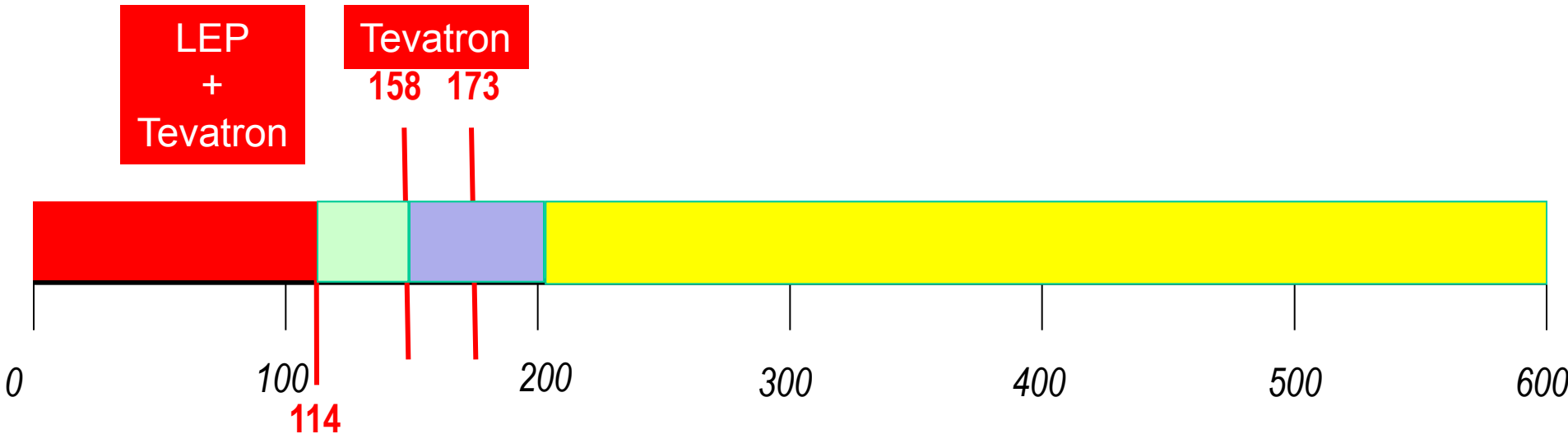


proton - (anti)proton cross sections



The Higgs Search Landscape: LHC Joins The Fray !

95% CL Excluded Mass range



Low Mass
($M_H \approx 120$ GeV)

$H \rightarrow \text{CC}$
 $H \rightarrow WW$
 $qqH \rightarrow \text{ll}$
 $V+ H \rightarrow bb$
 $qqH \rightarrow bb$
 $V+ H \rightarrow WW$

