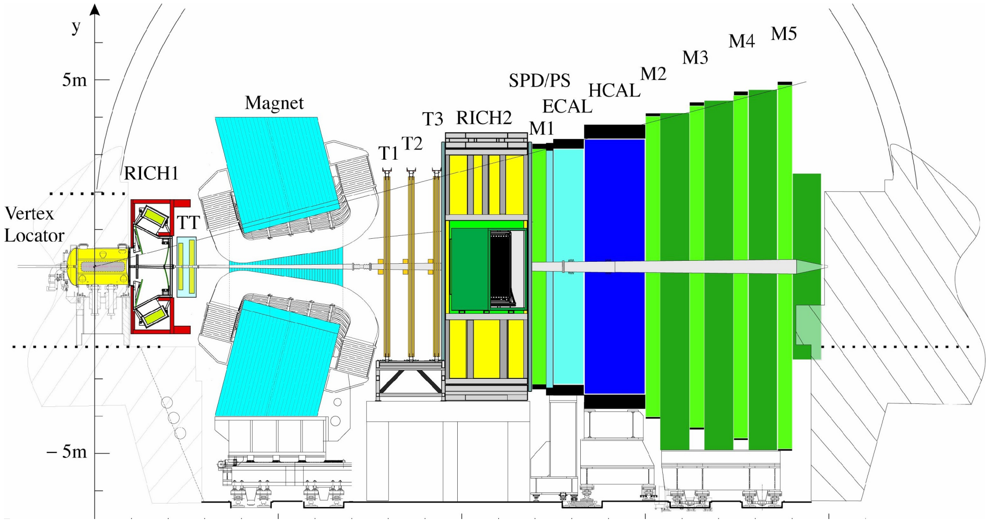
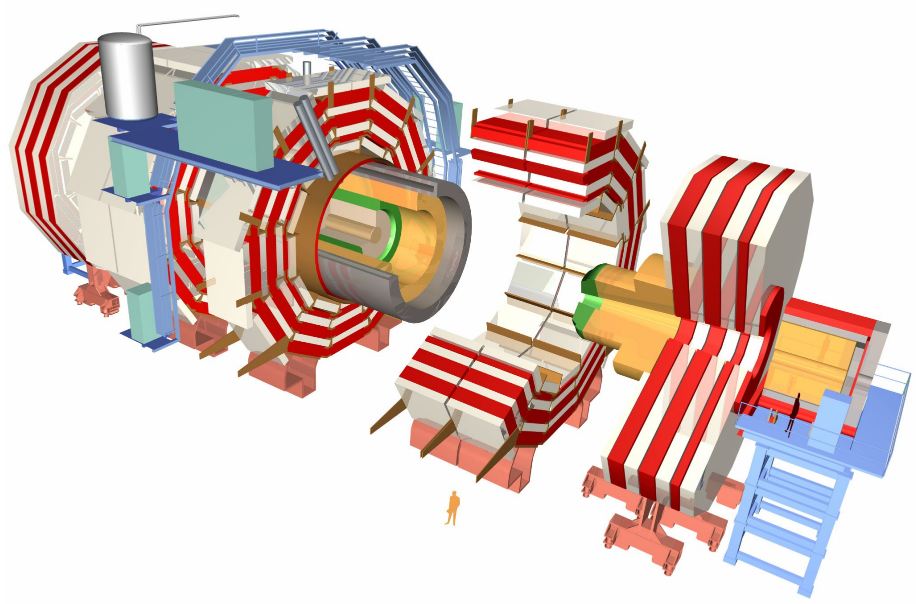
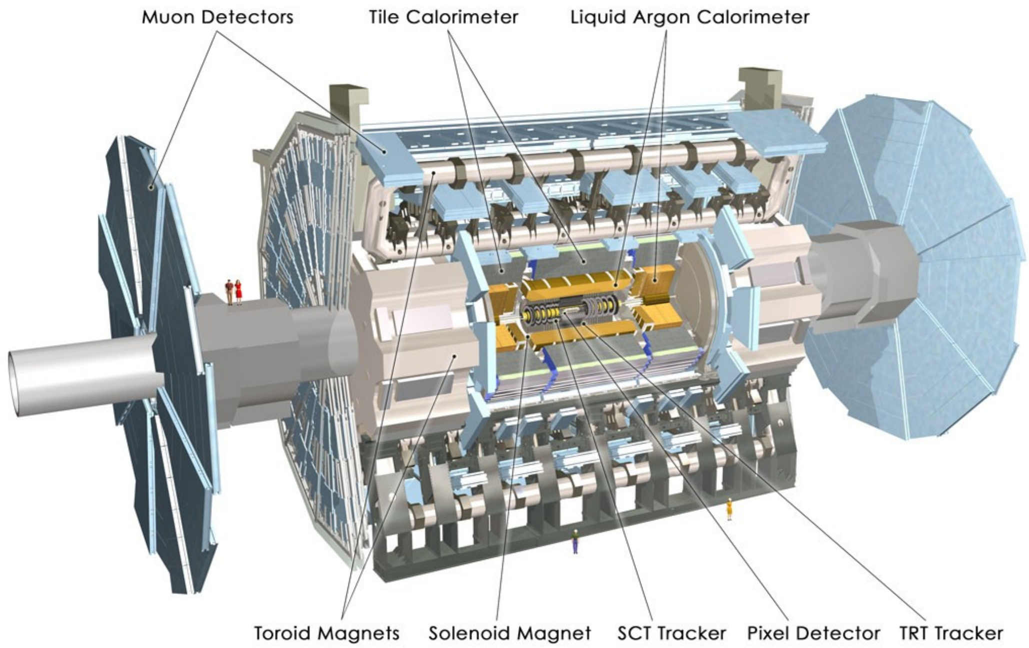


B Physics @ LHC

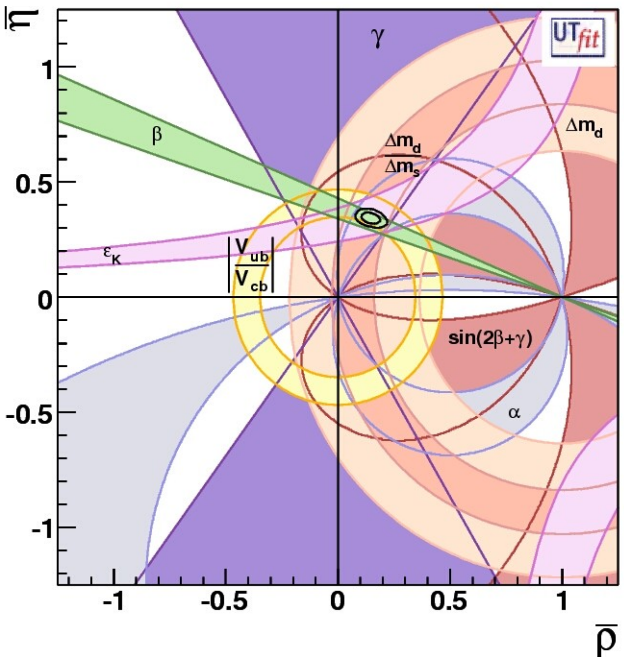
A. Sarti LNF - INFN





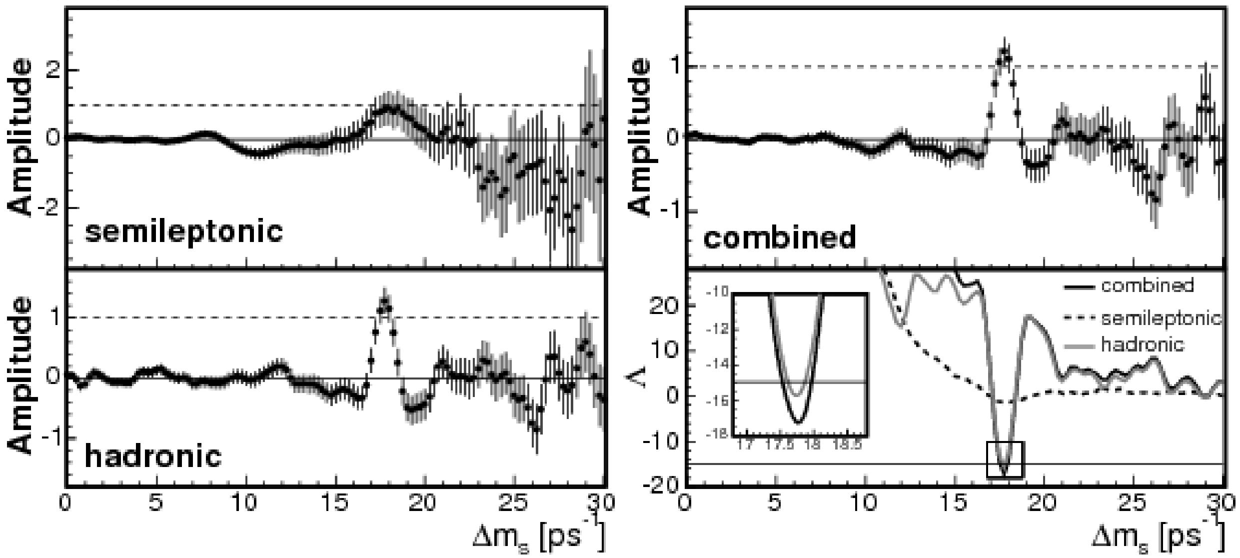
Why B physics?

- If NP is not completely decoupled from TeV scale, flavour sector should be affected!
- B meson system is a natural place where to look
  - B_d system constrained from B factories: B_s mesons (and B_d, B_c, Λ_b, ..) available @ LHC with large statistics!
    - b→s transitions can be studied in detail (Rare decays, precise CP violation analyses)
    - CKM sector can be further constrained (γ from trees, NP free, and γ from loops where, again, NP can sneak in....)



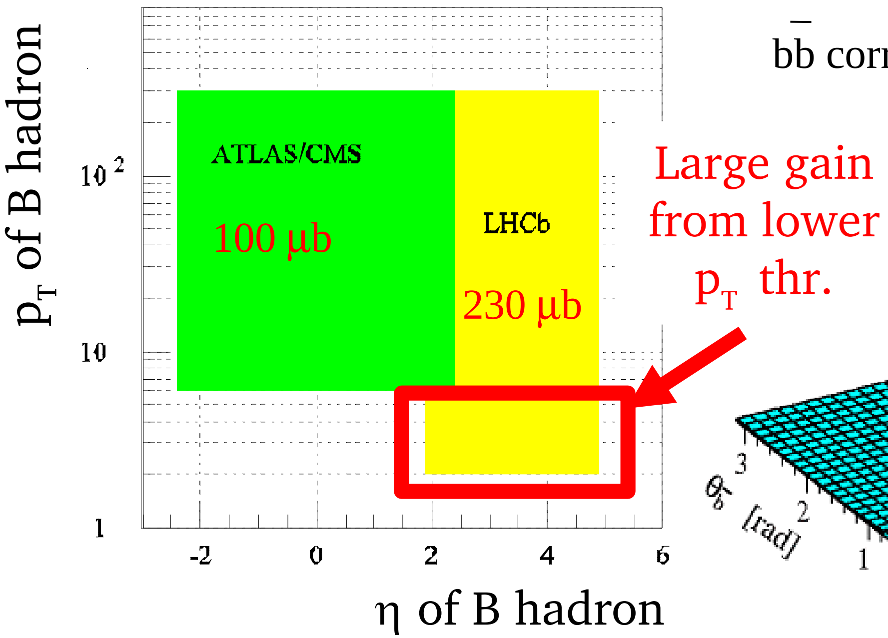
- B physics @ p machine (TeV scale) is doable
  - SM studies. E.g. D0 and CDF measurement of Δm_s
  - NP studies. E.g. D0 and CDF B_s mixing measurement → constraint in $\Delta\Gamma$ vs ϕ_s plane

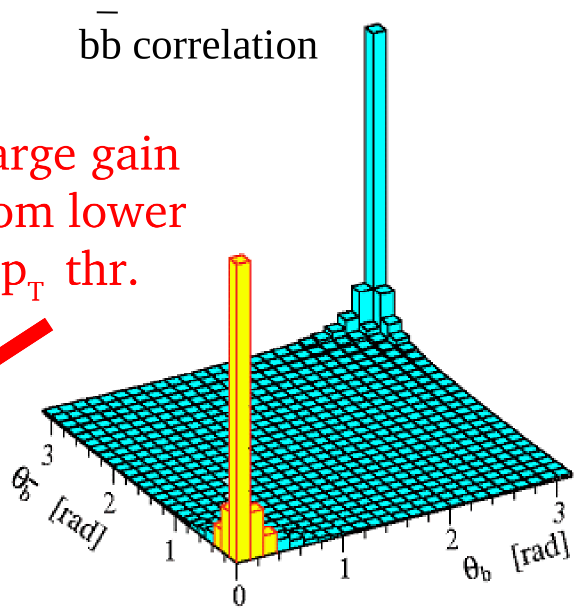
$\Delta m_s = 17.77 \pm 0.10\,(stat) \pm 0.07(syst)\ ps^{-1}$ PRL 97 (2006)

