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CP Violation and CKM parameters

(and a few slides on Rare Decays)

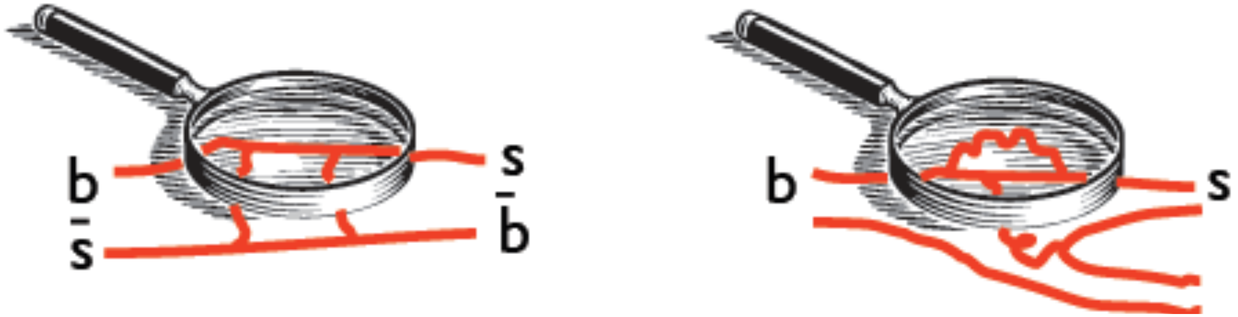
- ***Heavy Flavour physics as a tool to search for New Physics***

  - *Strategy*
  - *Experimental observables and comments on their sensitivity to NP*

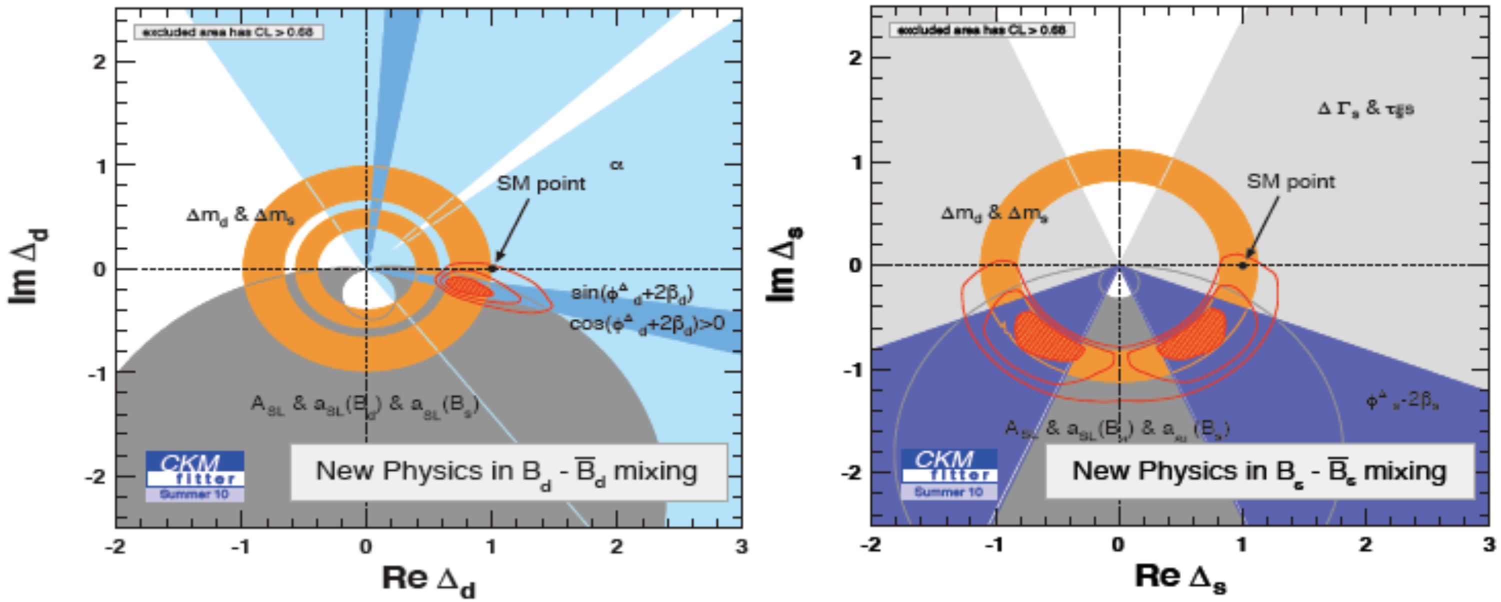
- ***Current sensitivity to NP effects and prospects for the nearest future (2011-2012)***