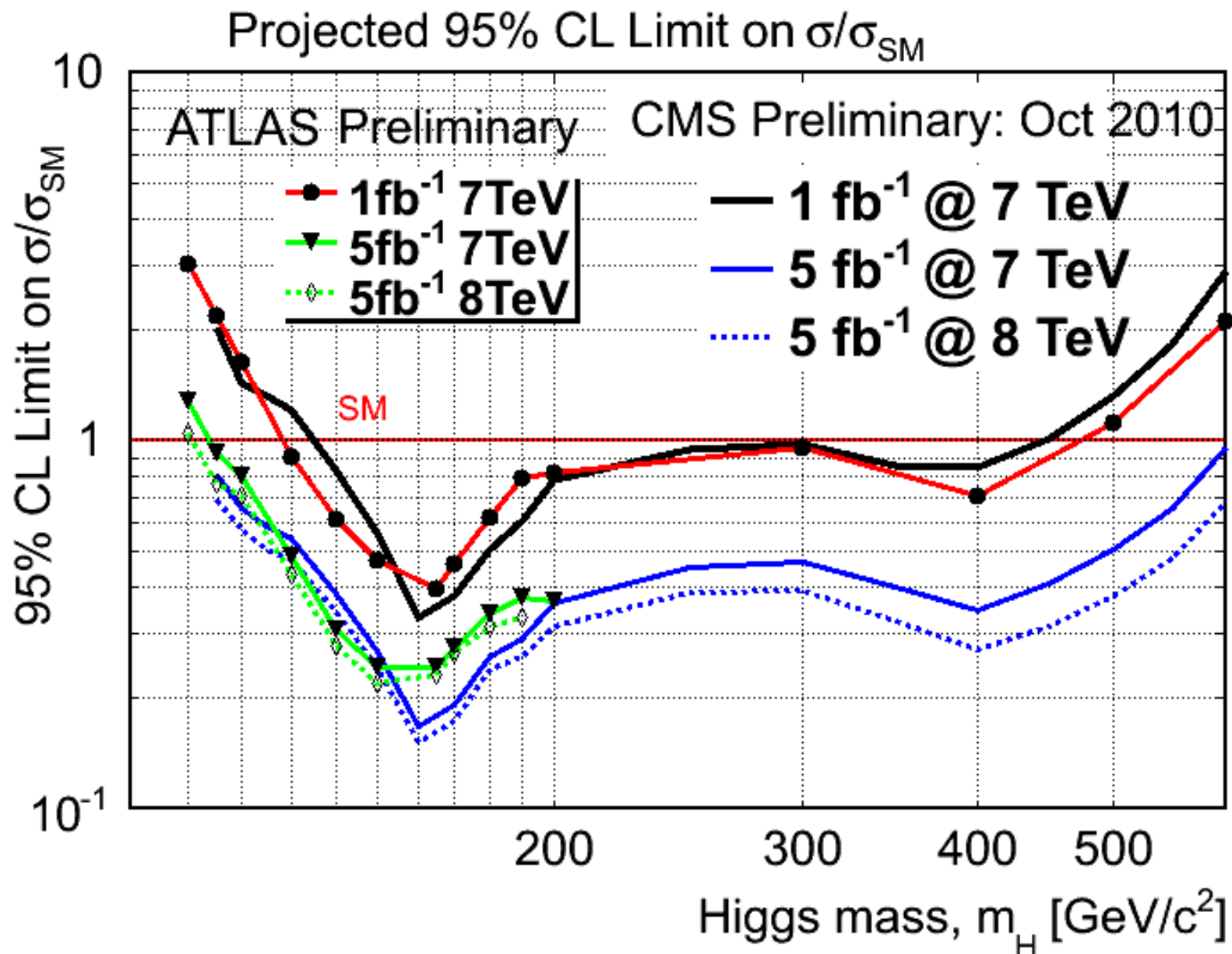
Mid Mass
($M_H \approx 160$ GeV)

$H \rightarrow WW$
 $H \rightarrow ZZ$

High Mass
($M_H \approx 400$ GeV)

$H \rightarrow ZZ$
 $H \rightarrow WW$

CMS & ATLAS Projections Compared



-
- Experiments well prepared to exploit ALL decay channels accessible
 - Experiments are cross-checking each other
 - Experiments are preparing to combine their results

Summary of Prospects



Higgs Boson, if it exists between masses of (114 - 600 GeV) will either be discovered or ruled out in \approx next two years

→ Decided to run in 2011 and 2012

SM Higgs Search Prospects (Mass in GeV)