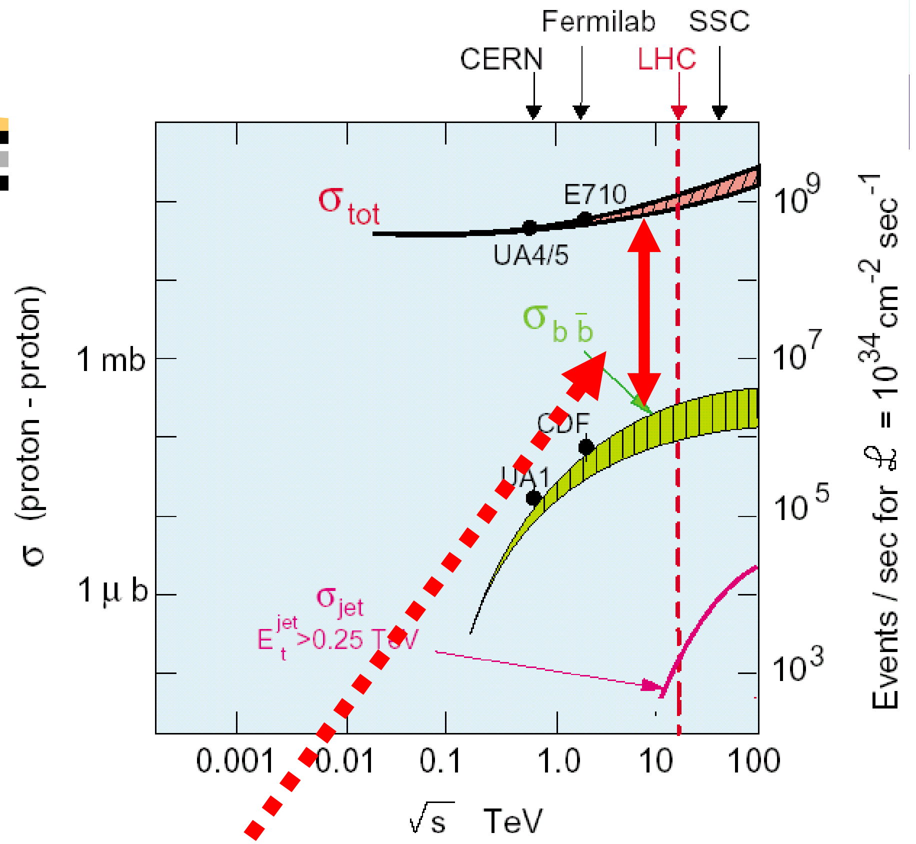


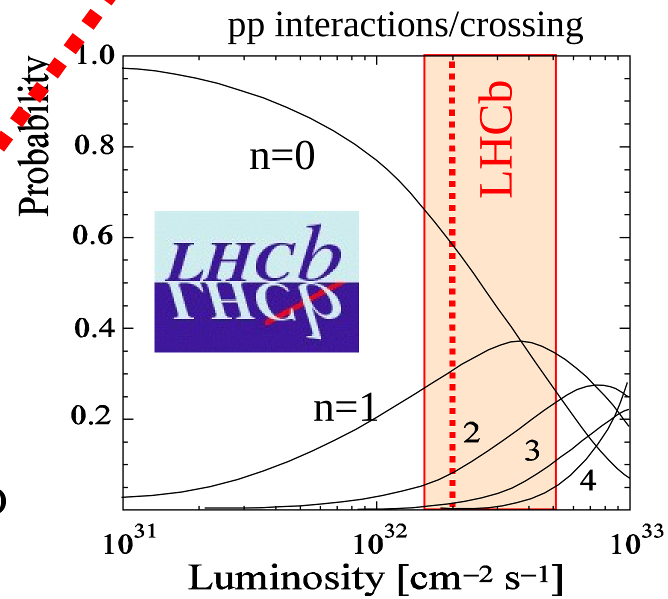
B physics @ LHC

Pythia production cross section







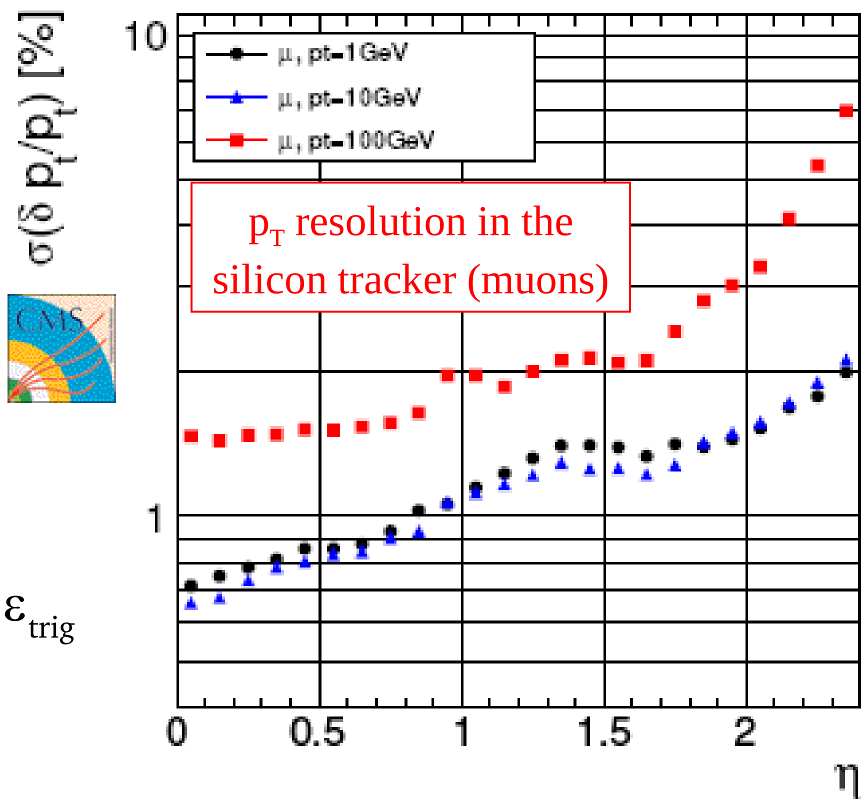


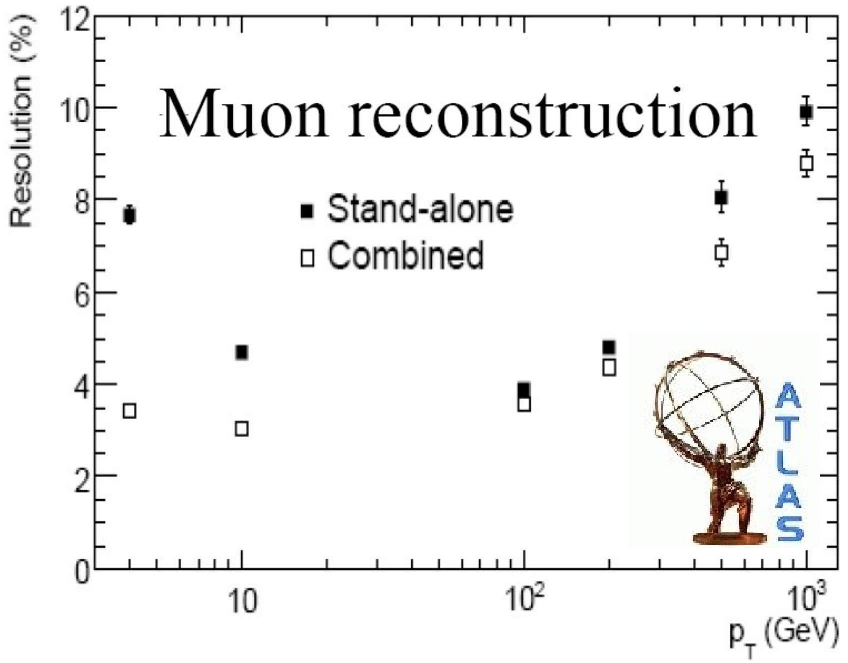
- B phys @ pp machine @ 14 TeV:
  - σ(bbar) ~ 500μb : 10^4 bbar/s @ L = 10^{32}
  - 3 experiments involved (1 dedicated, LHCb)
  - Huge background from pp to be suppressed
  - Becomes difficult when Lumi increases: pp interaction /crossing 1→ 23 from LHCb @ $2\cdot10^{32}$ to ATLAS & CMS @ 10^{33}

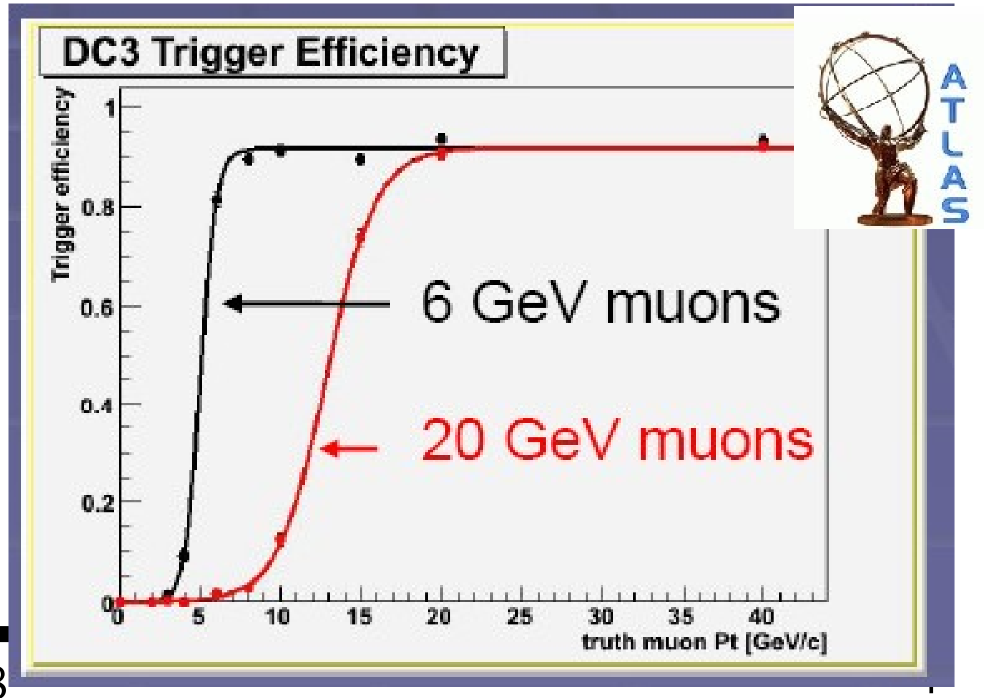
For detector details see talks in tomorrow session

ATLAS & CMS

- General purpose detectors
  - $|\eta|<2.5$ and full ϕ
- B-physics using trigger with large p_T μ
  - Good μ resolution in tracker and spectrometer
  - High μ ε_{rec} (E.g. CMS >98% for $|\eta|<2.4$) and ε_{trig}
  - p_T resolution ~ 1-2%
  - IP_T resolution ~ 10μm





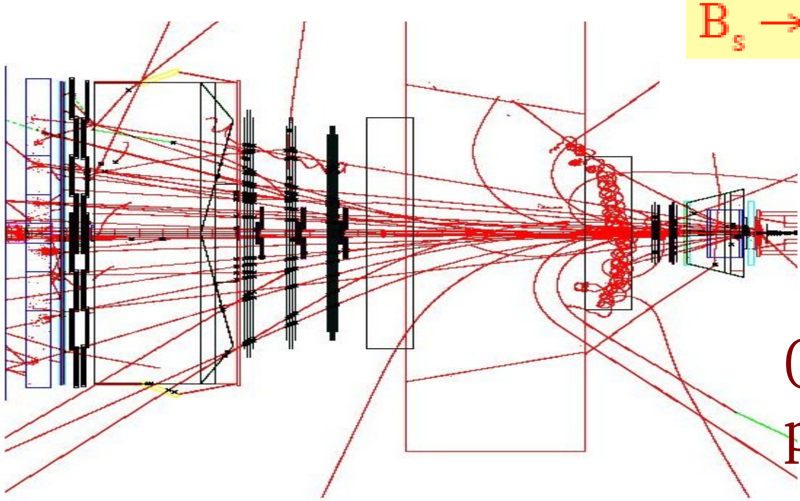


LHCb (tracking)

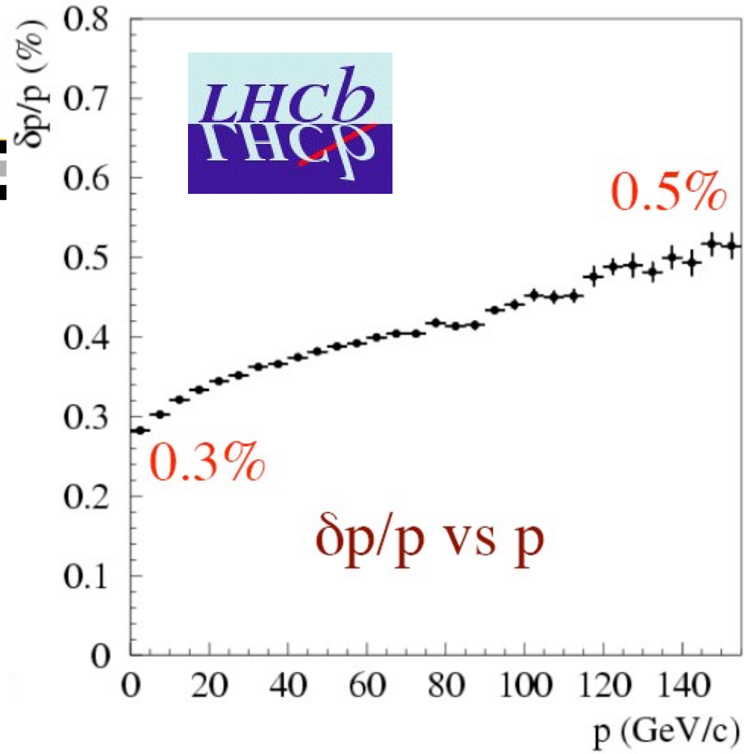
- Detector optimized for B physics studies
  - σ_p/p = 0.3%–0.5% depending on p
  - High efficiency (>95%) for long tracks from B decays and ~4% Ghosts for p_T>0.5 GeV/c
  - Impact parameter resolution $\sigma_{IP} \sim 30\ \mu m$
- Typical B resolutions
  - Proper time ~ 40 fs
  - Mass ~ 10 – 20 MeV/c^2

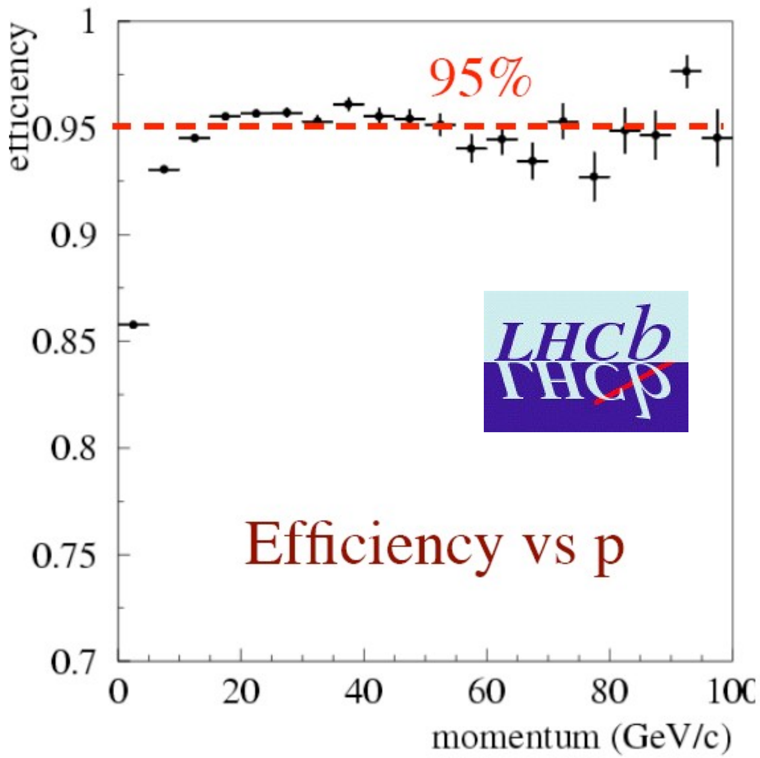
	Mass resolution
$B_s \to \mu\mu$	18 MeV/c^2
$B_s \to D_s\ \pi$	14 MeV/c^2
$B_s \to J/\psi\ \phi$	16 MeV/c^2
$B_s \to J/\psi\ \phi$	8 MeV/c^2 *

* with J/ψ mass constraint



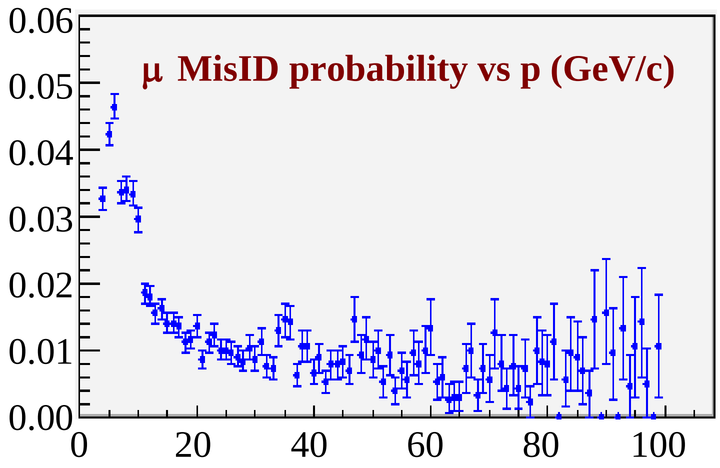
High-Multiplicity Environment (~30 charged particles per bb event @ $2\cdot10^{32}$)