  - *NP phases*
  - *Rare decays: rates and helicity structure*

Strategy: *find observables which test the penguin and box diagrams separately; make a test which involves quarks of all three generations → Explore both $B_{u,d}$ and B_s sectors, and b-baryons*



$$\Delta_q \equiv \frac{M_{12}^q}{M_{12}^{q,\mathrm{SM}}}, \qquad \Delta_q \equiv |\Delta_q| e^{i\phi_q^\Delta}.$$



Plenty of room for NP !!!

Observables: CPV phases, rates of rare processes and helicity structure of involved amplitudes

- ***Phases***

  CPV processes are the only measurements sensitive to the phases of New Physics e.g. measurements of β , β_s & γ

- ***Masses and magnitude of the couplings of New Particles***

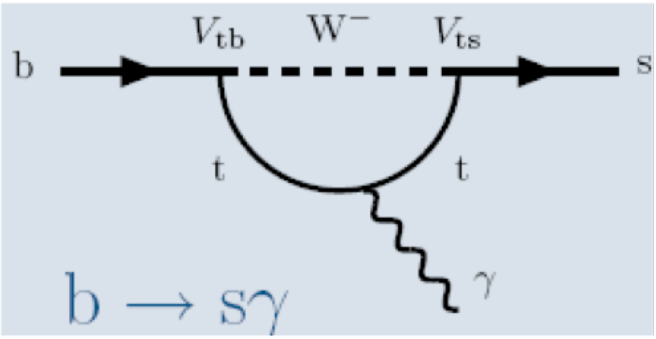
  Inclusive BR(b → sγ) indirectly constrains the scale of NP masses $\Lambda > 10^3$ *TeV for generic coupling (flavour problem)*

  BR(b→sγ):
  Exp. $3.55 \pm 0.26 \times 10^{-4}$
  Theor. $3.15 \pm 0.23 \times 10^{-4}$

  Look at specific cases with enhanced sensitivity to NP
  $B_{s,d} \to \mu\mu$, …

- ***Helicity structure of the couplings***

  Use the correlation between photon polarization and b flavour in **b→sγ**



$b \to \gamma(L) + (m_s/m_b) \times \gamma(R)$

φγ produced in B_s *and* $\overline{B}_s$ *decays do not interfere*

→ *corresponding CP asymmetry vanishes*

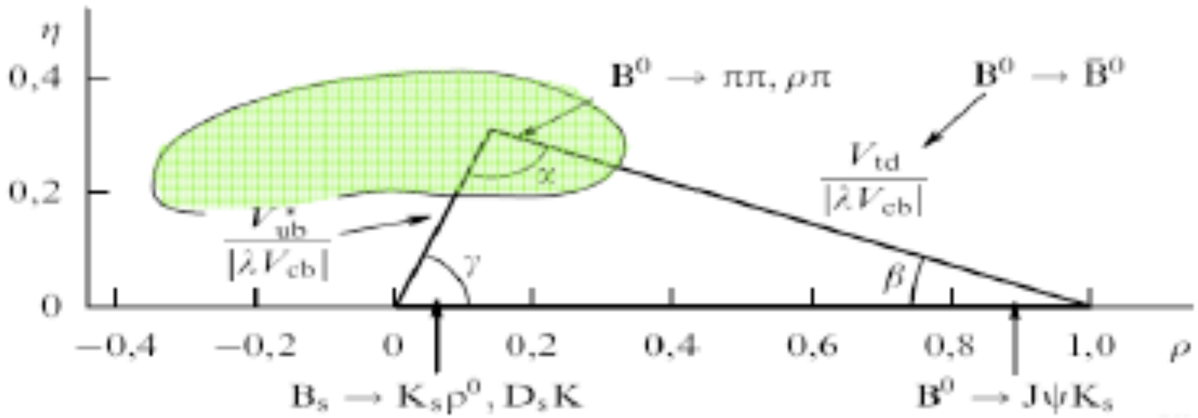
Significantly non-zero A_{CP} ***indicates a presence of right-handed current in the penguin loop***