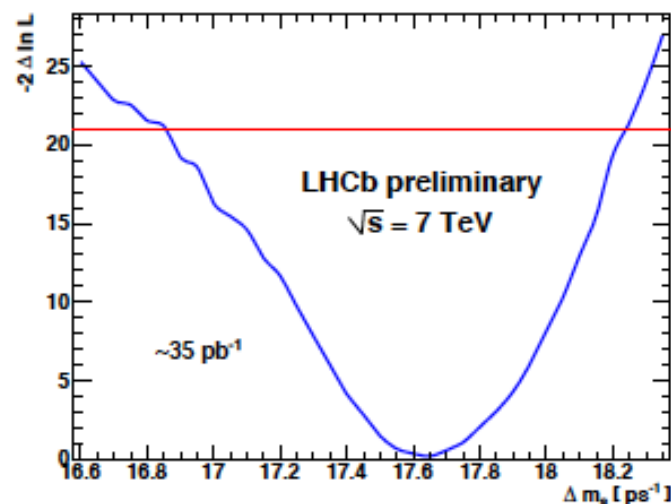
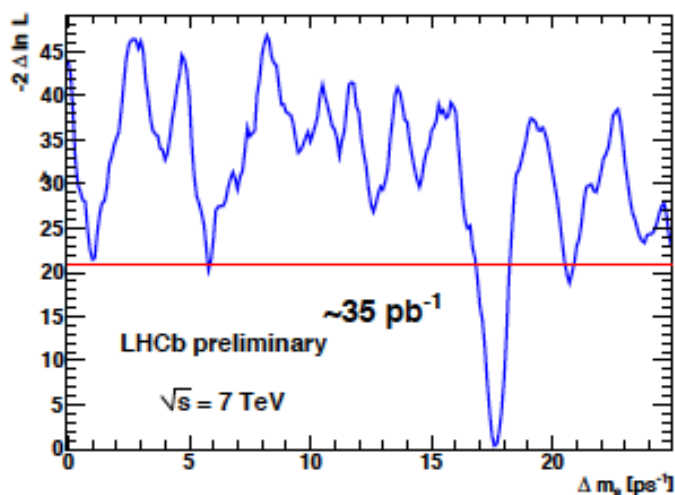
ATLAS + CMS $\approx 2 \times$ CMS	95% CL exclusion	3σ sensitivity	5σ sensitivity
1 fb^{-1}	120 - 530	135 - 475	152 - 175
2 fb^{-1}	114 - 585	120 - 545	140 - 200
5 fb^{-1}	114 - 600	114 - 600	128 - 482
10 fb^{-1}	114 - 600	114 - 600	117 - 535

...not only searches

- 2010 LHCb results show exciting prospects for 2011-2012

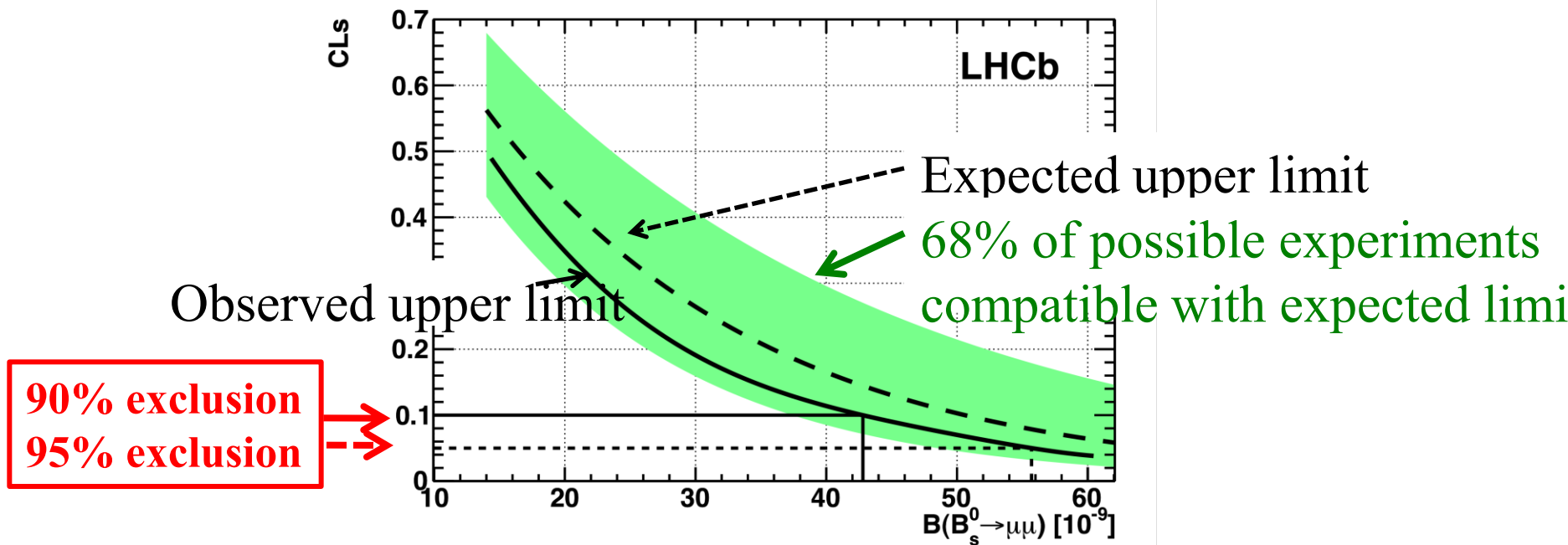
Use:

