



The LHC and Beyond



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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
-

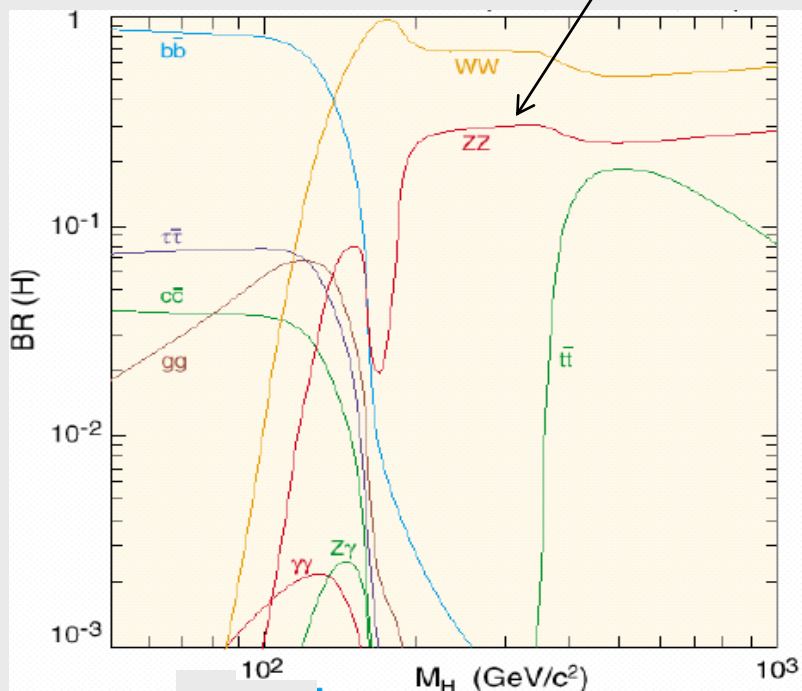
Here at CERN...

Prospects for the Higgs Boson at 7 TeV (2011-2012)