Similar study in $B \to K^*\mu^+\mu^-$ & $K^*e^+e^-$

Where are we now …

Current status and expectations for the next year(s)

Scan of the slide shown in late 80's



Precision of UT elements improved dramatically !
The shape of UT, assumed intuitively >30 year ago, looks however as currently

Current status: CPV phases

State-of-art is given by UT:

- ***Accuracy of sides is currently limited by models:***

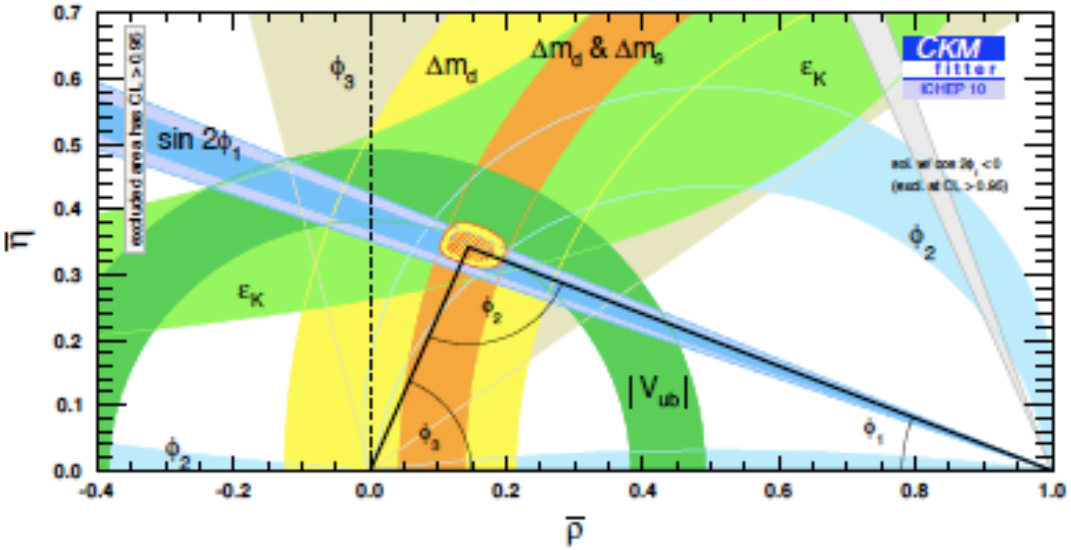
  Extraction of $|V_{ub}|$

  Calculation of $$\xi^2 = \frac{\hat{B}_{B_s} f_{B_s}^2}{\hat{B}_{B_d} f_{B_d}^2}$$

- ***Accuracy of angles (β,γ) is limited by experiment:***

  $\sigma(\alpha) \sim 5°,\ \sigma(\beta) = 0.8°,\ \sigma(\gamma) \sim 20°$

The quark sector is well described by the CKM mechanism



Becomes almost a precision measurement thanks to large BR($B^+ \rightarrow \rho^0 \rho^+$) measured by BaBar
Confirmation from BELLE is eagerly awaited !

Note:

UT geometry is such that the main constraint on NP comes from the comparison of the opposite elements i.e. angles vs sides

Box Diagrams (B_d)

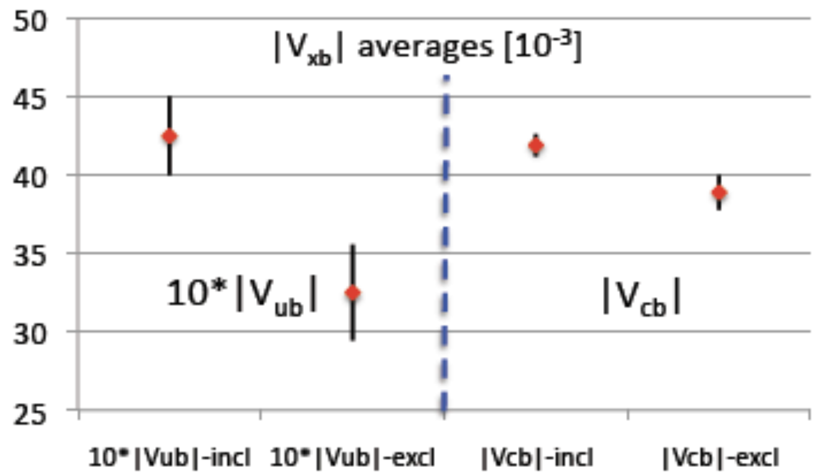
β **vs** $|V_{ub} / V_{cb}|$ *is largely limited by theory (~10% precision in* $|V_{ub}|$*)*
Note a discrepancy in $|V_{ub}|$ ***determined in inclusive and exclusive measurements :*** $|V_{ub}|_{incl} = (4.32 \pm 0.27) \times 10^{-3}$ **and** $|V_{ub}|_{\pi l \nu} = (3.51 \pm 0.47) \times 10^{-3}$