- per event proper time uncertainties, $\langle \sigma_t \rangle = 36 - 44$ fs
- per event mistag rate, $\varepsilon_{\text{eff}} = 3.8 \pm 2.1\%$ (OS only)



The line at 20.94 indicates the likelihood value evaluated in the limit of infinite mixing frequency

- $\Delta m_s = 17.63 \pm 0.11(\text{stat}) \pm 0.04(\text{sys}) \text{ ps}^{-1}$ (4.6 σ stat. significance)
- CDF: $\Delta m_s = 17.77 \pm 0.10$ (stat) ± 0.07 (sys) ps^{-1}



		@ 90% CL	@ 95% CL
LHCb	Today, 37 pb⁻¹	< 43 x10⁻⁹	< 56 x10⁻⁹
D0	World best, 6.1 fb⁻¹ PLB 693 539 (2010)	< 42 x10⁻⁹	< 51 x10⁻⁹
CDF	Preliminary, 3.7 fb⁻¹ Note 9892	< 36 x10⁻⁹	< 43 x 10⁻⁹

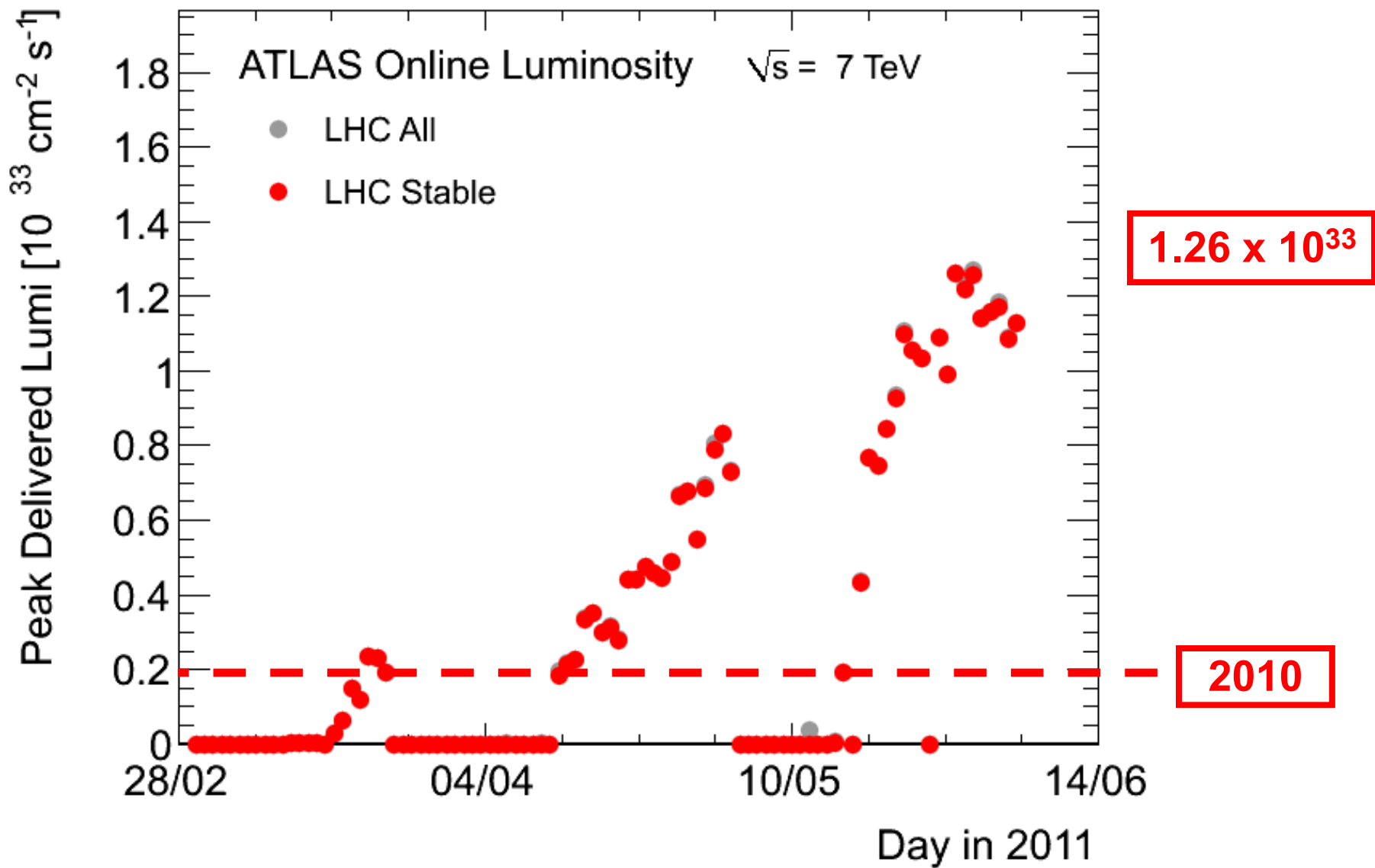


LHC in 2011 – so far

- Beam commissioning: 3 weeks ✓
 - Exit - stable beams with low number of bunches
- Ramp-up to ~200 bunches (75 ns): 2 weeks ✓
 - Multi-bunch injection commissioning continued
 - Stable beams
- Intermediate energy run: 4 -5 days ✓
- Technical Stop: 4+1 days ✓
- **Scrubbing run: 10 days** ✓
- Decided to run at **50 ns** spacing ✓
- Resume operation for physics and increase number of bunches: ✓
 - 300 – 400 – 600 – 800 – 900 – **1100** ...1400
 - Machine protection qualification at each step