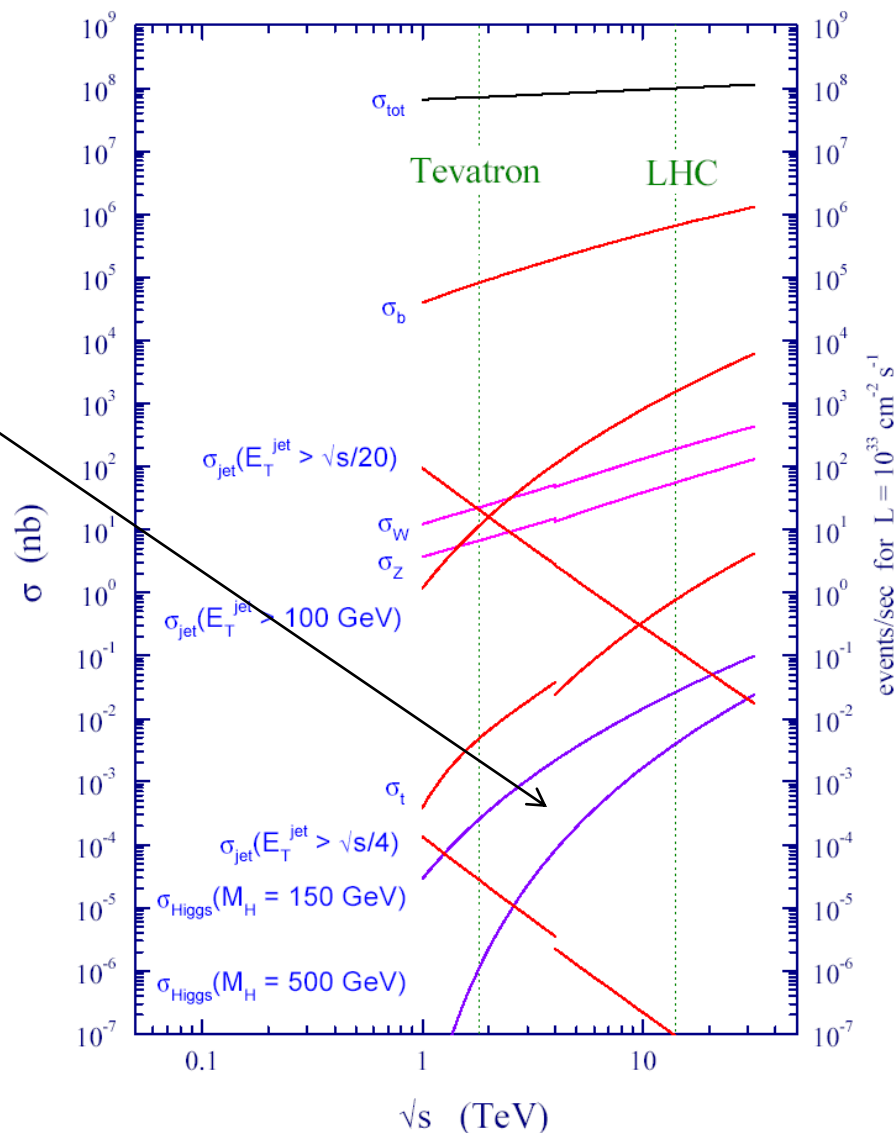
Search for the Higgs-Boson at the LHC

Production rate of the Higgs-Bosons depends on its mass

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

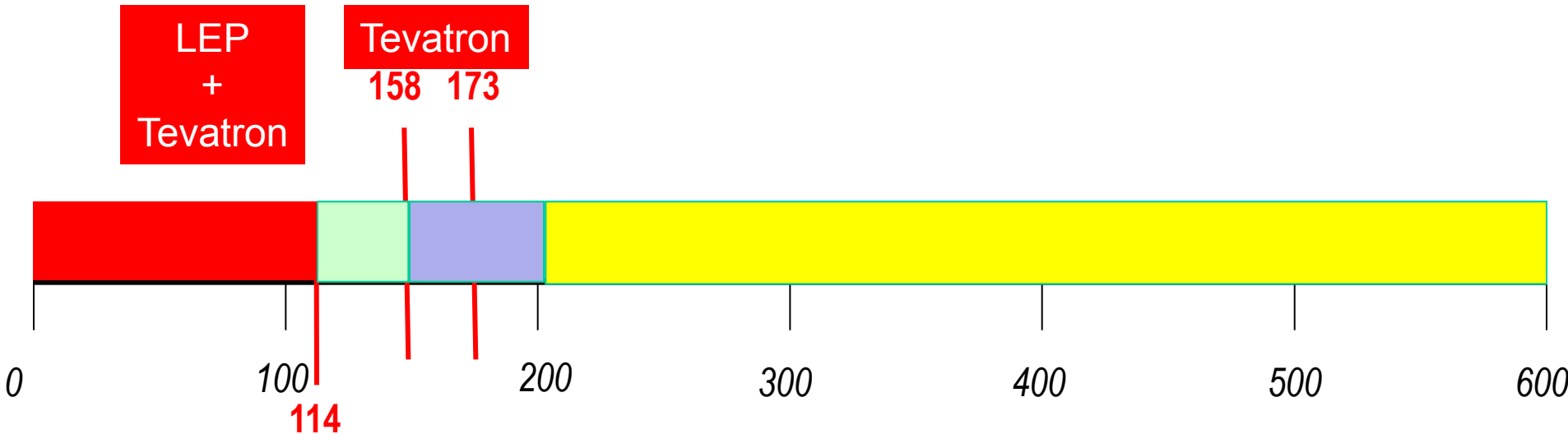


proton - (anti)proton cross sections



The Higgs Search Landscape: LHC Joins The Fray !