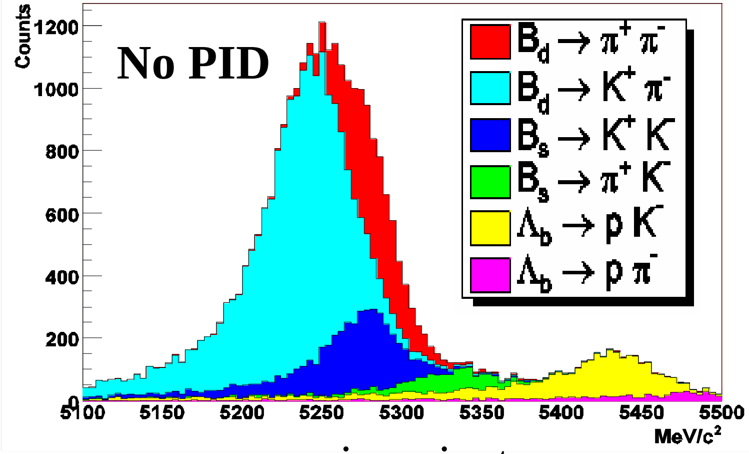




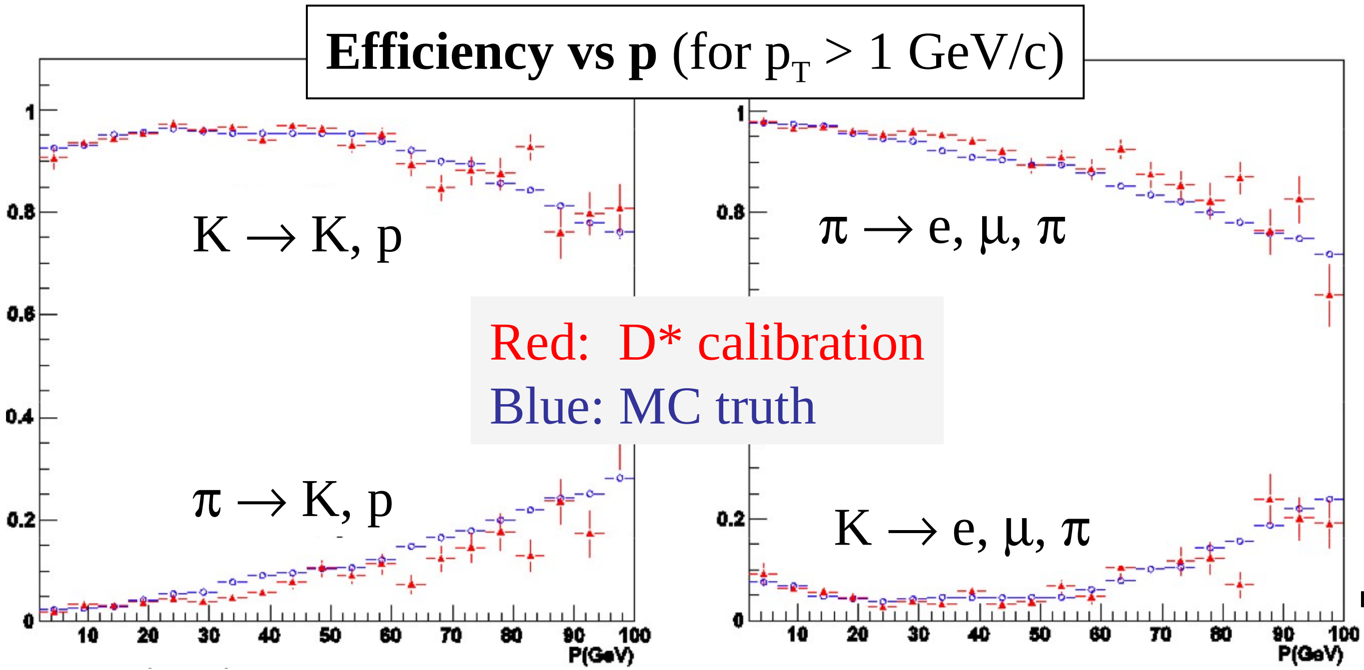
LHCb (Particle ID)

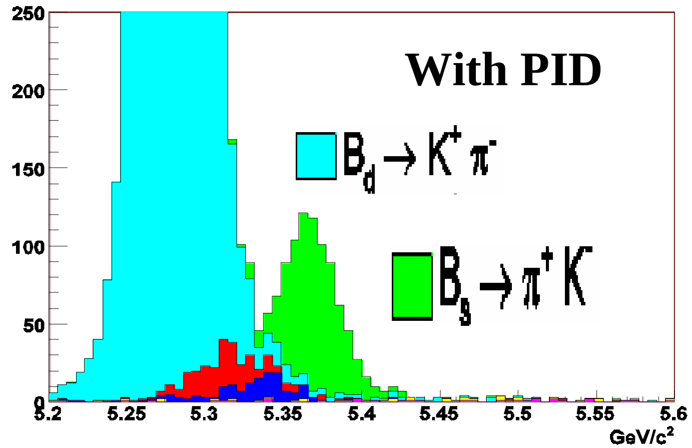
- High μ efficiency (> 95% in full range from 3GeV)
  - Measured on data using: generic μ (50 Hz), Prompt $J/\psi \to \mu\mu$ (< 2 Hz) and $J/\psi \to \mu\mu$ from B (0.3 Hz)
- μ misID (≤1%, p>10 GeV/c) measured using Λ decays
- Good π,K separation in 1-100 GeV range (2 RICH!)
- Hadron samples to calibrate π,K and measure μ misID:
  - $D^{*+} \to D^0(K^-\pi^+)\pi^+$ (16 Hz of hadrons)
  - Hadrons from $B \to hh$ (0.02 Hz) (E.g. misID in $B_s \to \mu\mu$ analysis)





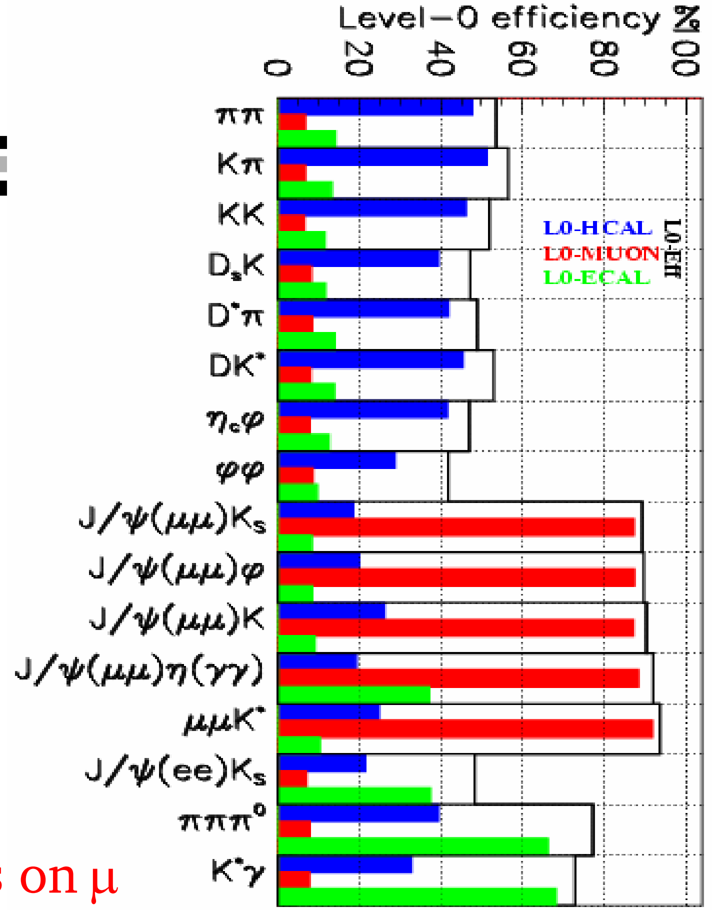
ππ invariant mass





Kπ invariant mass

Triggering @ LHC



- First level (Hrdw)
  - **CMS & ATLAS L1:** Outp rate <100kHz. Info from μ chambers and calorimeters
  - **LHCb L0:** Outp rate = 1 MHz. Info from pileup system, ECAL, HCAL and MUON: select minimum p_T h, μ, e, γ, π^0 **ε_{trig} for J/ψ channels > 80%, other channels ~40%**

- HLT (Sftw, after full readout)
  - **CMS & ATLAS HLT:** Outp rate ~200Hz. (10% useful for B phys)
  - **LHCb HLT:** Outp rate ~2 kHz. Several trigger lines: μ, μ+h, h, ECAL, …(start with L0 confirmation). Then inclusive and exclusive selections

Avoid hard cuts on μ displacement (unbiased selection crucial for proper time studies)!

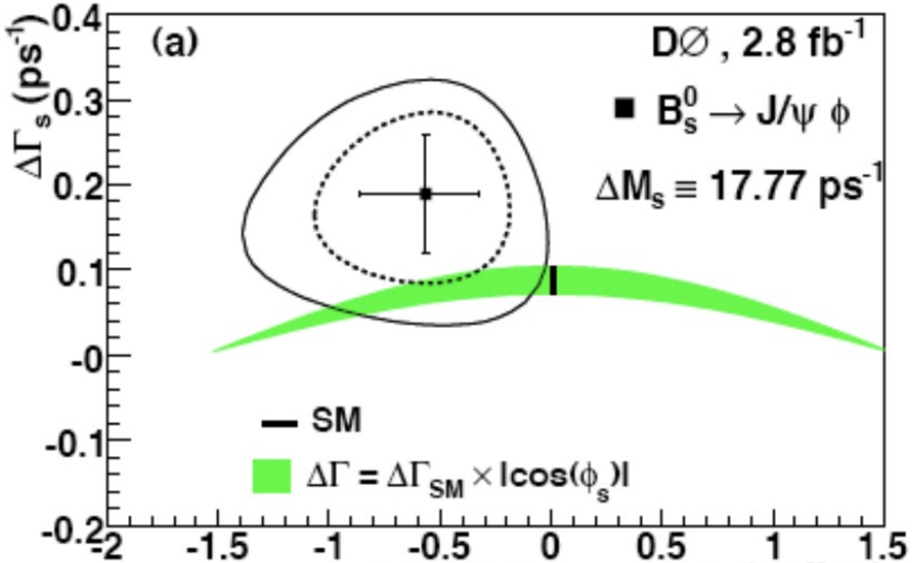
Output rate	Event type	Physics
200 Hz	Exclusive B candidates	B (core program)
600 Hz	High mass di-muons	J/ψ, b→J/ψX (unbiased)
300 Hz	D* candidates	Charm
900 Hz	Inclusive b (e.g. b→μ)	B (data mining)

$B_s \to J/\Psi\ \phi$

- Measure ϕ_s=-2β_s counterpart of ϕ_d=2β_d [sin 2β_d = 0.668±0.028]
- ϕ_s [SM] = –arg(V_{ts}^2) = –2$\lambda^2\eta$ = –0.0368 ± 0.0018 [CKMfitter, sum. 07] and hence sensitive probe of NP
- High BR ~3·10^{-5} and good exp. signature (μ trigger effective!)
- Time dependent CP asym. used to measure ϕ_s

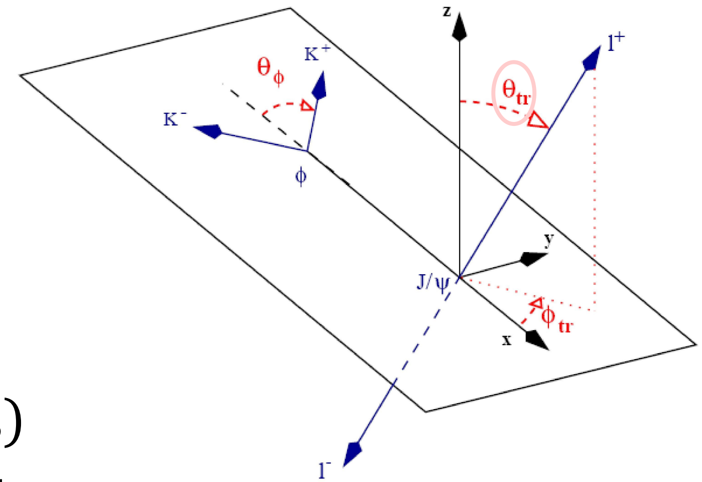
$$A_{CP}(t) = \frac{-\eta_f \sin\beta_s \sin(\Delta m_s t)}{\cosh(\Delta\Gamma_s t/2) - \eta_f \cos\beta_s \sinh(\Delta\Gamma_s t/2)}$$

J/ψϕ is not a pure CP eigenstate: angular analysis is needed to determine even (η_f = -1) and odd (η_f =1) states



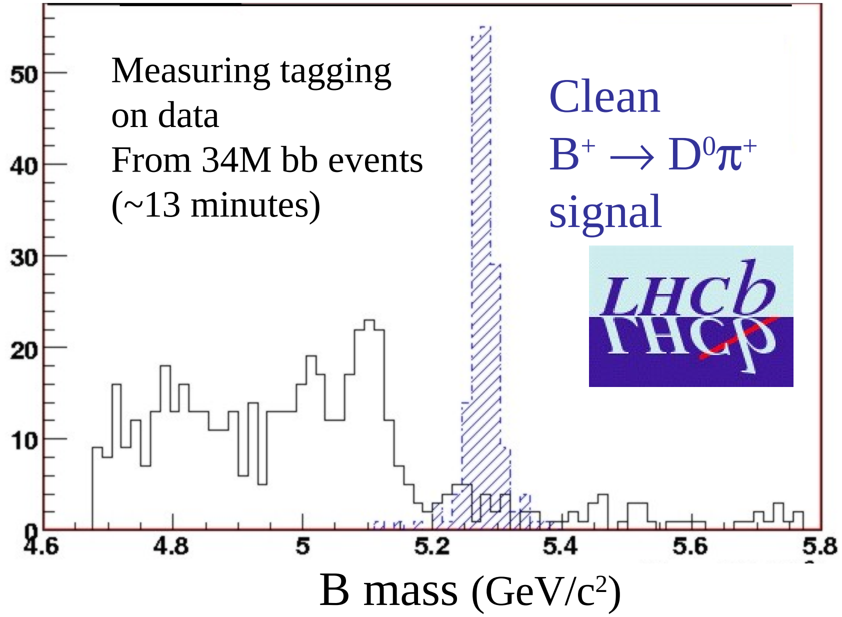
NB: $2\beta_s = -\phi_s$

NP suggested by M. Bona et al. (arXiv:0803.0659, combines CDF and D0 results)



Key ingredients: tagging and proper time

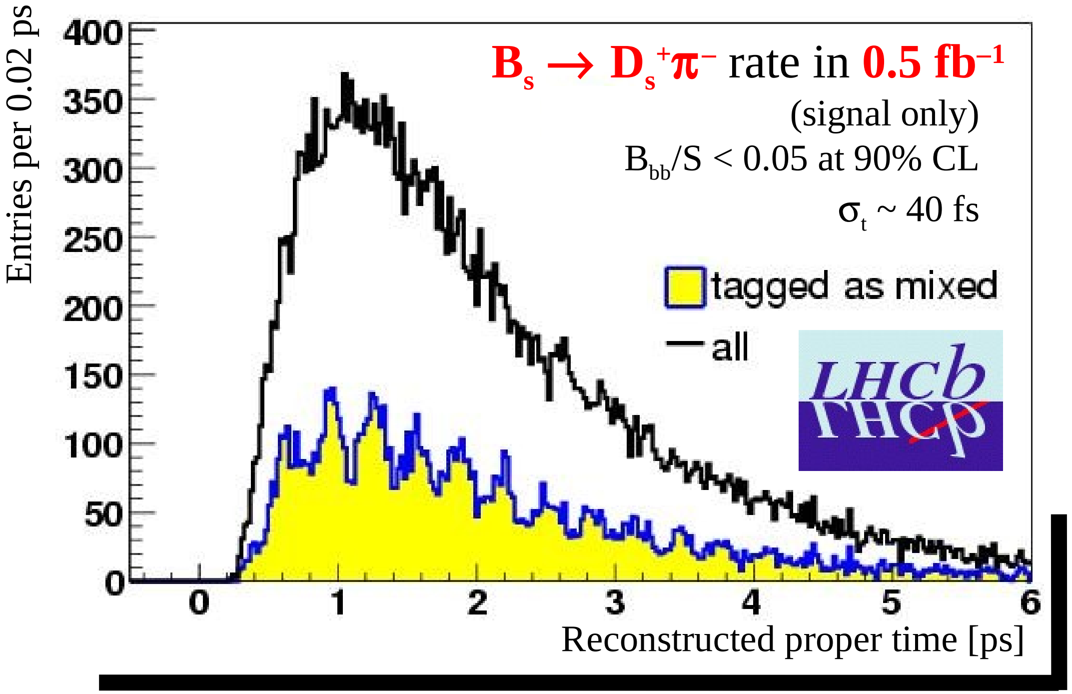
- Data samples. Assume ¼ nominal year: 2.5 fb^{-1} ATLAS, CMS and 0.5 fb^{-1} LHCb (feasible by 2009).
- Tagging:
  - LHCb: e, μ, K, vertex charge (OS) + pion (B^0) or kaon (B_s) (SS). **εD^2 = 6.6%**
  - ATLAS: e, μ, Qjet (OS). **εD^2 = 4.6%**
  - CMS: not yet done....



- Proper Time: B_s oscillation has to be well resolved
  - good that Δm_s is not too big!

resolution function must be well understood measuring lifetimes, oscillation plot with $D_s\pi$ etc.