(A.Lenz FPCP2011)

B. Kowalewski BEAUTY 2011

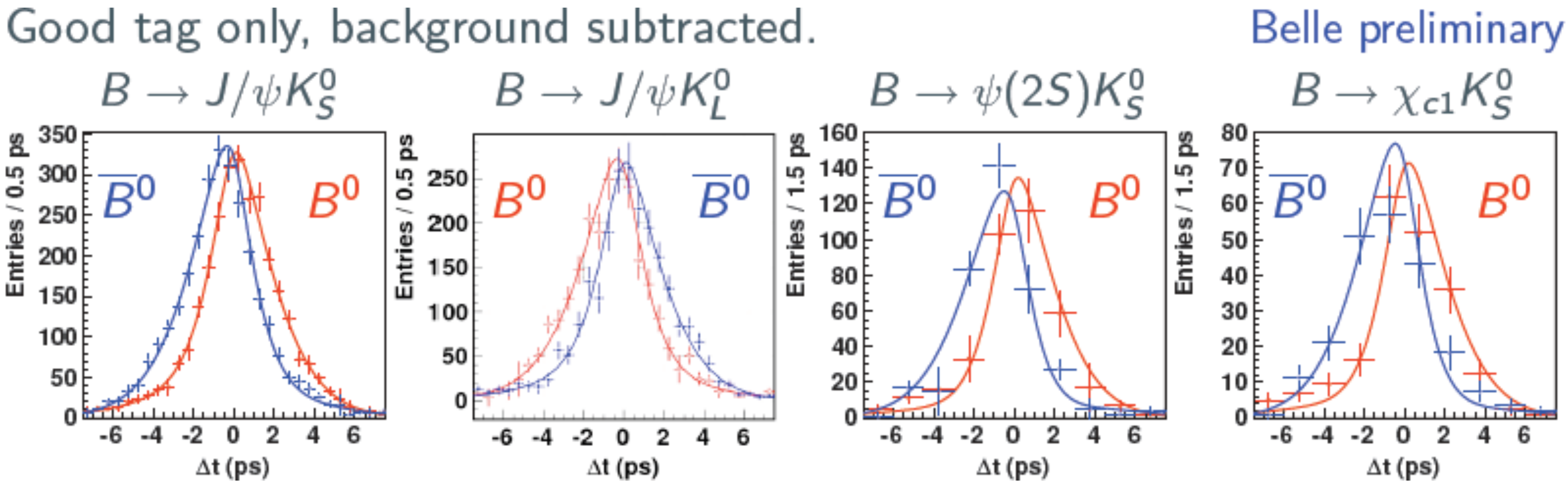
$$\left|\frac{V_{ub}}{V_{cb}}\right|_{incl} = 0.101 \pm 0.006$$

$$\left|\frac{V_{ub}}{V_{cb}}\right|_{excl} = 0.084 \pm 0.008$$

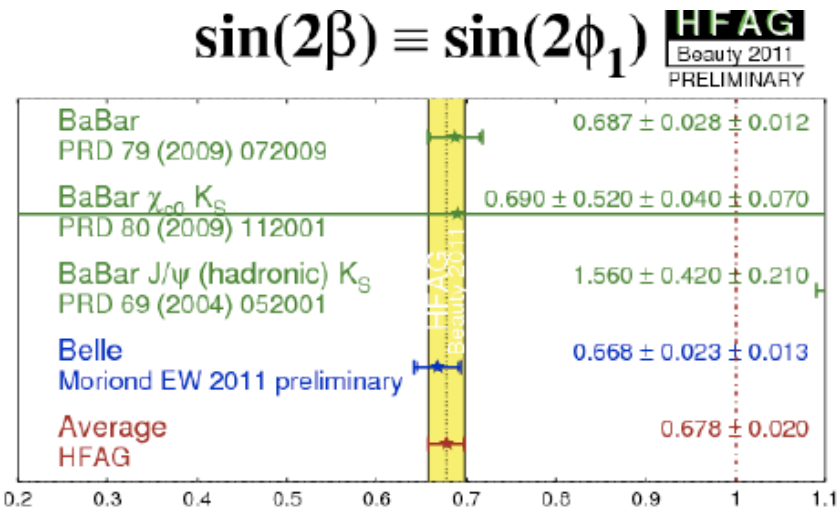


- *Continued tension between inclusive and exclusive results*
- *Possible improvement ???*
  - b→ulν measurements
  - combined data + theory fits to b→clν b→πlν