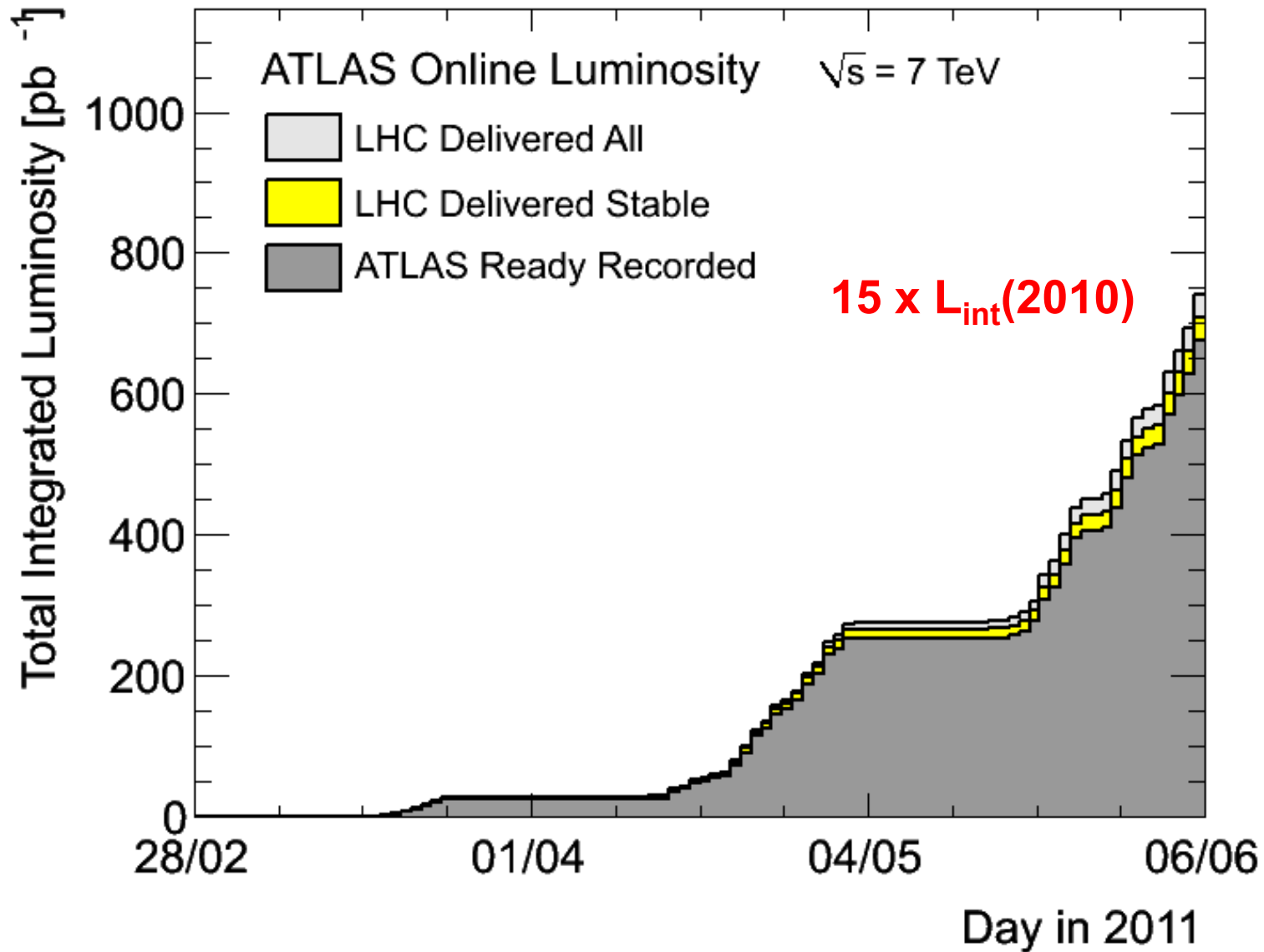


Peak luminosity 2011

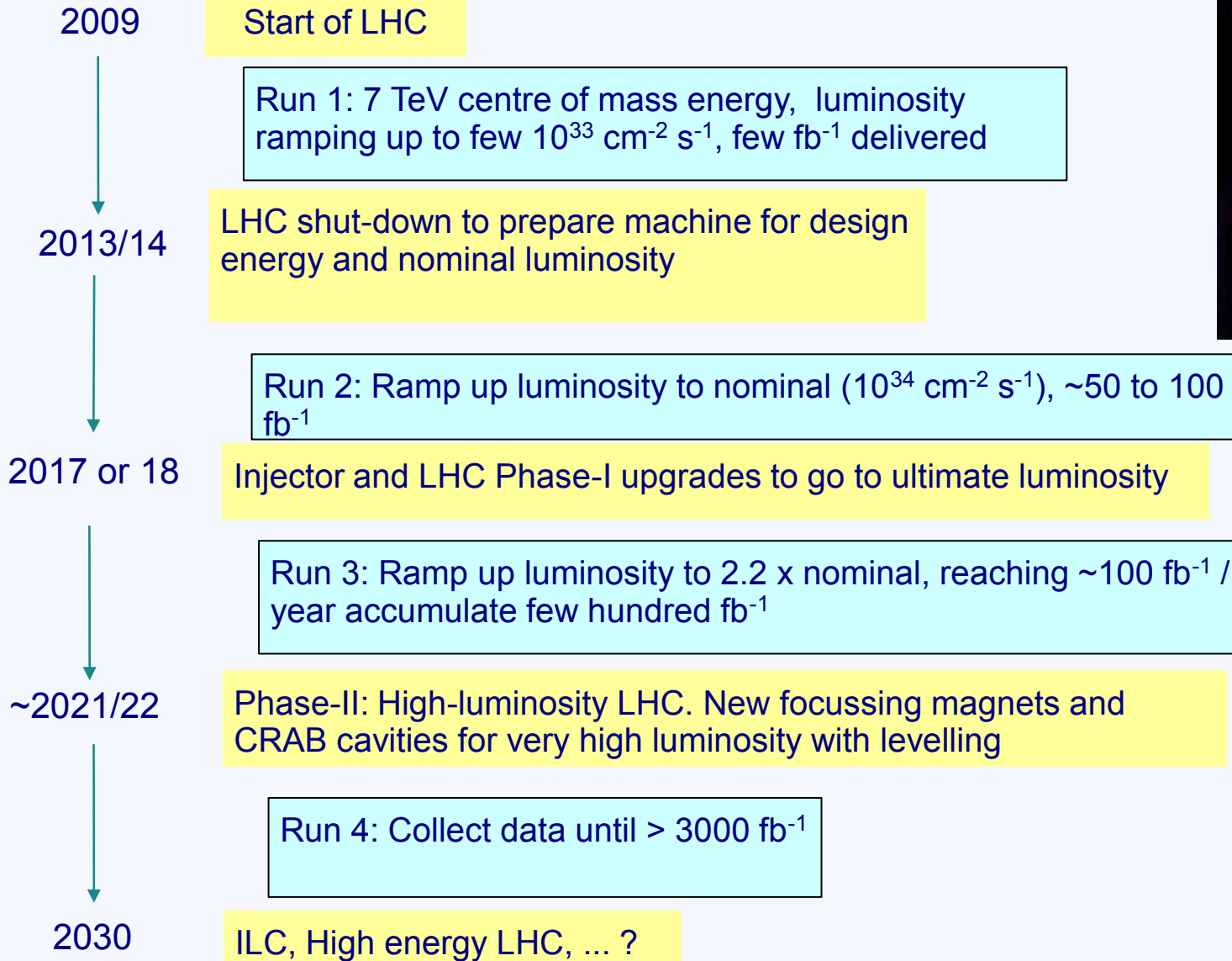




...and integrated luminosity 2011



LHC Time-line



LHC experiments timeline

LHC schedule harmonized/agreed with the experiments

- Consolidation/incremental upgrades in 2013-2013, getting more substantial in 2017 (major upgrade for LHCb in 2017?)
- Major upgrades in 2021
- Upgrade proposals submitted/in submission to the LHCC

Working the schedule backwards, and considering realistic construction and commissioning times, all experiments are already on a very tight timeline for R&D and final choices!

CERN is not only LHC.....

CERN now/in the next 5-10 years

from the conclusions of
SPSC and INTC chairs

High Energy Frontier

LHC

Neutrino Oscillations

Multidisciplinary