	ATLAS	CMS	LHCb
σ_τ [fs]	83	77	36



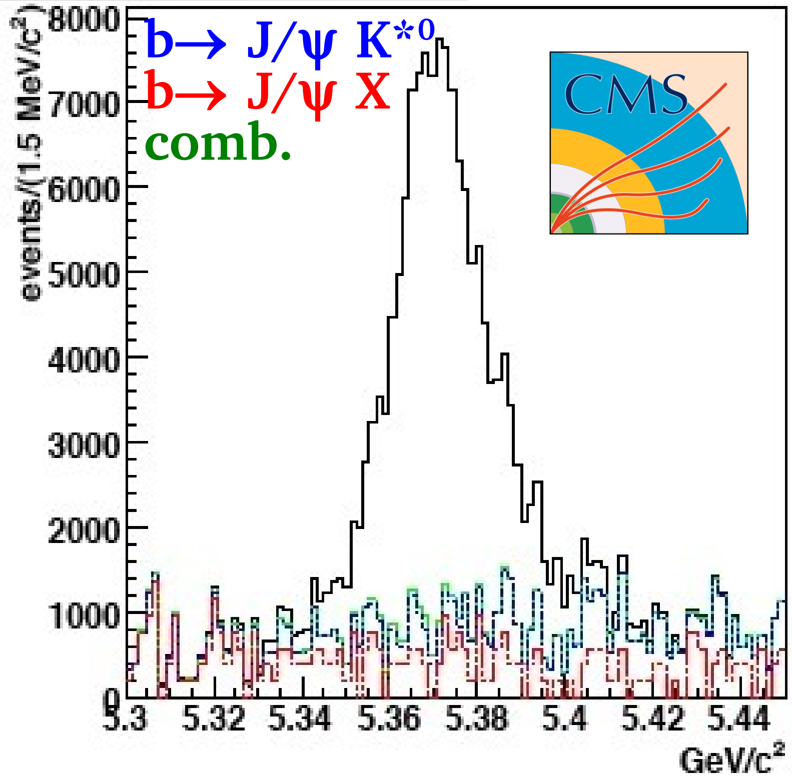
Mass resolution, B/S, yields

B_s mass resolutions and Background/Signal ratios

	ATLAS	CMS	LHCb
σ_m [MeV/c^2]	16.5*)	14*)	14+)
B/S	0.18	0.25	0.12

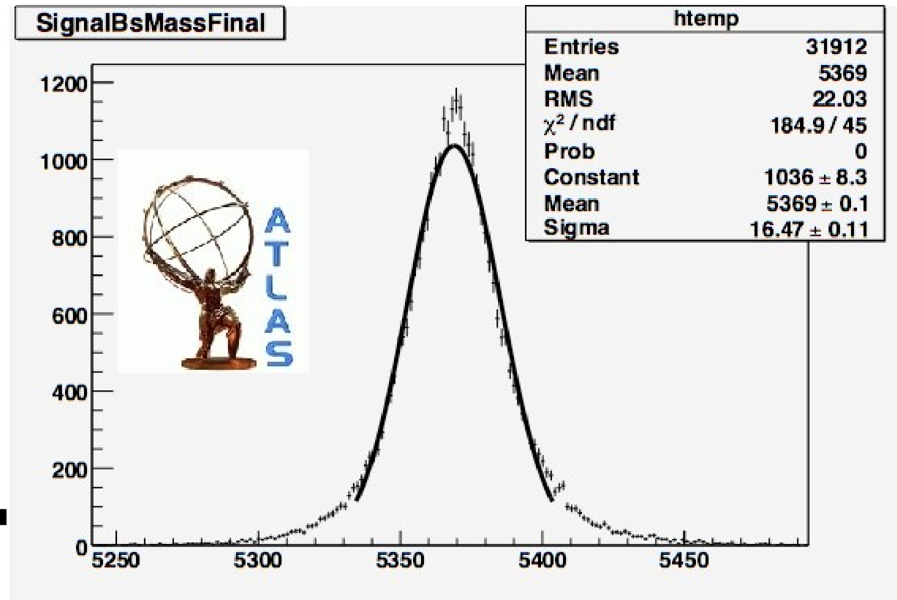
*) with J/ψ mass constraint

+) without mass constraint, improves bkg control



Numbers of reconstructed J/ψ ϕ and those effectively flavour tagged (¼ year)

	ATLAS	CMS	LHCb
N_{rec}	23 k	27k	33 k
$N_{rec}^{eff\text{-}tag}$	1.0 k	-	2.2 k



Measuring ϕ_s

With 2009 data

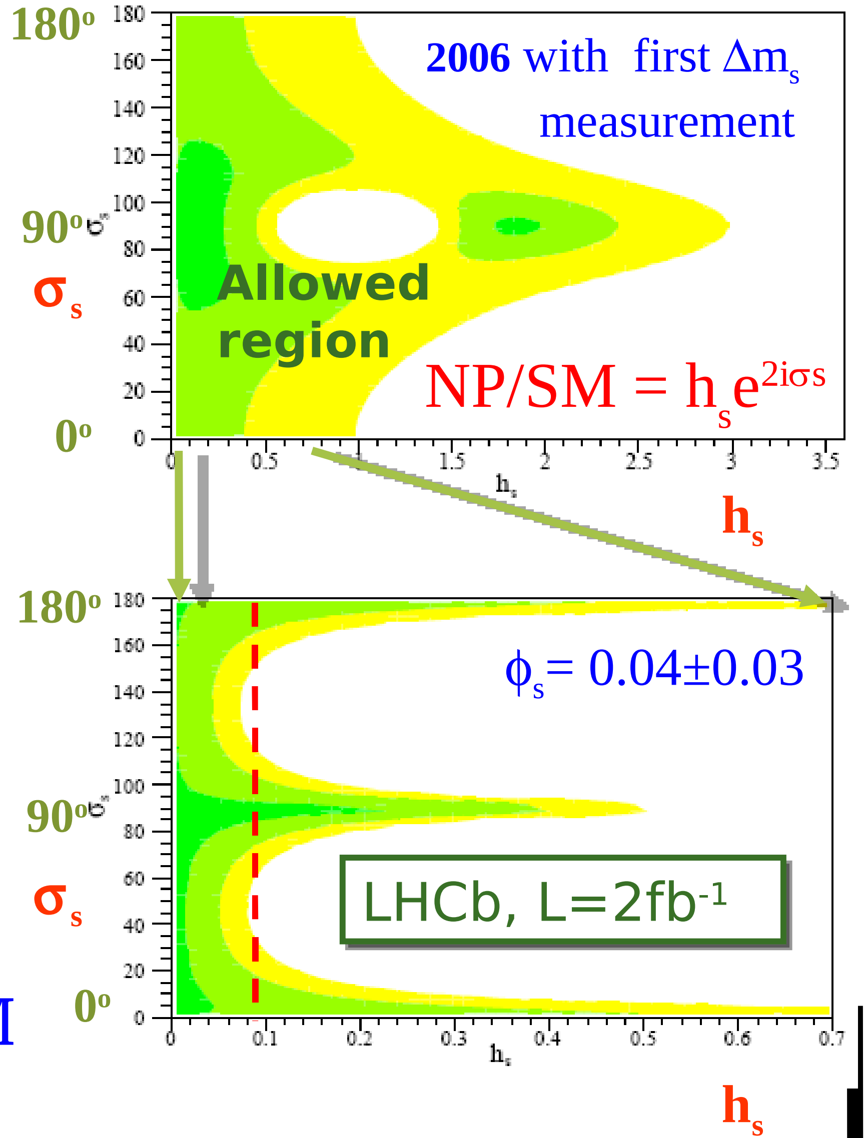
	ATLAS	CMS	LHCb
$\sigma(\phi_s)$	0.159	-	0.042
$\sigma(\Delta\Gamma_s)/\Delta\Gamma_s$	0.41	0.13	0.12

LHCb: BSM effect down to the level of SM can be excluded/ discovered with the 2009 data ($J/\psi\, \eta$, $\eta_c\, \phi$, $D_s^+ D_s^-$ can be added. No angular analysis, but smaller statistics)

With > 2009 data

ATLAS and CMS: $\sigma(\phi_s) \approx 0.04$ with $\int L \cdot dt = 30$ fb^{-1} data LHCb By ~2013, SM prediction of ϕ_s tested to a level of ~5σ

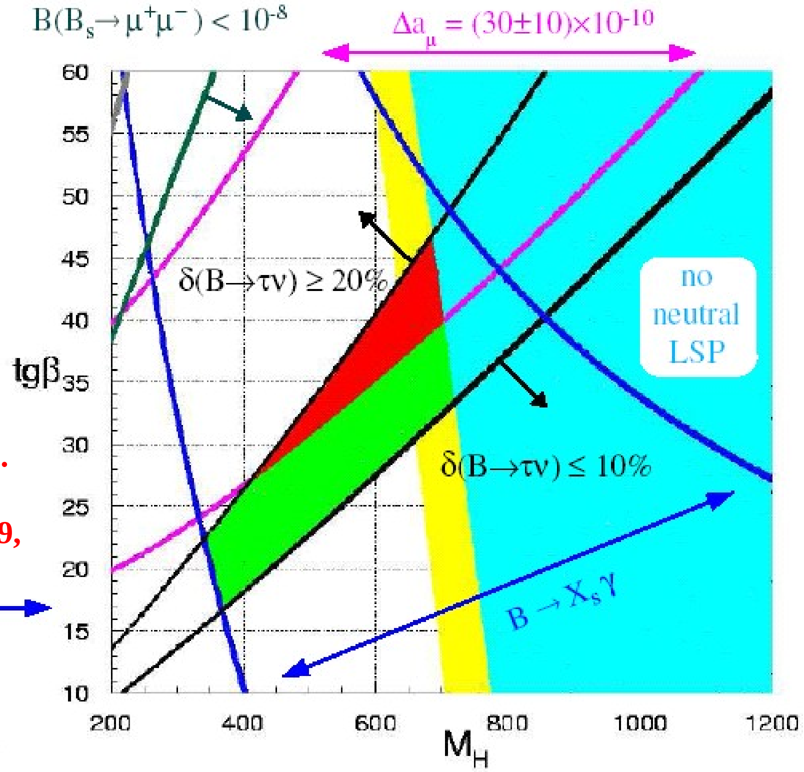
From Z. Ligeti et al hep-ph/0604112
Allowed regions CL > 0.90, 0.32, 0.05

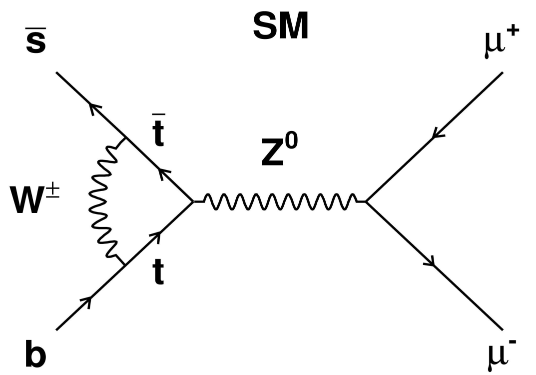


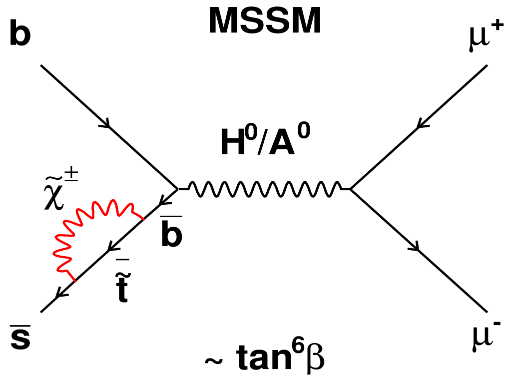
$B_s \to \mu\mu$

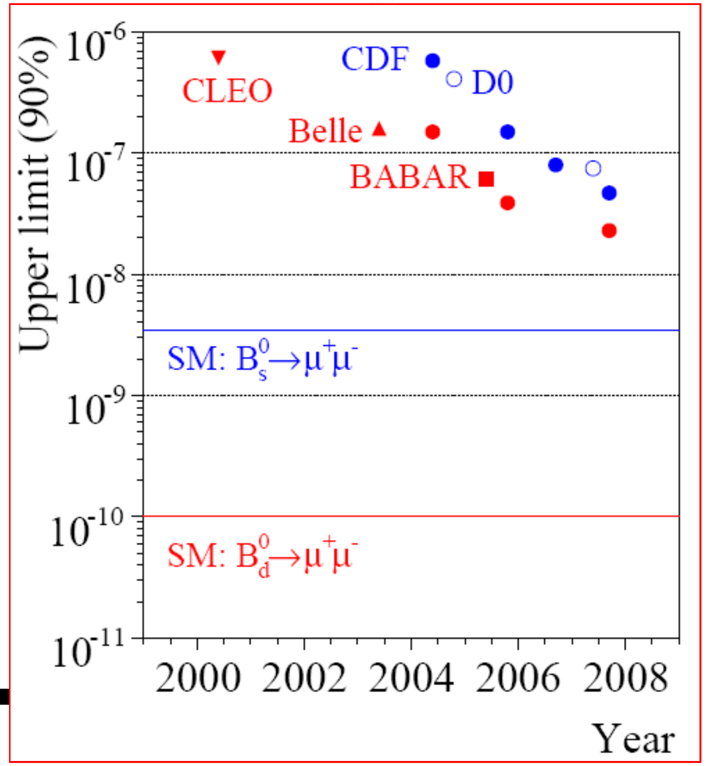
- $B_s \to \mu\mu$ very rare
  - Effective FCNC +Helicity suppression ~ $(m_m/m_b)^2$
- SM predictions
  - $\mathcal{B}(B_s \to \mu\mu) = (3.5 \pm 0.5) \times 10^{-9}$
  - $\mathcal{B}(B_d \to \mu\mu) = (1.0 \pm 0.2) \times 10^{-10}$
- Very sensitive to NP with large tanβ
  - MSSM ~ $\tan^6\beta / M^4_A$
  - Large tanβ favoured by b → sγ, (g-2)μ, B → τν, etc. Upper limit on BR($B_s \to \mu\mu$) plays crucial role

[G. Isidori e P. Paradisi Phys Lett. B639, 499 (2006)]









[1] arXiv:0712.1708v1 [hep-ex]

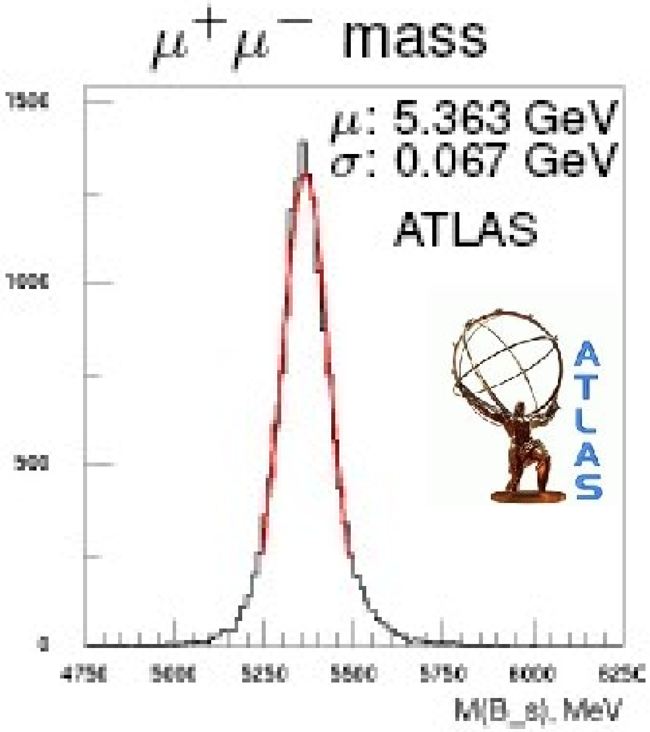
[2] arXiv:0705.300v1 [hep-ex]