New measurement of sin(2β) by BELLE



CPV is cleanly observed in all four modes



BELLE with 772×10⁶ BB pairs:

$\sin(2\phi_1) = 0.668 \pm 0.023 \quad \pm 0.013$ preliminary

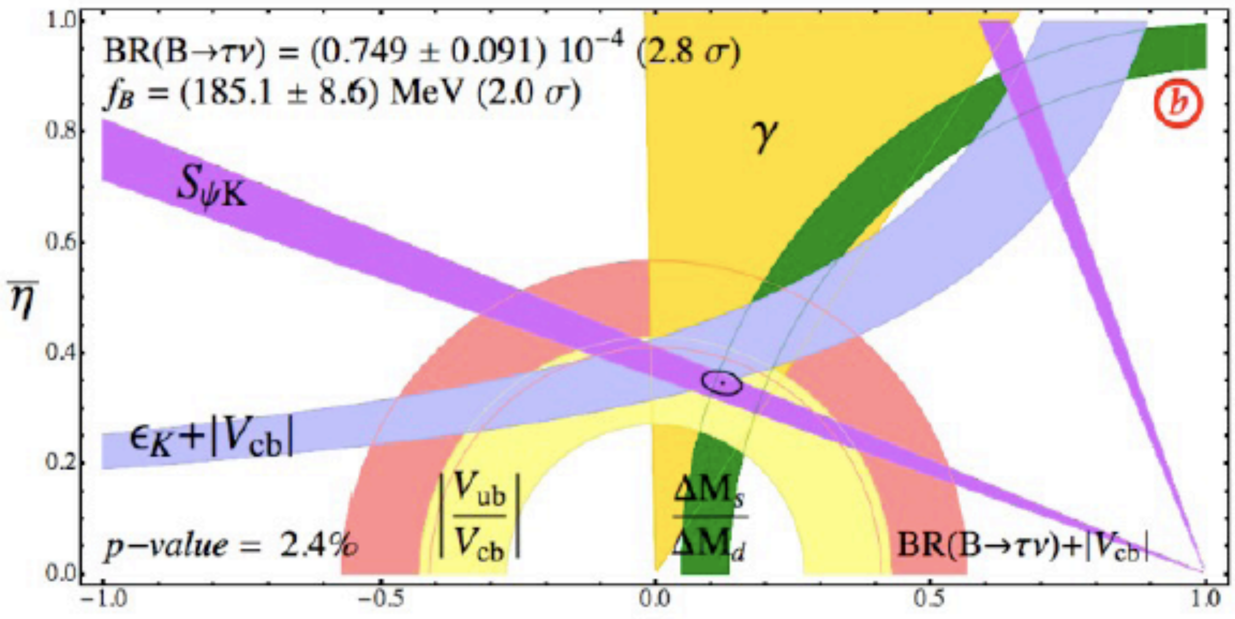
Current world's most precise measurement of Φ_1

Indirect estimation: $\sin(2\phi_1) = 0.830^{+0.013}_{-0.034}$ (global fit, CKMfitter ICHEP10)

γ vs $\Delta m_d / \Delta m_s$ is limited by experiment: γ is poorly measured

Tension in the current CKM fit:

- *Several possible hints for NP (A_{SL}, V_{ub} from $B \rightarrow \tau\nu$)*
- *Large contribution from NP not excluded*
- ***Precision measurement of γ in trees is important !!!***



From Lunghi and Soni, arXiv:1010.6069
(see also CKM fitter, UT fit, etc., etc.)

Note:

γ = (74 ± 11)° used as input while CKM fitter gives (71^{+21}_{-25})°
Direct measurement is less precise than SM prediction !