95% CL Excluded Mass range



Low Mass
($M_H \approx 120$ GeV)

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

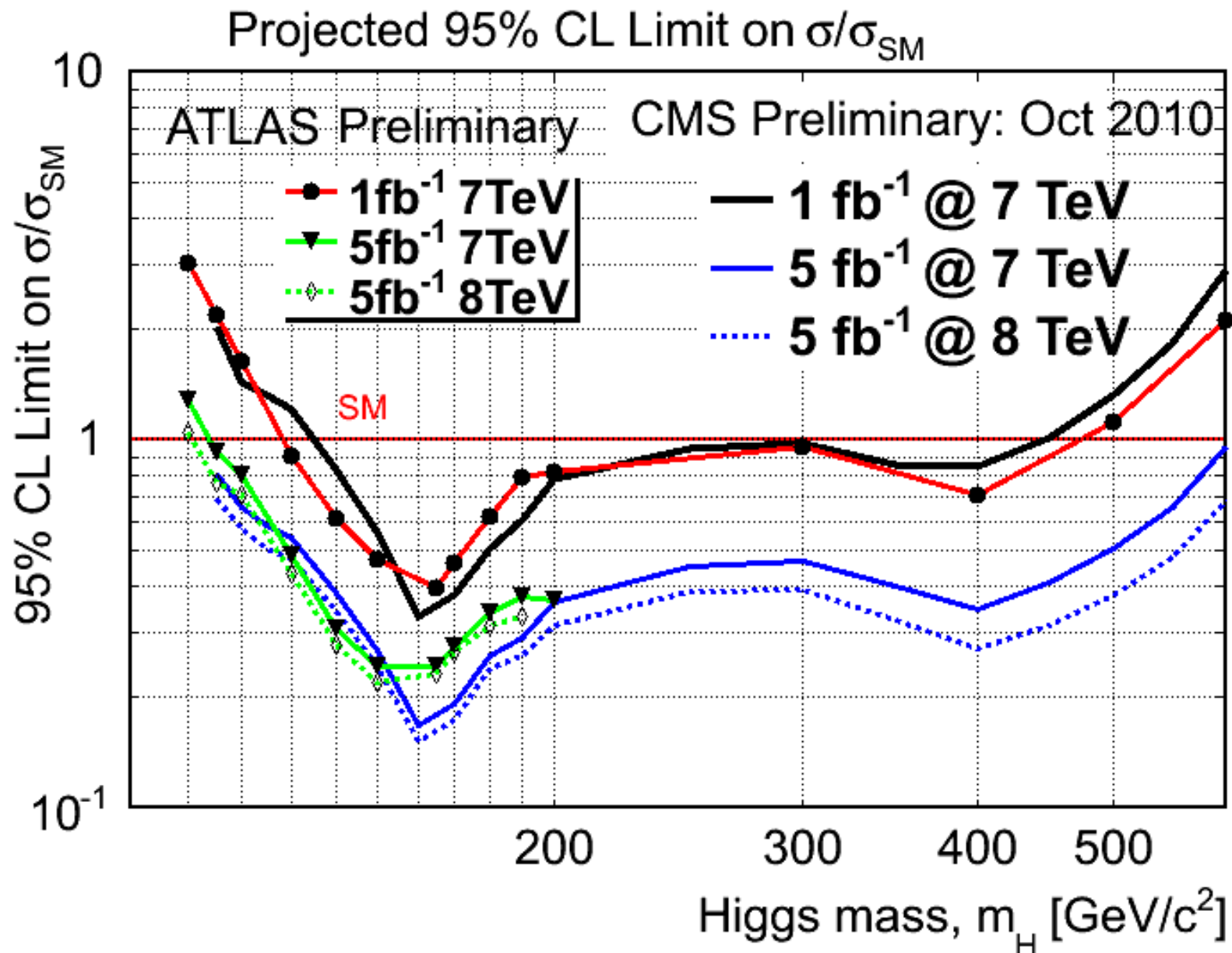
Mid Mass
($M_H \approx 160$ GeV)