climate, medicine, ...



....and accelerators R&D

- CTF3
- HE-LHC
- New acceleration techniques (plasma,etc)
- High power drivers

A key element in the success of the program will be the capability to setup an efficient network with the European Labs and Universities

2011-2013: busy and exciting times for HEP

To:

- Assess the implications of the **emerging physics scenario** for the **next big thing**
- Deliver the ILC **TDR** (and the CLIC **CDR**)
- Proceed towards a **global vision** of the HEP program, investigating **new governance models** and **decision making** mechanisms across the regions

What can you expect from CERN?

- CERN as laboratory at the energy frontier
- Active role in defining the governance of the next global project
- Preparations **to bid for hosting it, but also to participate to it elsewhere**

Recalling the agenda

Important steps in the coming years

- CDR for CLIC 2011/12
- TDR for ILC 2012
- CDR for LHeC in 2011/12
- LCWS in Granada in 2011
- ICFA Seminar at CERN 3-6 October 2011
- Update of European strategy for particle physics
start: EPS 2011, finalize December 2012
- IEEE 2012 special event to promote LC

In summary

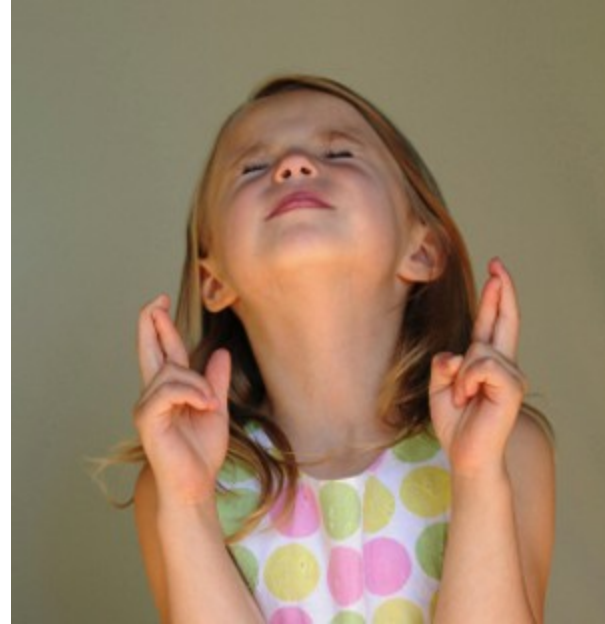
- By year 2013, **experimental results** will be dictating the agenda of the field.
- Early discoveries will greatly accelerate the case for the construction of the next facilities (Linear Collider, ν -factory, HE-LHC...)
- No time to idle: a lot of work has to be done in the meantime

In summary

We will need

- Flexibility
- Preparedness
- Visionary global policies

■ ...and a bit of luck!



Thank you!