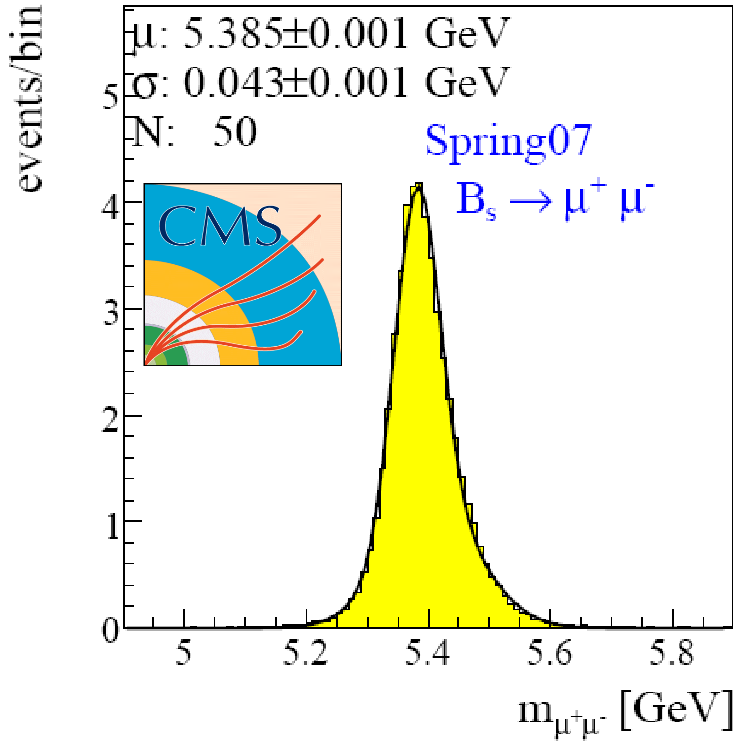
[1] CDF BR < 4.7 10^{-8} 90% CL @ 2fb^{-1}

[2] D0 BR < 7.5 10^{-8} 90% CL

$B_s \to \mu\mu$ analysis

- Analysis Strategies
  - LHCb Combine geometrical information into a likelihood (GL); Divide (GL, Mass, PID) space in N bins and evaluate expected events/bin for signal, signal+bkg
  - ATLAS + CMS: cut on isolation, pointing, decay length. CMS counts events in $\pm 2.3\sigma$ mass window, ATLAS perform bayesian estimate of # of events
- Trigger
  - LHCb ~1.5 kHz inclusive μ ;
  - CMS ~ 0.9kHz, di-μ;
  - ATLAS 20 Hz B phys trigger
- Performances
  - Di-μ mass resolution: LHCb σ ~20 MeV/c^2 ; CMS ~ 43 MeV/c^2 and ATLAS ~ 67 MeV/c^2





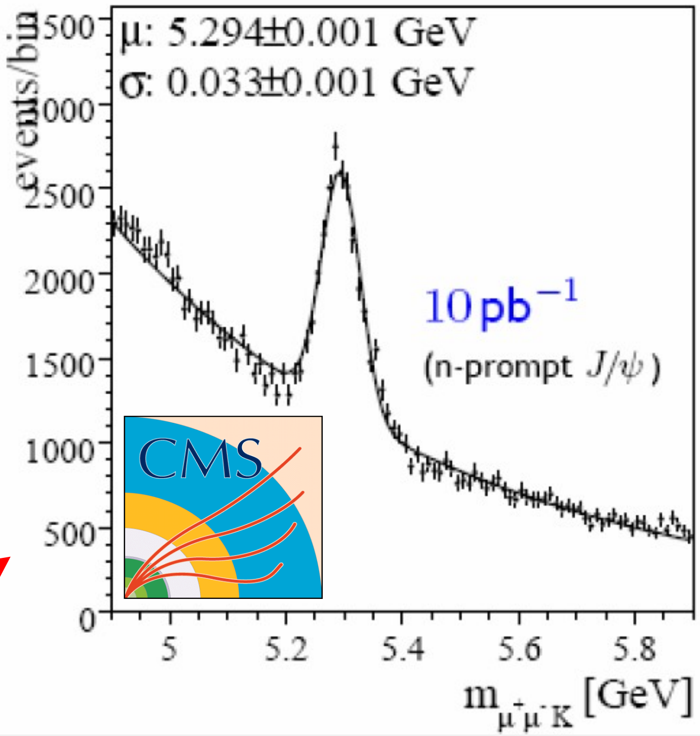
Yields (S,B)

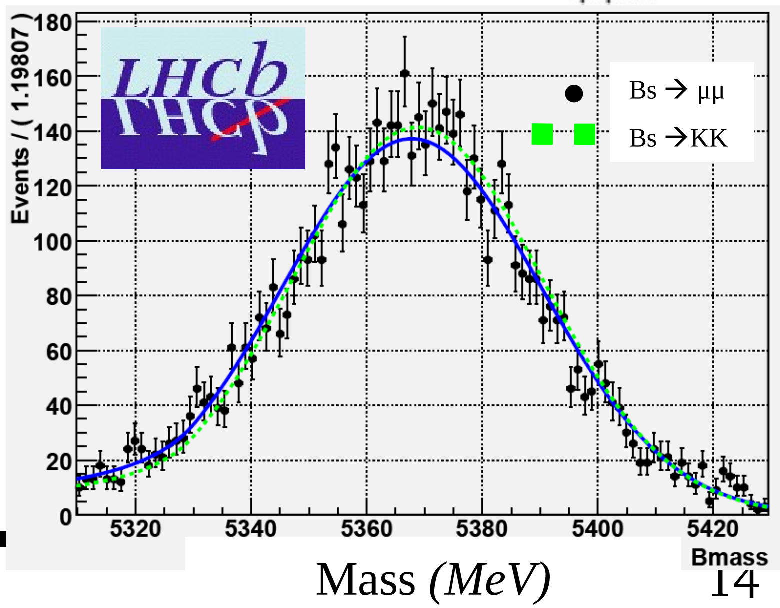
– Background
- Main background (b→μ,b→μ, b→μ , b→c→μ)
- B→hh, small compared with b→μ,b→μ
- Bc^+→J/Ψμν dominant of exclusive, but still small

❑ Event yields [1 nominal year of data taking] :
- LHCb: S ~30, B ~ 83 @ $2fb^{-1}$
- CMS: S~ 6, B ~ 14 @ $10fb^{-1}$
- ATLAS: S ~ 7, B ~ 20 @ $10fb^{-1}$

❑ Normalization channel: B^+→J/ψ K^+
- 2M events @ $2fb^{-1}$

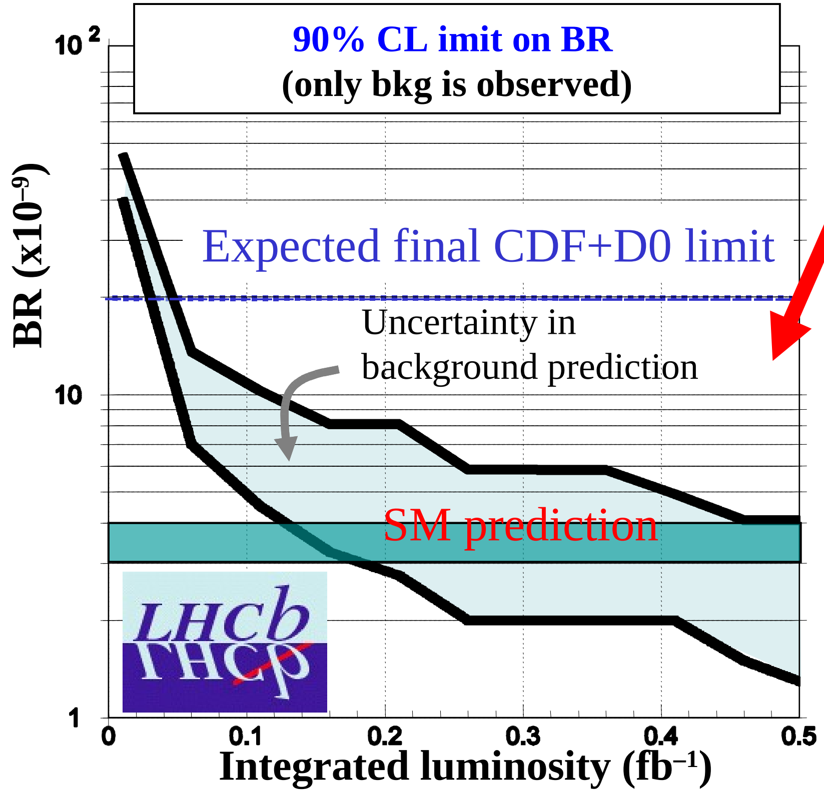
❑ (LHCb) Control channels:
- Signal description: B→hh ~200 k @ $2fb^{-1}$
- background (from sidebands)



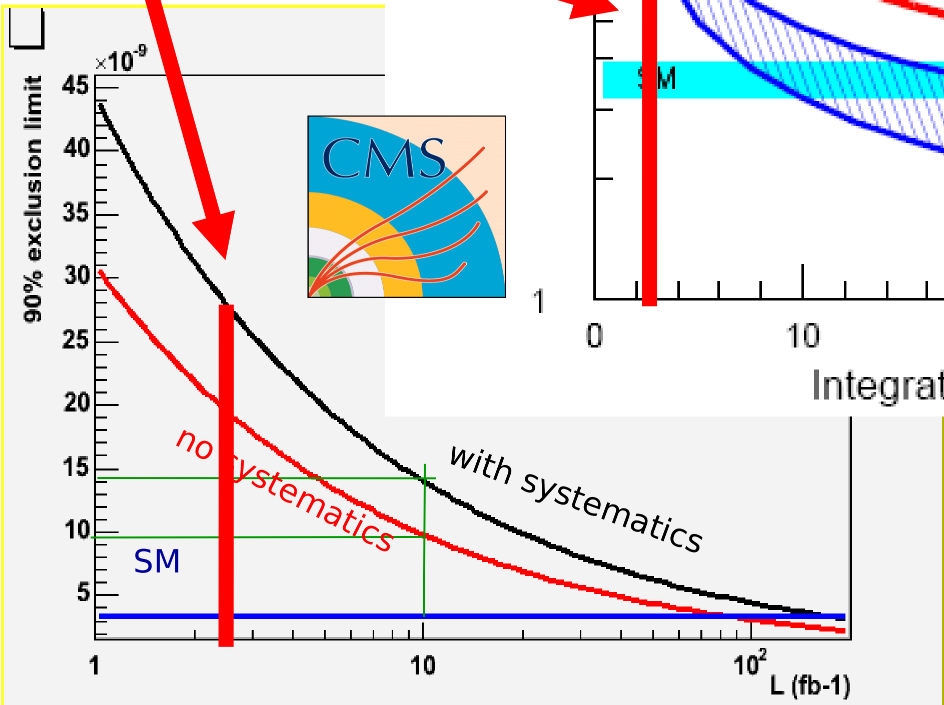


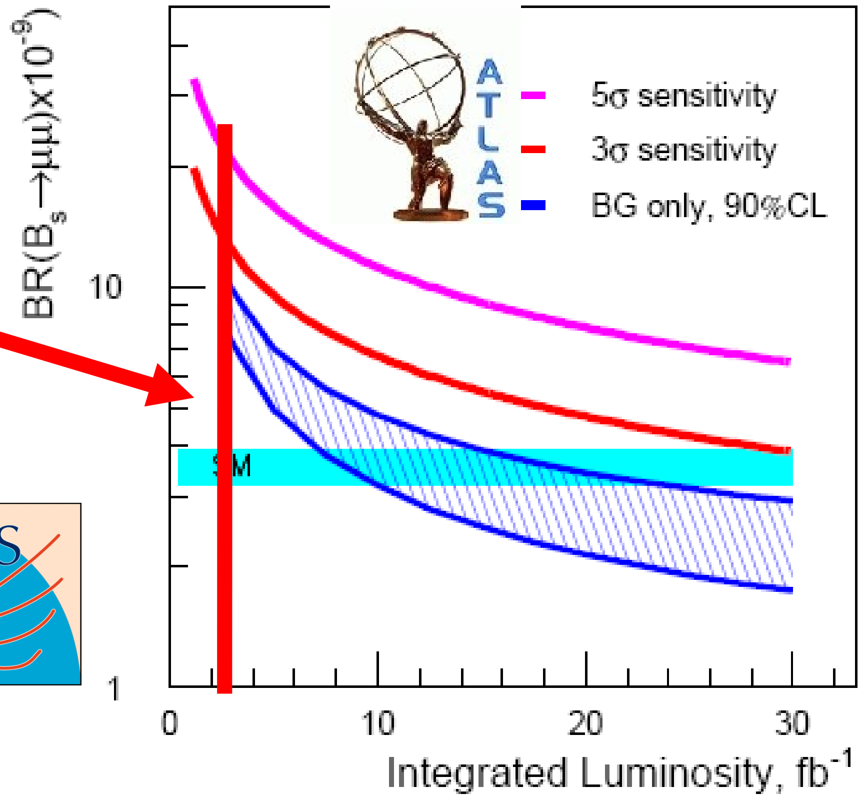
Results

2009 data



LHCb potential





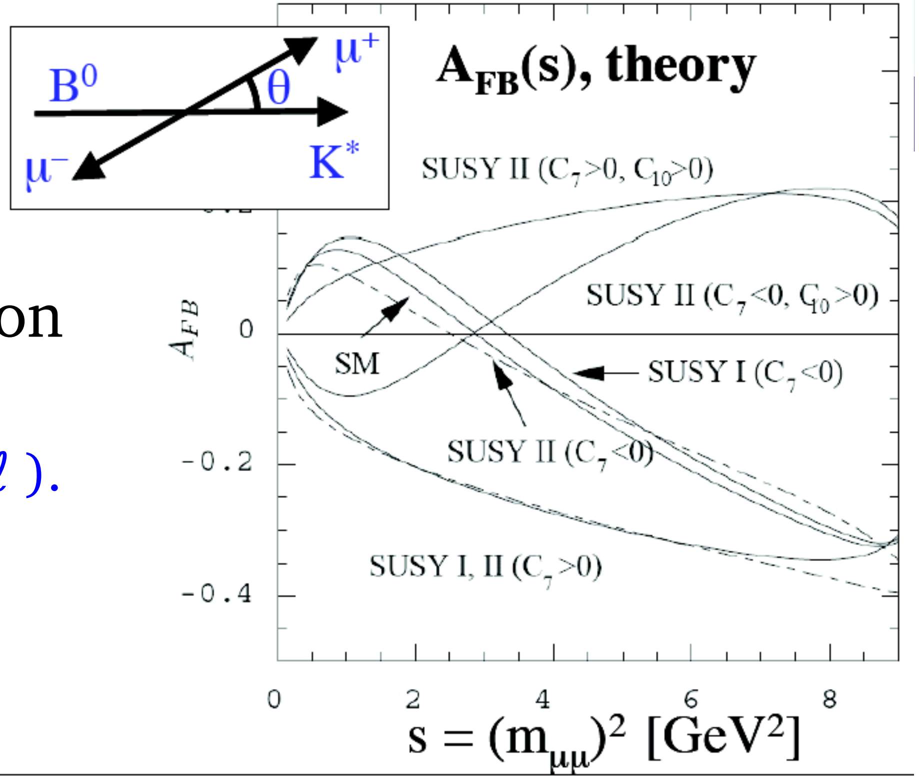
With 0.1 fb^{-1} → measure BR $9(15)\cdot10^{-9}$ at 3(5)σ
With 0.5 fb^{-1} → measure BR $5(9)\cdot10^{-9}$ at 3(5)σ

Exclusion:
0.1 fb^{-1} ⇒ BR < 10^{-8}
0.5 fb^{-1} ⇒ < SM

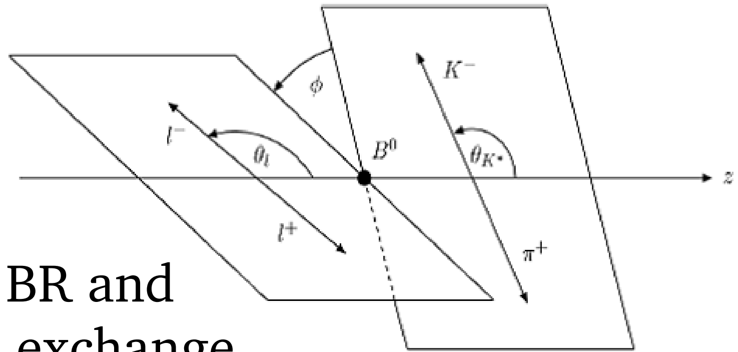
SM agreement
2 fb^{-1} ⇒ 3σ evidence
6 fb^{-1} ⇒ 5σ observation