New measurement of Δm_s by LHCb

Tagged time-dependent analysis using $B_s \rightarrow D_s^- \pi^+$ and $B_s \rightarrow D_s^- 3\pi^+$

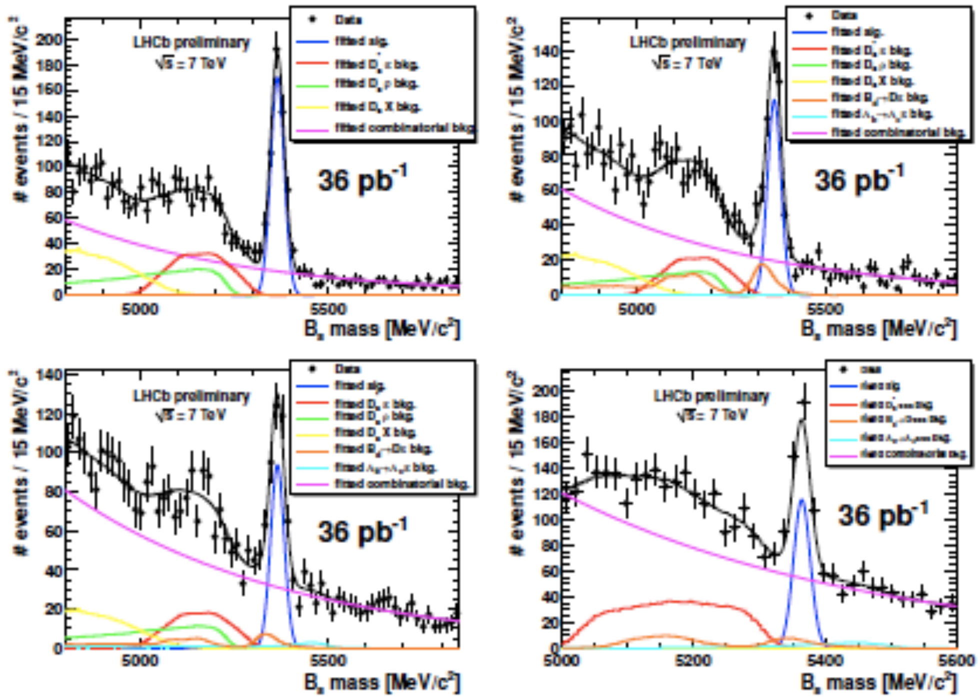
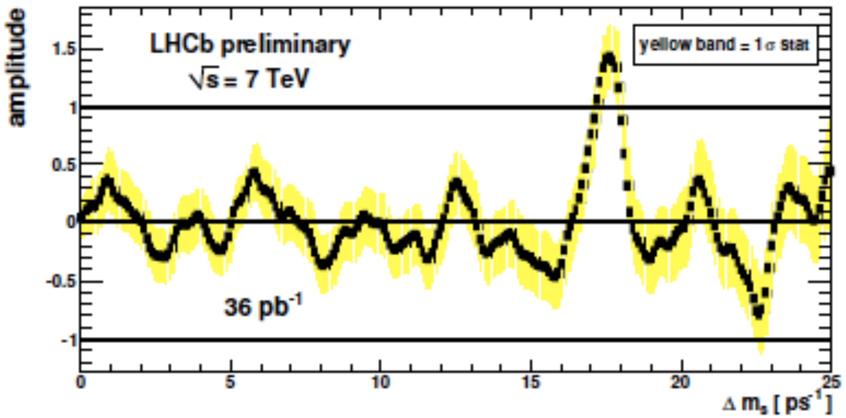
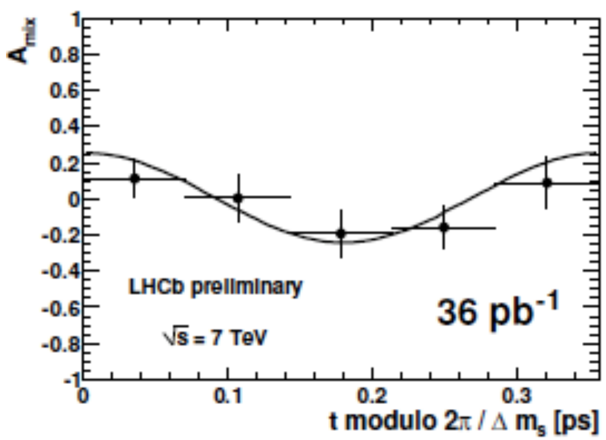