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

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)

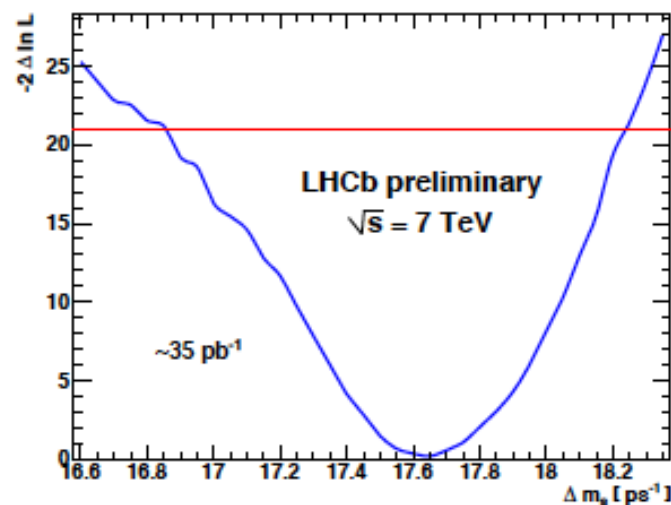
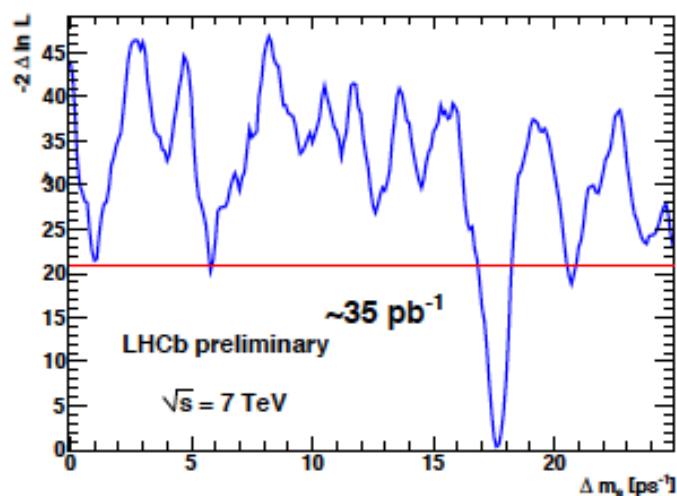
ATLAS + CMS $\approx 2 \times$ CMS	95% CL exclusion	3σ sensitivity	5σ sensitivity
1 fb^{-1}	120 - 530	135 - 475	152 - 175
2 fb^{-1}	114 - 585	120 - 545	140 - 200
5 fb^{-1}	114 - 600	114 - 600	128 - 482
10 fb^{-1}	114 - 600	114 - 600	117 - 535