ATLAS and CMS are contributing with performances comparable to Tevatron exp.

b→sll decays



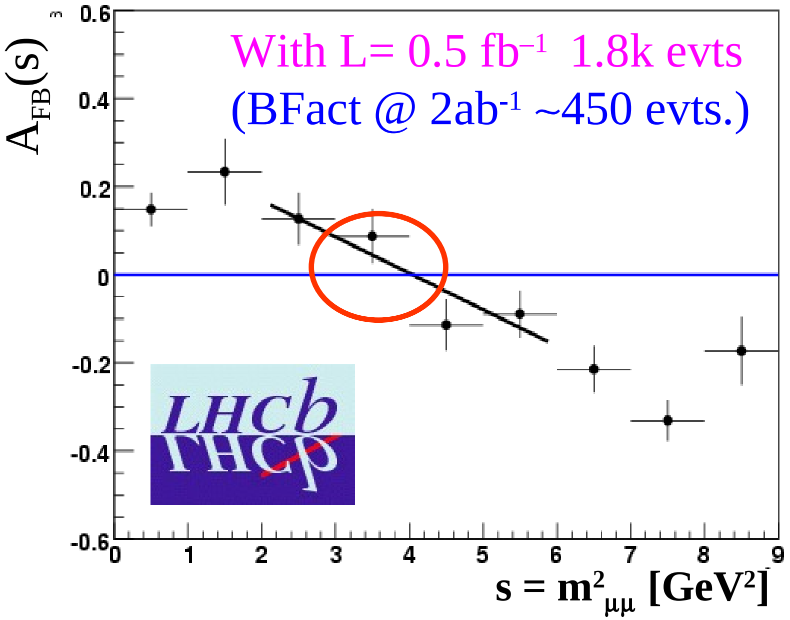
- Inclusive decay difficult to access at hadron collider.
  - Good prospects for excl decays (B→ Kℓℓ, K*ℓℓ).
- Hadronic uncertainty reduced in:
  - Forward-backward asymmetry A_{FB} and s_0
  - Transversal asymmetries
  - Ratio of μμ and ee modes



– Suppressed loop decay in SM.
- NP could contribute at the same levels, could modify BR and angular distributions: sensitivity to SUSY, gravitation exchange, extra-dimensions.
- E.g. in SM [Beneke et al hep-ph/0412400]:
  BR(Bd→K*μμ)=(1.22 $^{+0.38}_{-0.32}$) x10^{-6} and zero crossing of A_{FB} (s_0)
  s_0= $s_0(C_7,C_9)$= 4.39 $^{+0.38}_{-0.35}$ GeV²

$B_d \rightarrow K^* \mu\mu$

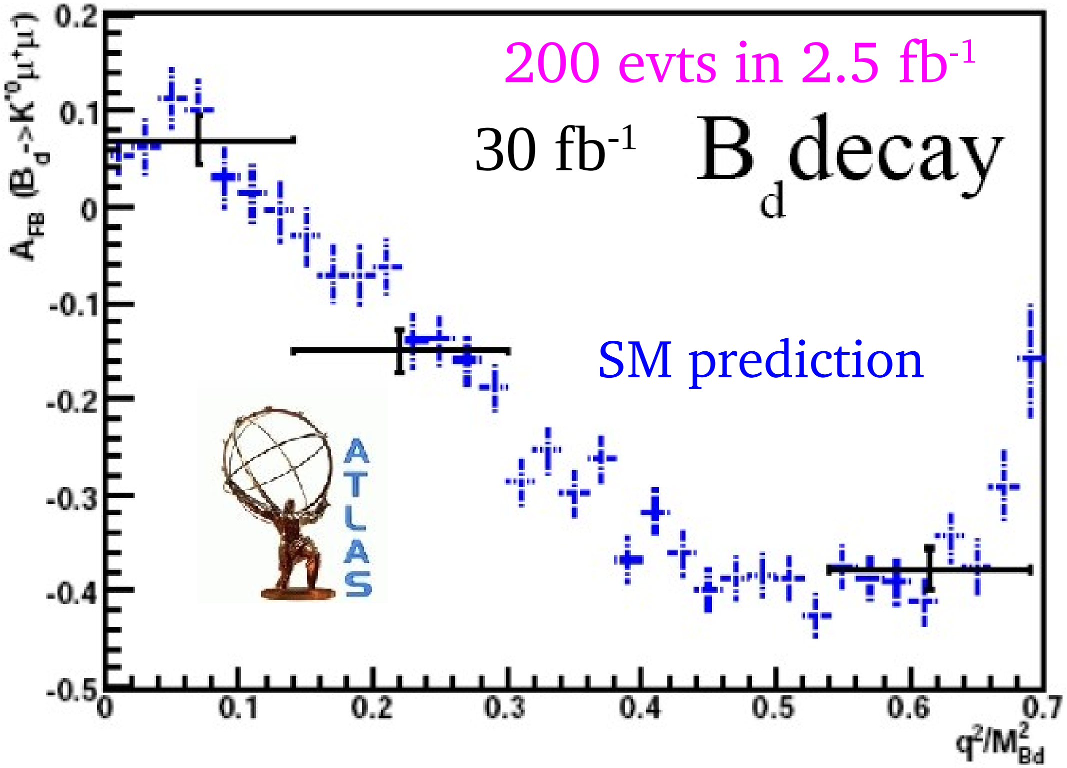
- Measure A_{FB} as a function of the μμ invariant mass. Determine s_0, the $m^2_{\mu\mu}$ for which $A_{FB}=0$. CMS studies just started....



LHCb : $B_{bb}/S = 0.2 \pm 0.1$ (ignoring non-resonant Kπμμ events for the time being).

L= 2fb⁻¹ $\sigma(s_0) = \pm 0.46$ GeV²

L=10 fb⁻¹ $\sigma(s_0) = \pm 0.27$ GeV² → at the level of present theoretical precision



Interval of q^2/M_B^2	0.00 − 0.14	0.14 − 0.33	0.55 − 0.71
Number of events	570	540	990
Statistical error	4.2%	4.3%	3.2%
A_{FB} SM prediction	10%	−14%	−29%

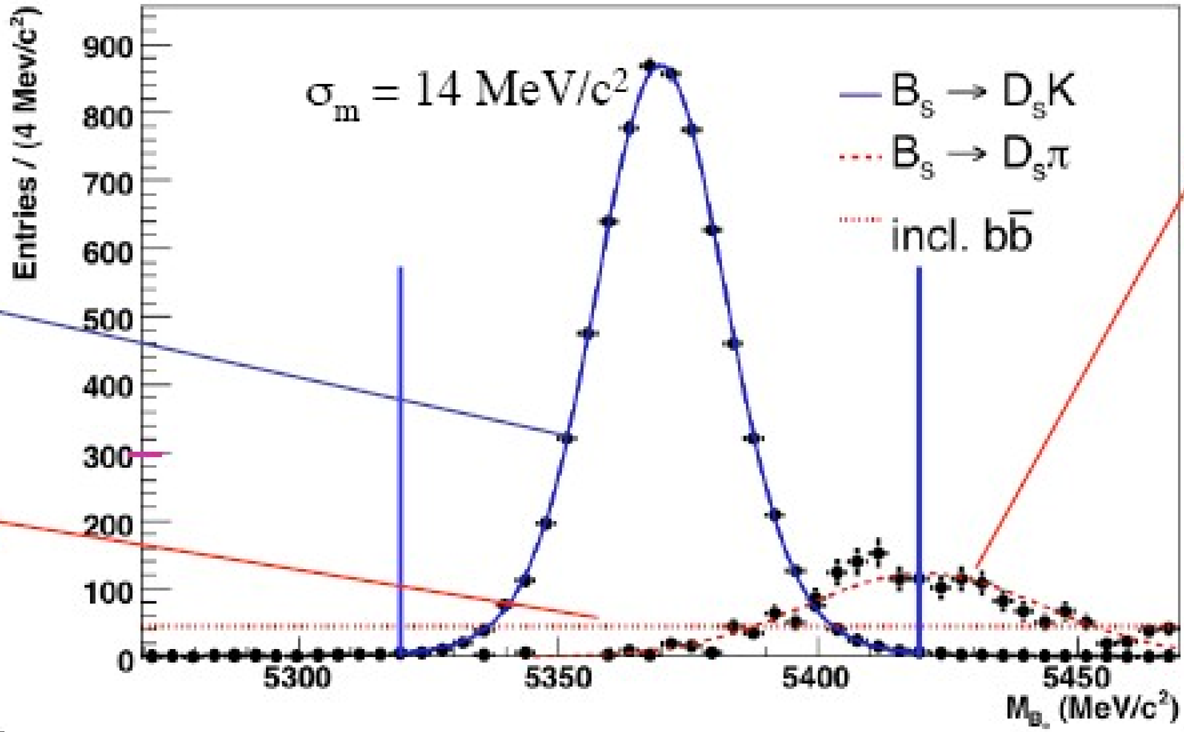
γ measurement

- Several independent ways to CKM γ @ LHCb: trees and loops
  - $B \rightarrow DK$: ADS/GLW and GGSZ strategies are pursued. Dependence on D strong phases affect sensitivity
  - $B_s \rightarrow D_s K$: clean γ measurement using interference of $b \rightarrow u$ and $b \rightarrow c$ transitions via B_s mixing

Decay	2 fb^{-1} yield	B_{bb}/S
$B^{-,+} \rightarrow D(K\pi)K^{-,+}$ favoured	28k	0.6
$B^{-,+} \rightarrow D(K\pi\pi\pi)K^{-,+}$ favoured	28k	0.6
$B^{-,+} \rightarrow D(K\pi)K^{-,+}$ supp.	100	>2
$B^{-,+} \rightarrow D(K\pi\pi\pi)K^{-,+}$ supp.	200	>2
$B^{-,+} \rightarrow D(hh)K^{-,+}$	4k	2

Expect 6.2k signal events in 2 fb^{-1}

$B_{bb}/S < 0.18$ at 90% CL



$B_s \rightarrow D_s^- \pi^+$ background (with ~15 × larger BR) suppressed using PID: → residual contamination only (15±5)%

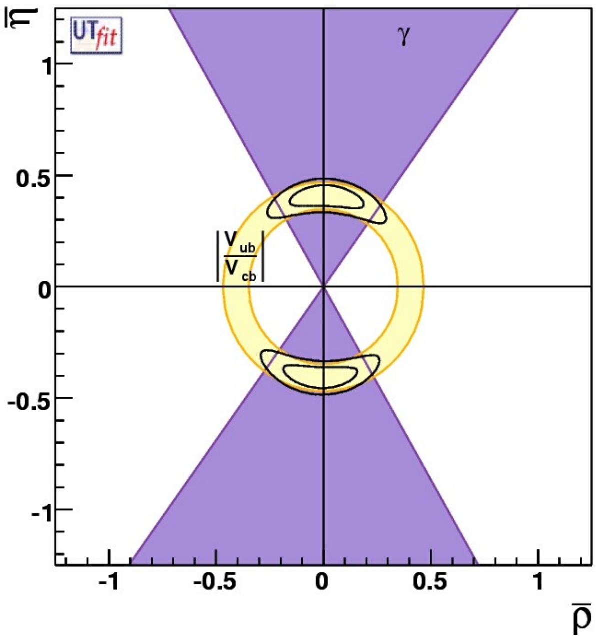
All specific backgrounds B/S = [0.08,3] at 90% CL

γ measurement (trees)

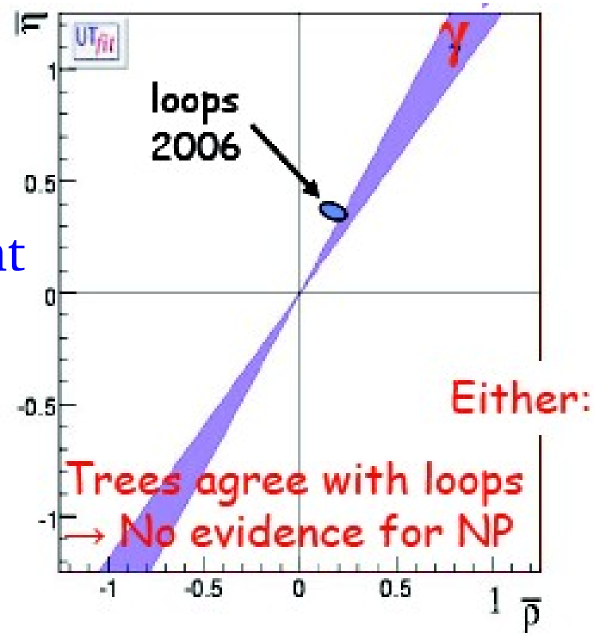
B mode	D mode	Method	$\sigma(\gamma)$ 2fb^{-1}
$B_s \to D_s K$	$KK\pi$	tagged, A(t)	10°
$B^+ \to D K^+$	$K\pi$+ $K3\pi$ +$KK/\pi\pi$	counting, ADS+GLW	5° - 13°
$B^+ \to D^* K^+$	$K\pi$	counting, ADS+GLW	Under study
$B^+ \to D K^+$	$K_s\pi\pi$	Dalitz, GGSZ	7-12°
$B^+ \to D K^+$	$KK\pi\pi$	4 body Dalitz	18°
$B^+ \to D K^+$	$K\pi\pi\pi$	4 body Dalitz	Under study
$B^0 \to D K^{*0}$	$K\pi$ + KK + $\pi\pi$	counting, ADS+GLW	9°
$B \to \pi\pi, KK$	–	Tagged, A(t)	10°

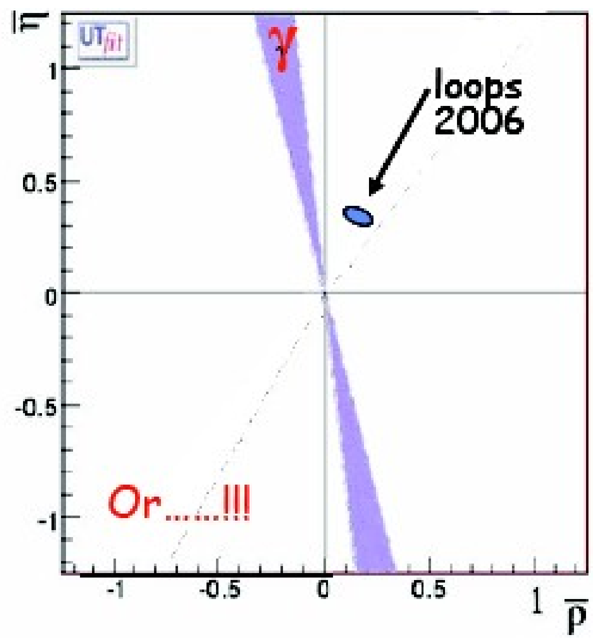
- Combined LHCb sensitivity to γ with tree decays only (educated guess):
  - $\sigma(\gamma) \sim 5^o$ @2 fb^{-1}
  - $\sigma(\gamma) \sim 2.5^o$ @10 fb^{-1}

γ with loops decays only



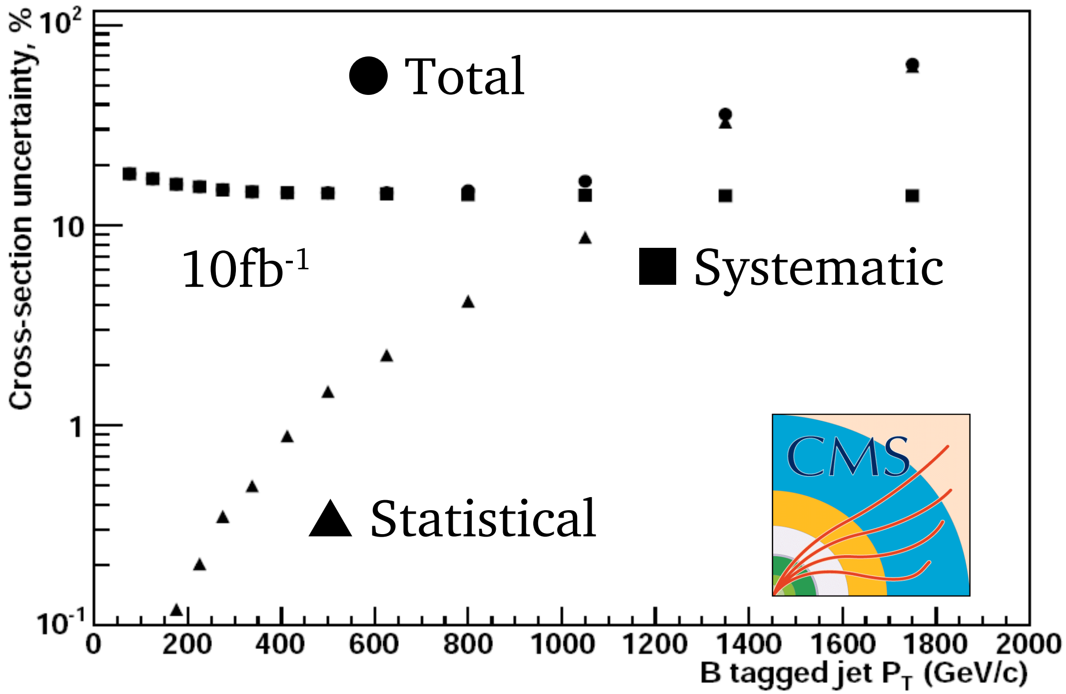
Impact of LHCb measurement @ 10fb^{-1}





σ(bbar)

- Predicted to be 500μb with large errors (extrapolations from 1.8 TeV using NLO QCD). Measurement can be used to:
  - Tests MC descriptions, NLO QCD calculations and PDF knowledge
  - Know precisely the bkg for NP processes
- Approach
  - Inclusive and exclusive ($B^+ \rightarrow J/\Psi K^+$): use μ trigger + b jet tagging (ATLAS & CMS) or J/Ψ events to measure b production rate
  - Requires μ trigger (high p_T) and jets with E_T>50(30)GeV/c in CMS (ATLAS)
    - L1 ε_{trig} ~ 15%. ε_{Btag} on HLT selected ev ~ 60%
- Performances (preliminary)
  - Largest sys are from fragmentation and jet energy scale
  - σ(stat)~ 1% in ATLAS with $100pb^{-1}$ (1month of data @ 10^{32}) in LHCb with $50nb^{-1}$ (10 min @ $2\cdot10^{32}$)
  - CMS (in p_T bins): with $10fb^{-1}$~O(10%)



Conclusions

- LHC program is proceeding without major delays
  - Expect first beam in August and first collisions soon afterwards
- 3 experiments are getting ready for the B physics challenge: with the expected performance they will be able to test SM and BSM effects trough the analysis of
  - (Golden) b→s observables, that can cleanly reveal NP effects: e.g. **$B_s \to \mu\mu$ BR down to SM** and **B_s mixing phase @ 0.04 level** with 2009 data
  - b→sll decays: with few years of data taking can go at the level of present theoretical uncertainty
  - **γ uncertainty down to 10°** expected with 2009 data
  - Cross section for bbar production: few % results with early data and full p_T scan (@ 10%) with 2009 data
  - .. and many more important items left outside (see LHCb physics page!)
- Few months before the LHC startup: stay tuned!

Thanks to U. Langenegger (CMS) and A.Policicchio (ATLAS) for help preparing the talk

Spares

$J/\psi\ \phi$ comparison in 1 slide

	ATLAS	CMS	LHCb
Integrated lumi. (fb^{-1}) (1/4 of nominal year)	2.5	2.5	0.5
$B_s \to J/\psi\phi$ events	23k	27k	33k
Background (B/S)	0.18 Dominated by $J/\psi K^*$, $J/\psi K\pi$	0.25 Dominated by $J/\psi K^*$, $J/\psi K\pi$	0.12 Dominated by combinatorial
Mass resolution (MeV)	16.6	14	14
Proper time resolution (fs)	83	77	36
Angles	Acceptance and resolution neglected	Resolution neglected, non flat acceptance included	Acceptance and resolution neglected
Flavour tagging εD^2 (%)	μ,e,Qjet (OS) 4.6	Not yet 0	μ,e,K, Qvtx, OS+SS 6.6
$\sigma(2\beta_s)$	**0.159**	**0.125**	**0.042**

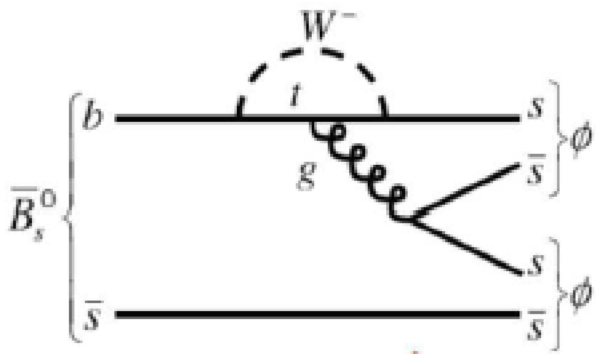
$B_s \to \phi\phi$

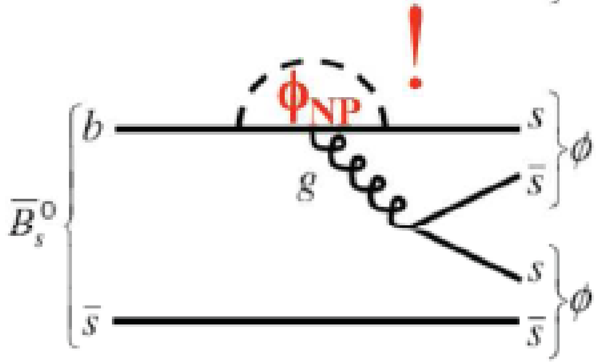
$B_s \to \phi\phi$

- **CP violation <1% in SM** because mixing and penguin phases cancel
- But New Physics can affect mixing and decays differently

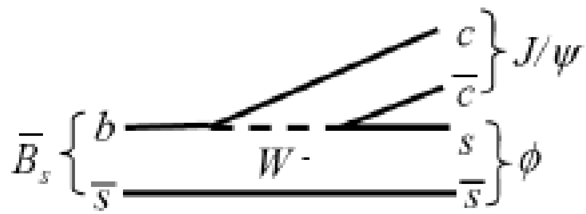
  ➢ $\Delta\phi^{NP} \neq 0$

- Yield = 3.1k ($2fb^{-1}$, assuming B.R. = 1.4×10^{-5})
- B/S < 0.8 at 90% C.L.





After $10fb^{-1}$: $\sigma_{stat}(\Delta\phi^{NP})=0.05$



Also: use **$B_s \to J/\psi\phi$** to disentangle New Physics contributions to mixing and decays

Ref: CERN-LHCb-2007-047
CERN-LHCb-2007-130

Radiative decays

- $B_d \to K^*\gamma$ $A_{CP} < 1\%$ in SM, up to 40% in SUSY
  Can measure at <% level.
  Reference channel for all radiative decays.

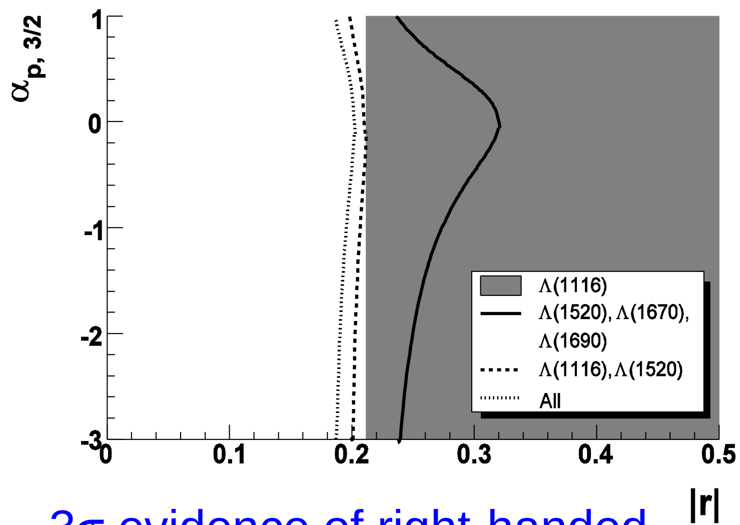
- $B_s \to \phi\gamma$ No mixing-induced CP asymmetry in SM, up to 50% in SUSY.
  Sensitivity for $A_{CP}(t)$ measurement under study.

- $\Lambda_b \to \Lambda\gamma$ Right-handed component of photon polarization O(10%) in SM. Can be higher BSM.

$$\alpha_\gamma = \frac{P(\gamma_L) - P(\gamma_R)}{P(\gamma_L) + P(\gamma_R)} \qquad \alpha_\gamma^{LO} = \frac{1 - |r|^2}{1 + |r|^2}$$

Measure photon asymmetry α_γ from angular distributions of γ and hadron in $\Lambda_b \to \Lambda(p\pi, pK)\gamma$ decays.

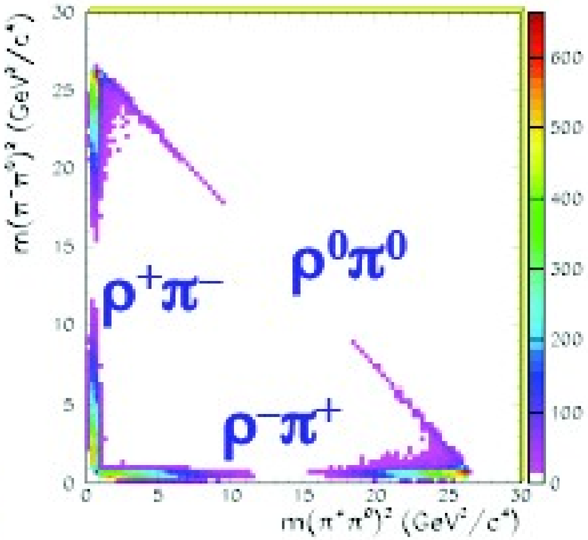
Decay	Yield 2 fb^{-1}	B_{bb}/S
$B_d \to K^*\gamma$	68k	0.60
$B_s \to \phi\gamma$	11.5k	< 0.55
$\Lambda_b \to \Lambda(1116)\gamma$	0.75k	< 42
$\Lambda_b \to \Lambda(1670)\gamma$	2.5k	< 18

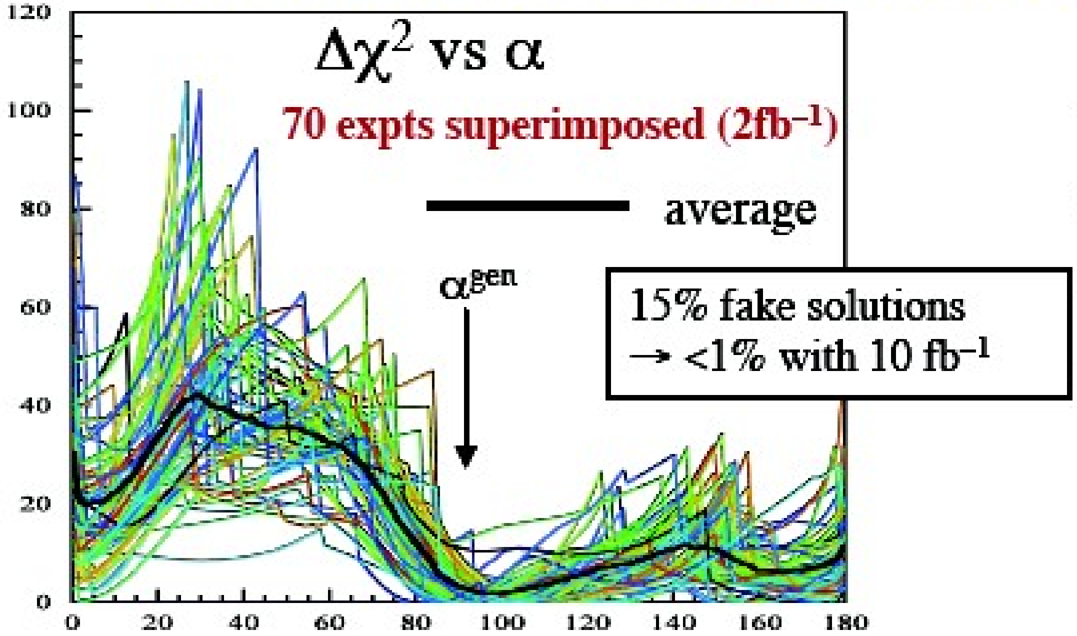


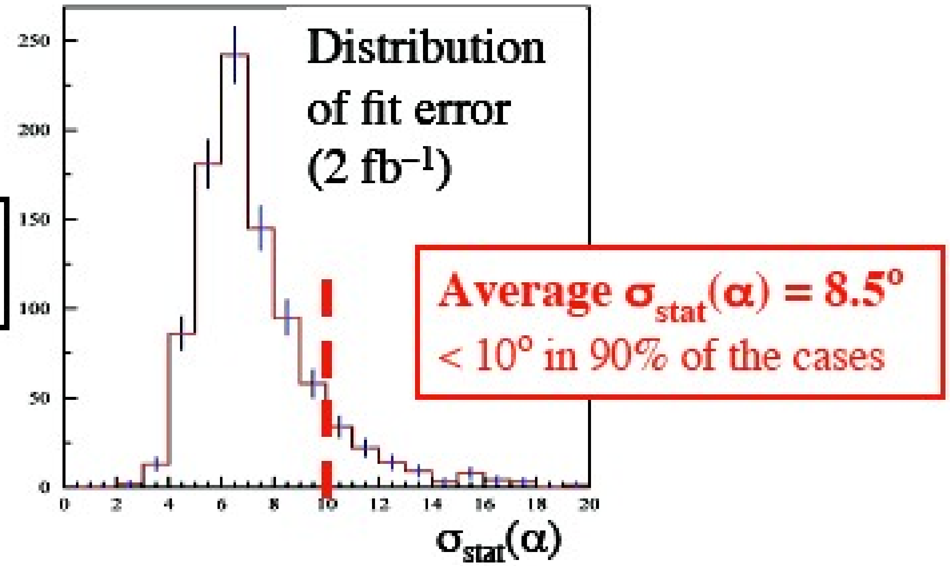
3σ evidence of right-handed component to 21% with 10 fb^{-1}

α measurement

- SU(2) analysis of $B^0 \to \rho^+\rho^-, \rho^\pm\rho^0, \rho^0\rho^0$:
  - Main LHCb contribution could be $B^0 \to \rho^0\rho^0$ 1.2k evts/2 fb^{-1}, B/S < 5
- Time-dependent Dalitz plot analysis of $B^0 \to \rho\pi \to \pi^+\pi^-\pi^0$ (Snyder & Quinn)
  - 14k signal events/2fb^{-1}, $B_{bb}/S < 0.8$ (< 1.6 charmless)







γ from loops

❑ Measure CP asymmetry in each mode:

$$A_{CP}(t) = \frac{A_{dir}\cos(\Delta m t) + A_{mix}\sin(\Delta m t)}{\cosh(\Delta\Gamma t/2) - A_{\Delta\Gamma}\sinh(\Delta\Gamma t/2)}$$

— With 2 fb^{-1}:

- 36k $B^0 \to \pi^+\pi^-$, $B_{bb}/S \sim 0.5$, $B_{hh}/S = 0.07$
  36k $B_s \to K^+K^-$, $B_{bb}/S < 0.06$, $B_{hh}/S = 0.07$

$\sigma(\mathcal{A}^{dir}_{\pi\pi})$	0.043	$\sigma(\mathcal{A}^{dir}_{KK})$	0.042
$\sigma(\mathcal{A}^{mix}_{\pi\pi})$	0.037	$\sigma(\mathcal{A}^{mix}_{KK})$	0.044