...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 $^{-1}$

Fit the $\phi_s^{J/\psi\phi}$ phase

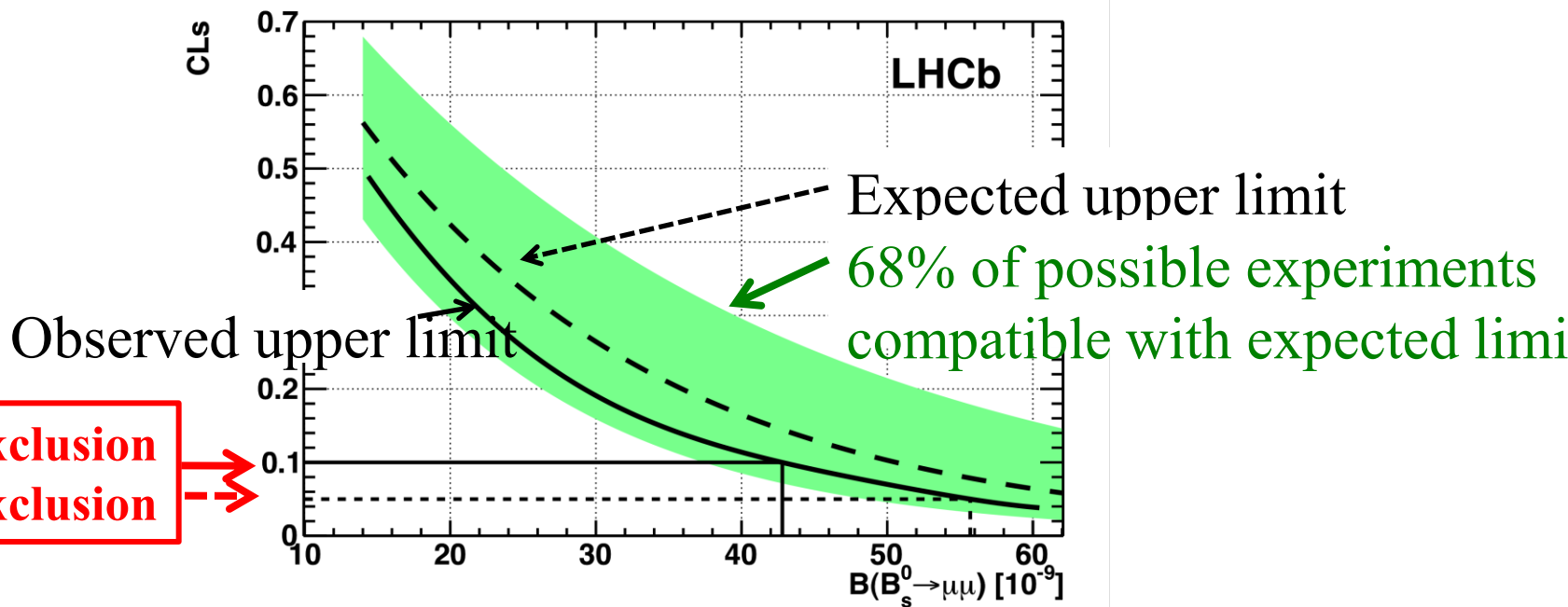
- Expected sensitivity using toy MC [arXiv:0912.4175]:

$$\sigma_{stat}(\phi_s^{J/\psi\phi}) \sim 0.03 \text{ rad for } 2 \text{ fb}^{-1} \text{ at } 14 \text{ TeV} \quad (\phi_s^{\text{SM}} = -0.0363 \pm 0.0017 \text{ rad})$$

Today performance measured on real data:

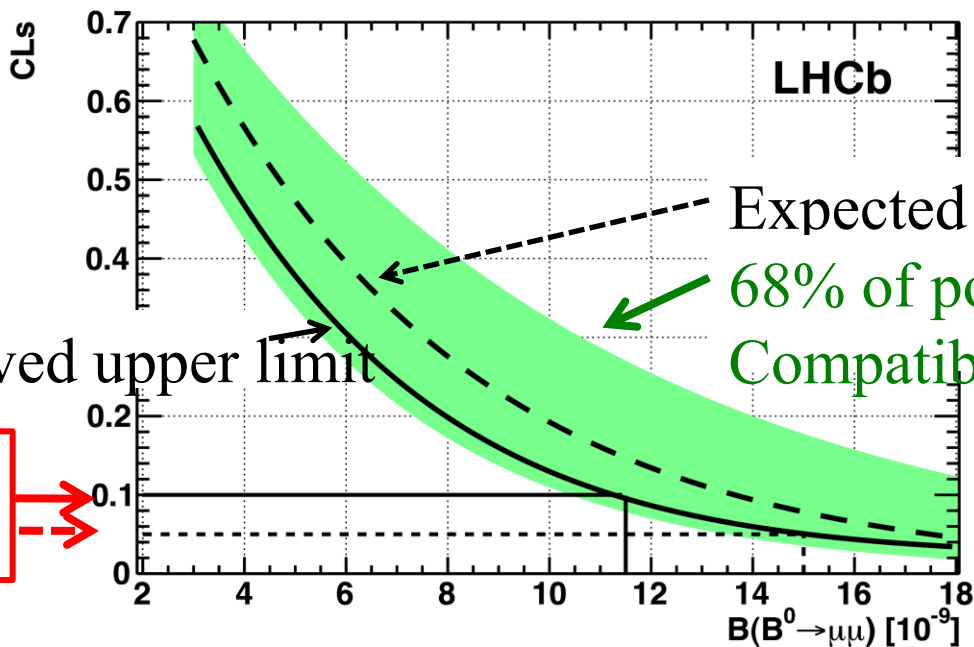
	LHCb 36 pb ⁻¹	CDF 5.2 fb ⁻¹
$B_s^0 \rightarrow J/\psi\phi$	960	6500
Proper time resolution	50 fs	100 fs
OS tagging power	$2.5 \pm 0.8\%$	$1.2 \pm 0.2\%$
SS tagging power	work ongoing	$3.5 \pm 1.4\%$

⇒ expect world best measurement of $\phi_s^{J/\psi\phi}$ very soon!



		@ 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

Search for $B_d \rightarrow \mu\mu$



Observed upper limit

Expected upper limit

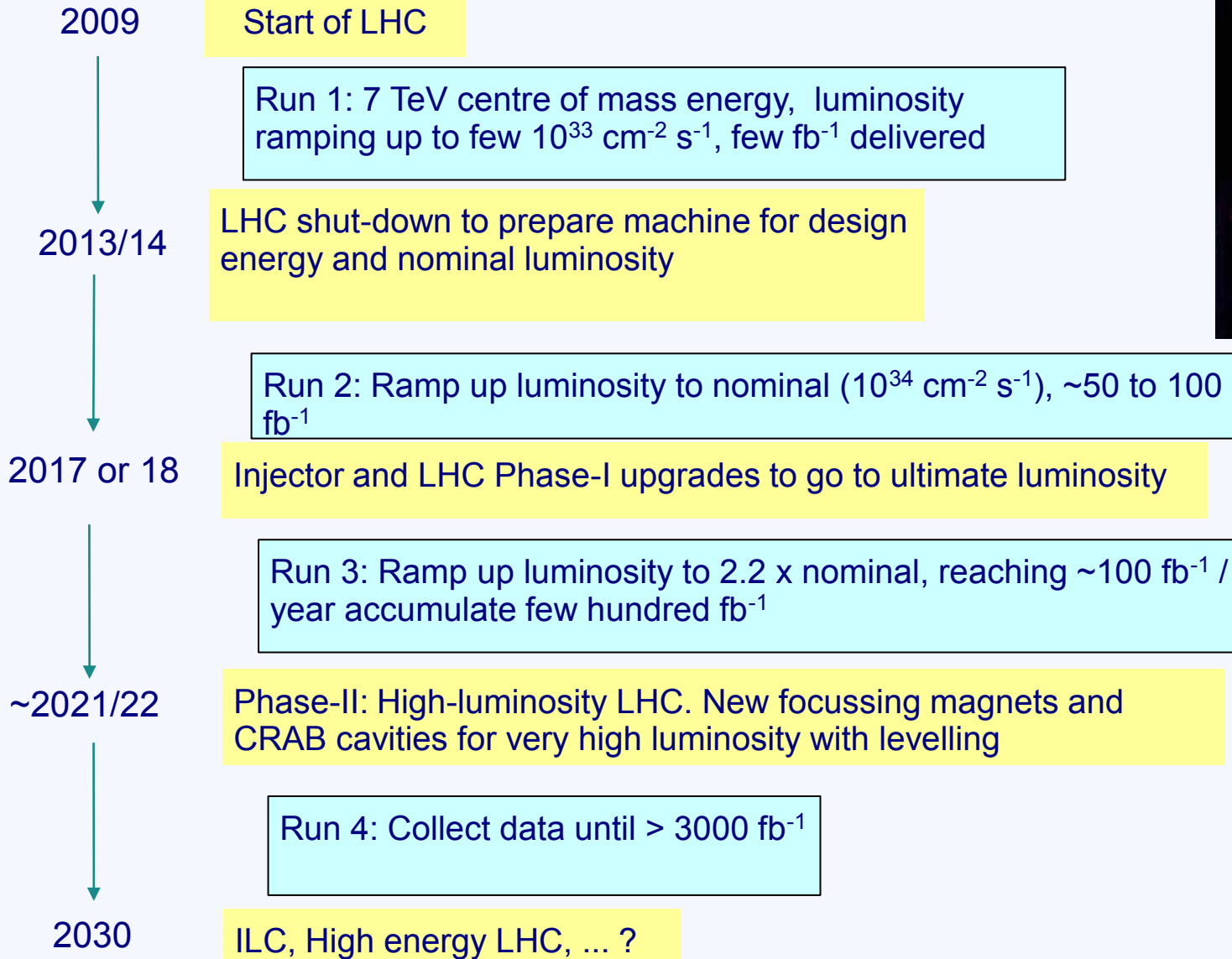
68% of possible experiments

Compatible with expected limit

90% exclusion
95% exclusion

		@ 90% CL	@ 95% CL
LHCb	Today, 37 pb⁻¹	< 12 x10⁻⁹	< 15 x10⁻⁹
CDF	World best, 2 fb⁻¹ PRL 100 101802 (2008)	< 15 x10⁻⁹	< 18 x10⁻⁹
CDF	Preliminary, 3.7 fb⁻¹ Note 9892	< 7.6 x10⁻⁹	< 9.1 x 10⁻⁹

A LHC Time-line



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, implementing **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**

CERN Opening (Council in June 2010)

CERN has made a substantial step into globalization by:

- Geographical Enlargement/Opening
 - full and associate membership independent of geographical location