~ 2x better than current $B \to \pi\pi$ world average

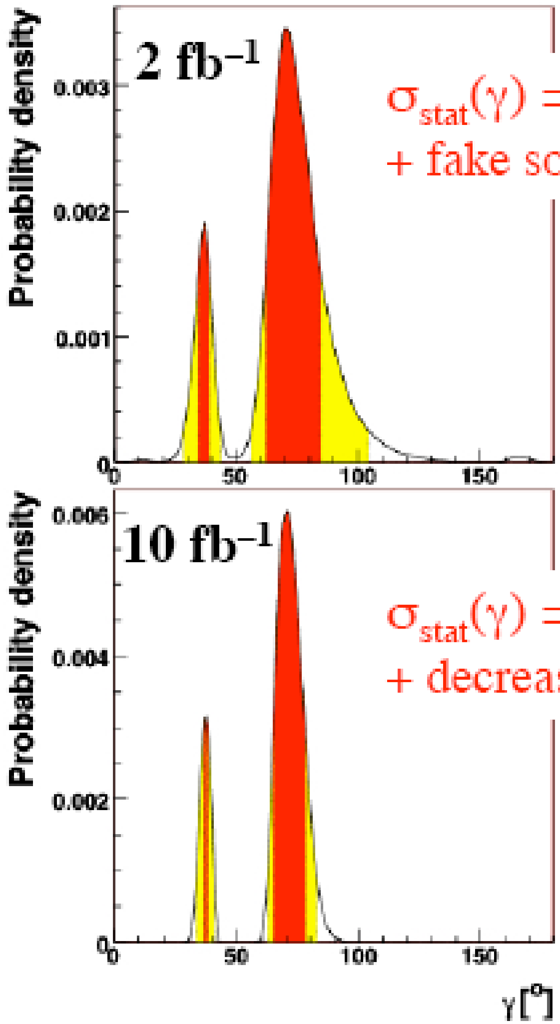
— A_{dir} and A_{mix} depend on mixing phase, angle γ, and penguin/tree amplitude ratio $d\,e^{i\theta}$

❑ Exploit U-spin symmetry (Fleischer):

— If $d_{\pi\pi} = d_{KK}$ and $\theta_{\pi\pi} = \theta_{KK}$ assumed:

- 4 measurements and 3 unknowns
  → can solve for γ
  (taking 2β and ϕ_s from other modes)

Assume only $0.8 < d_{KK}/d_{\pi\pi} < 1.2$:



LHCb physics reach 0.5 fb^{-1}

Decay mode	0.5 fb^{-1} yield	0.5 fb^{-1} stat. sensitivity	Rough stat. break-even point with competition *
$B_d \to J/\psi(\mu\mu)K_S$	59k	$\sigma(\sin(2\beta)) = 0.04$	2 fb^{-1}
$B_s \to D_s^- \pi^+$	35k	$\sigma(\Delta m_s) = 0.012\ ps^{-1}$	0.2 fb^{-1}
$B_s \to D_s^- K^\pm$	1.6k	$\sigma(\gamma) = 21$ deg	–
$B_s \to J/\psi(\mu\mu)\varphi$	**33k**	**$\sigma(\varphi_s) = 0.046$**	**0.3 fb^{-1}**
$B_d \to \varphi K_S$	230	$\sigma(\sin(2\beta_{eff})) = 0.46$	8 fb^{-1}
$B_s \to \varphi\varphi$	780	$\sigma(\Delta\phi^{NP}) = 0.22$	–
$B^+ \to D(hh)K^\pm$ $B^+ \to D(K_S\pi\pi)K^\pm$	16k 1.3k	$\sigma(\gamma) = 12–14$ deg	0.3 fb^{-1}
$B_d \to \pi^+\pi^-$	8.9k	$\sigma(S, C) = 0.074, 0.086$	1–2 fb^{-1}
$B_s \to K^+K^-$	9.0k	$\sigma(S, C) = 0.088, 0.084$	–
$B_d \to \rho\pi \to \pi^+\pi^-\pi^0$	3.5k	α	2 fb^{-1}
$B_d \to K^{*0}\gamma$	15k	A_{CP}	0.4 fb^{-1}
$B_s \to \varphi\gamma$	2.9k	$A_{CP}(t)$	–
$B_d \to K^{*0}\mu^+\mu^-$	1.8k	$\sigma(q^2_0) = 0.9\ GeV^2$	0.1 fb^{-1}
$B_s \to \mu^+\mu^-$	**18**	**BR_{SM} at 90%CL**	**0.05 fb^{-1}**

* Assuming naive $1/\sqrt{N}$ scaling of stat. uncertainty of existing results at Tevatron (→ 16 fb^{-1}) or current B factories (→ 1.75 ab^{-1})

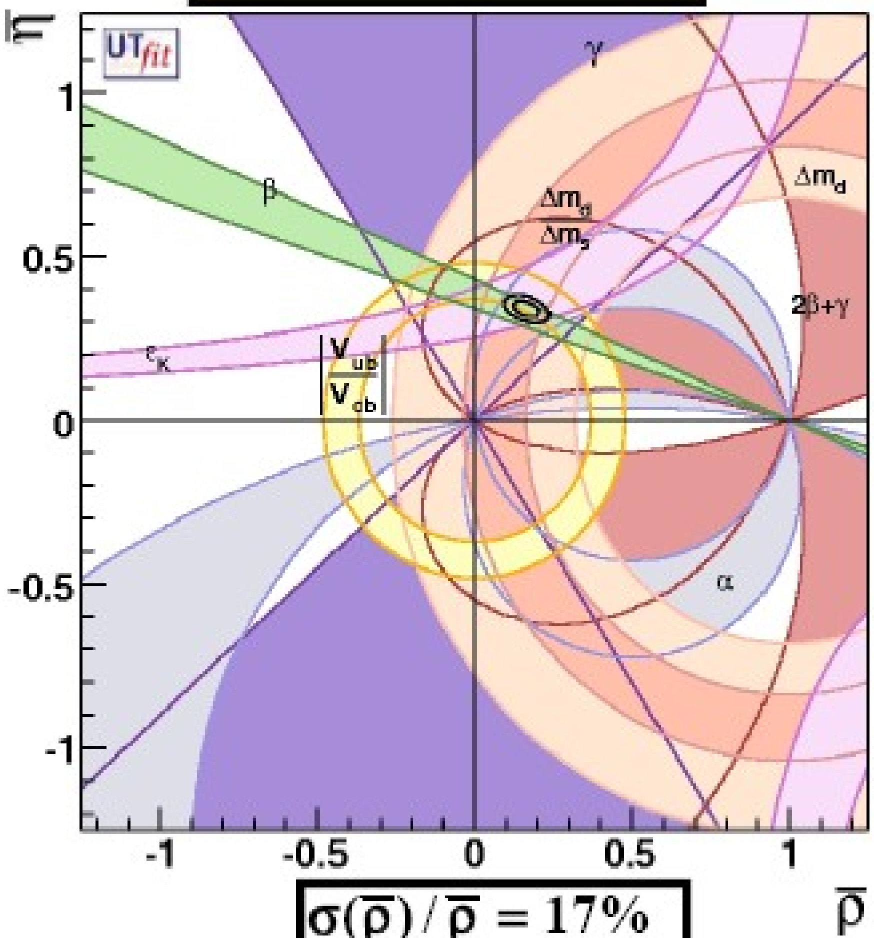
– For many measurements based on B_s, or untagged B^0, B^+ decays only few 0.1 fb^{-1} are necessary to produce the world's best results

LHCb sensitivities

	Channel	Yield	Precision
γ	From tree channels		$\sigma(\gamma) \sim 4^o$
α	$B_d \to \pi^+ \pi^- \pi^0$ $B \to \rho^+\rho^0, \rho^+ \rho^-, \rho^0\rho^0$	14k 9k, 2k, 1k	$\sigma(\alpha) \sim 10^o$
β	$B_d \to J/\psi(\mu\mu)K_S$ $B_d \to \phi K_S$	240k 0.8k	$\sigma(\sin 2\beta) \sim 0.02$ $\sigma(\sin 2\beta) \sim 0.32$
ϕ_s	$B_s \to J/\psi(\mu\mu)\phi$ $B_s \to \phi\phi$	131k 4k	$\sigma(\phi_s) \sim 0.021$ $\sigma(\phi_s) \sim 0.10$
Rare decays	$B_s \to \mu^+\mu^-$ $B_d \to K^{*0}\mu^+\mu^-$ $B_d \to K^{*0}\gamma$ $B_s \to \phi\, \gamma$	20 7.2 k 35k 11 k	$\sim 3\sigma$ SM value $\sigma(C_7^{eff}/C_9^{eff}) \sim 0.13$ $\sigma(A_{CP}) \sim 0.01$
charm	$D^{*+} \to D^0 (K^-\pi^+)\, \pi^+$	50 M	

LHCb contribution to CKM fit

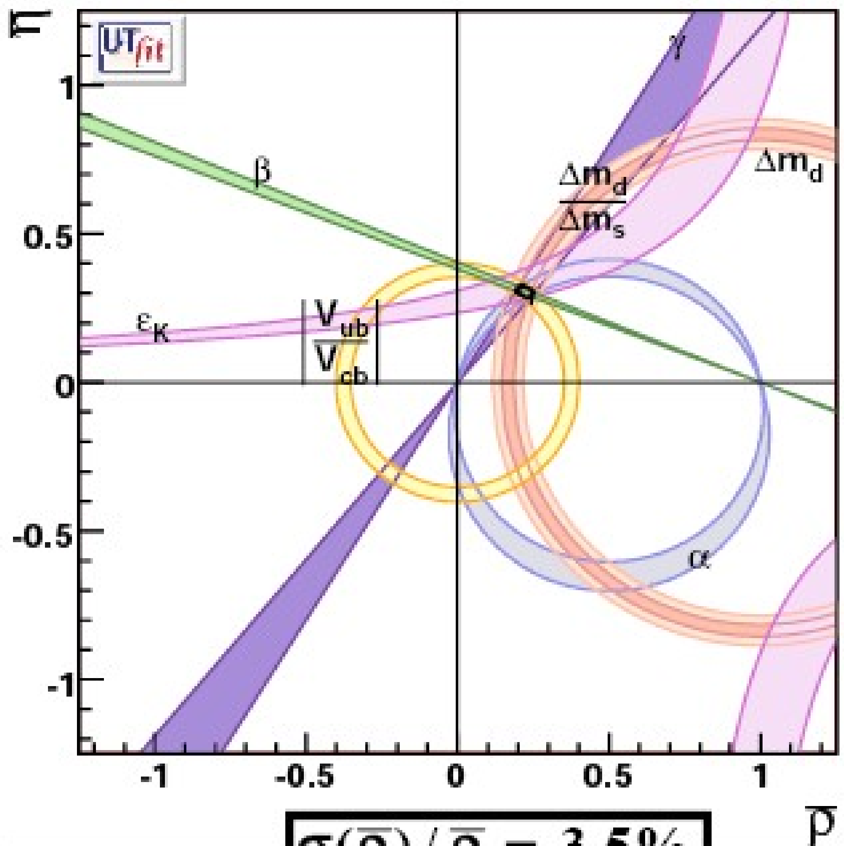
Summer 2007



$\sigma(\bar{\rho})/\bar{\rho} = 17\%$

$\sigma(\bar{\eta})/\bar{\eta} = 4.7\%$

LHCb at L=10fb^{-1}



$\sigma(\bar{\rho})/\bar{\rho} = 3.5\%$

$\sigma(\bar{\eta})/\bar{\eta} = 1.7\%$

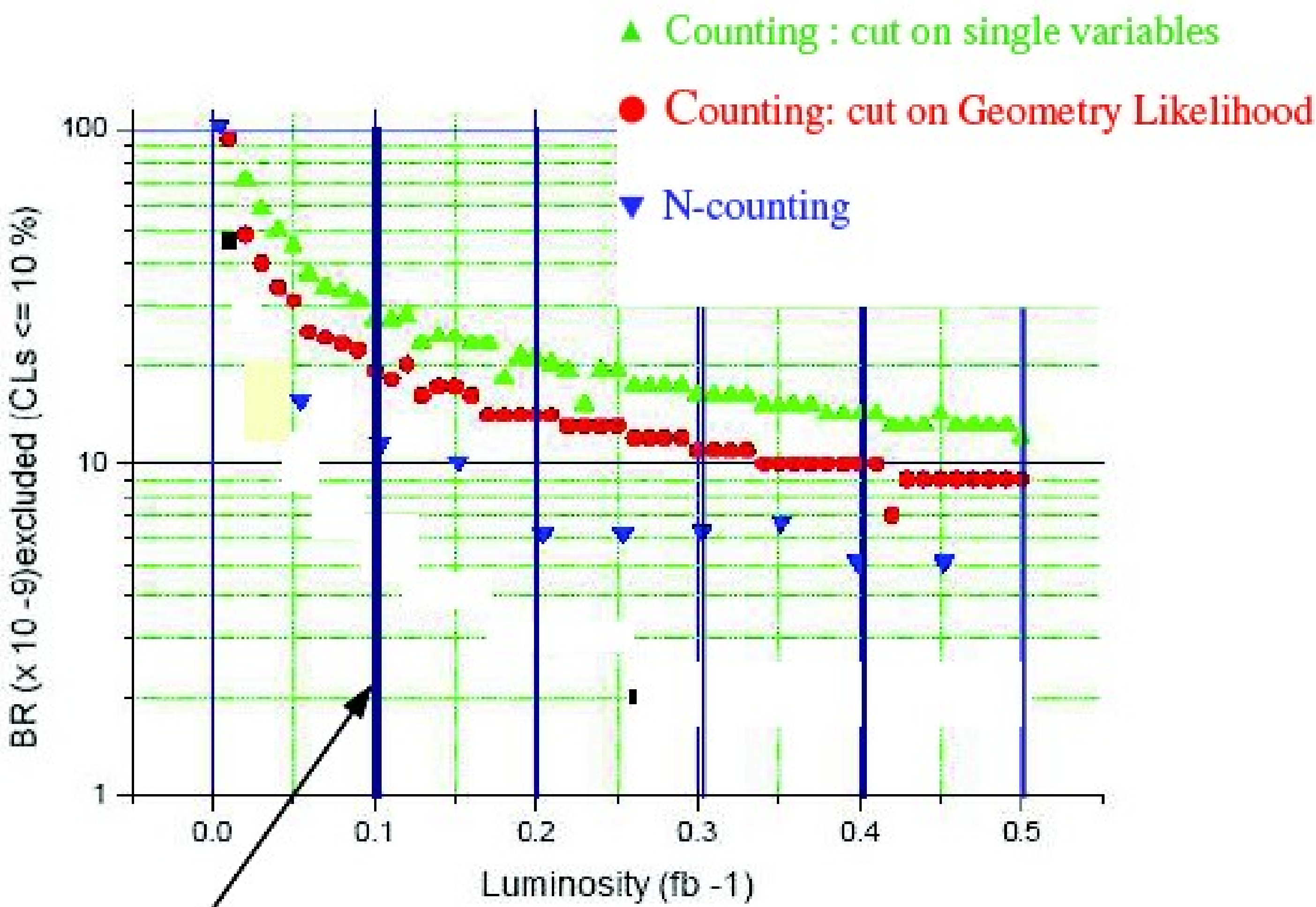
Lattice QCD improvements assumed: $\sigma(\xi)/\xi = 1.5\%$

$\sigma(\sin(2\beta)) = 0.01$; $\sigma(\gamma) = 2.4^\circ$; $\sigma(\alpha) = 4.5^\circ$

Bs mumu strategies

1) Counting method:	2) "Refined" Counting Method:	3) N-counting:
- cut on single variables (lifetime, invariant mass, IPS, etc..) - compute the compatibility of the remaining events with S(BR)+B hypothesis: **-ATLAS/CMS method** **- First CDF publication *(Phys.Rev.Lett.93 (2004), 032001)***	- combine the variables in a a single variable (Likelihood) and cut on it - compute the compatibility of the remaining events with S(BR)+B hypothesis **CDF publications 2005-2006:** ***- Phys.Rev.Lett95 (2005) 221805*** ***- CDF Public Note 8176***	-combine the variables in a single variable - do not cut on it instead compute the compatibility with the S(BR)+B hypothesis bin-by-bin ***LHCb Public Note 2007-033 (January 2007)*** ***CDF Public Note 8957 (August 2007)***

Comparison of strategies



with L ~ 0.1 fb^{-1}: 1) counting: BR< 3 • 10^{-8} @ 90% CL
2) refined counting: BR< 2 • 10^{-8} @ 90% CL
3) N-counting : BR < 1 • 10^{-8} @ 90% CL