- Participation in Global Projects
 - coordinate broad European participation in a future global accelerator project hosted elsewhere

Recalling the agenda

Important steps in the coming years

- CDR for CLIC 2011/12
- TDR for ILC 2012
- 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

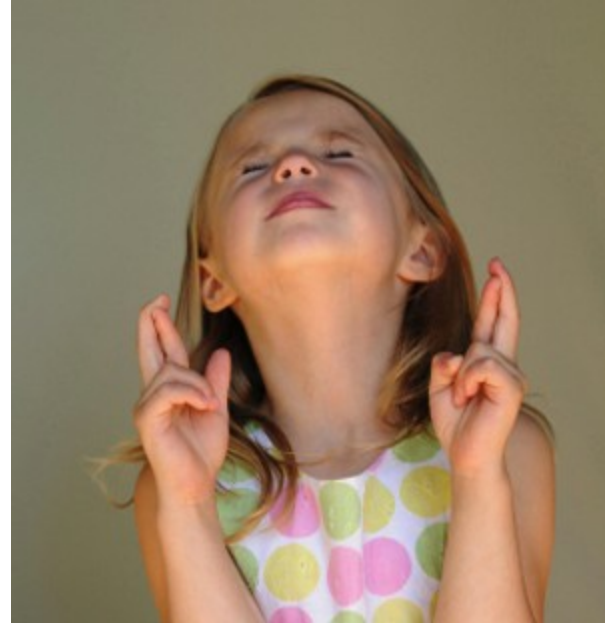
- By year 2013, **experimental results** will be dictating the agenda of the field.
- Early discoveries will greatly accelerate the case for the construction of the next facilities (Linear Collider, ν -factory, HE-LHC...)
- No time to idle: a lot of work has to be done in the meantime, **especially on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

In summary

We will need

- Flexibility
- Preparedness
- Visionary global policies

■ ...and a bit of luck!



Thank you!