Figure 3: Fit to the mass distribution of $B_s^0 \rightarrow D_s^-(\phi\pi^-)\pi^+$ (top left), $B_s^0 \rightarrow D_s^-(K^*K^-)\pi^+$ (top right), $B_s^0 \rightarrow D_s^-(K^+K^-\pi^-)\pi^+$ (bottom left) and $B_s^0 \rightarrow D_s^- 3\pi$ (bottom right) candidates.



asymmetry modulo $2\pi / \Delta m_s$



Δm_s = 17.63 ± 0.11 ± 0.04 ps^{-1}

CDF: Δm_s = 17.67 ± 0.10 ± 0.07 ps^{-1}

Small systematic uncertainty due to LHCb excellent proper time resolution

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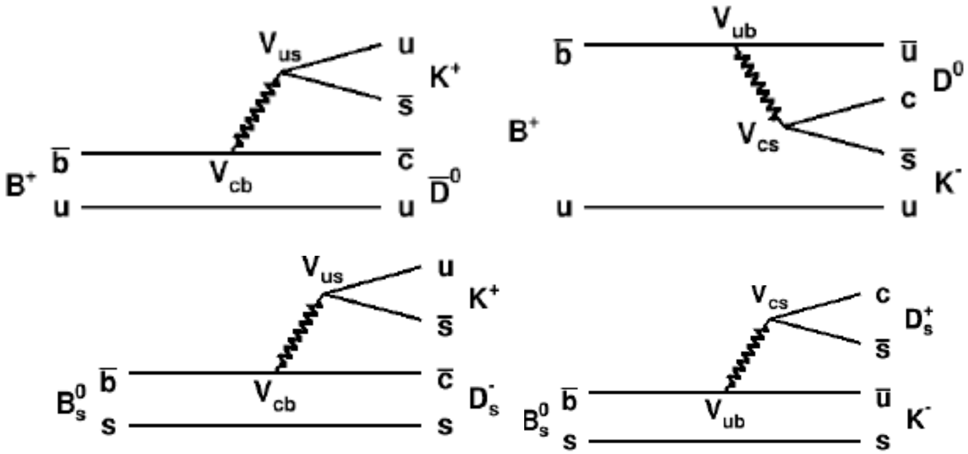
Prospects for γ measurements

ADS: Doubly Cabibbo-suppressed D decays
GLW: CP-eigenstates (Cabibbo-suppressed)
GGSZ: Cabibbo-favoured multibody decays with Dalitz plane

Two strategies:

- *Time-independent CPV: $B^+ \to D^0 K^+$, also $B^0 \to D^0 K^{*0}$*
- *Time-dependent CPV: $B_s \to D_s K^+$, also $B^0 \to D^- \pi^+$ (only possible @ hadron colliders)*



Time-independent analyses of BaBar/BELLE

BaBar		***BELLE***	
$(68\ ^{+15}_{-14} \pm 4 \pm 3)^\circ$	$[B^\pm \to D^{(*)} K^{(*)\pm}]$ [model-dep. GGSZ]	$(78\ ^{+11}_{-12} \pm 4 \pm 9)^\circ$	$[B^\pm \to D^{(*)} K^{\pm}]$ [model-dep. GGSZ]
		$(77.3\ ^{+15.1}_{-14.9} \pm 4.2 \pm 4.3)^\circ$	$[B^\pm \to D K^{\pm}]$ [model-indep. GGSZ]

$$A_{ADS} = \frac{\Gamma(B^- \to D_{DCS} K^-) - \Gamma(B^+ \to \bar{D}_{DCS} K^+)}{\Gamma(B^- \to D_{DCS} K^-) + \Gamma(B^+ \to \bar{D}_{DCS} K^+)} = \frac{2 r_B r_{K\pi} \sin(\delta_B + \delta_{K\pi}) \sin\gamma}{r_B^2 + r_{K\pi}^2 + 2 r_B r_{K\pi} \cos(\delta_B + \delta_{K\pi}) \cos\gamma}$$

$$R_{ADS} = \frac{\Gamma(B^- \to D_{DCS} K^-) + \Gamma(B^+ \to \bar{D}_{DCS} K^+)}{\Gamma(B^- \to D_{CF} K^-) + \Gamma(B^+ \to \bar{D}_{CF} K^+)} = r_B^2 + r_{K\pi}^2 + 2 r_B r_{K\pi} \cos(\delta_B + \delta_{K\pi}) \cos\gamma$$

New ADS

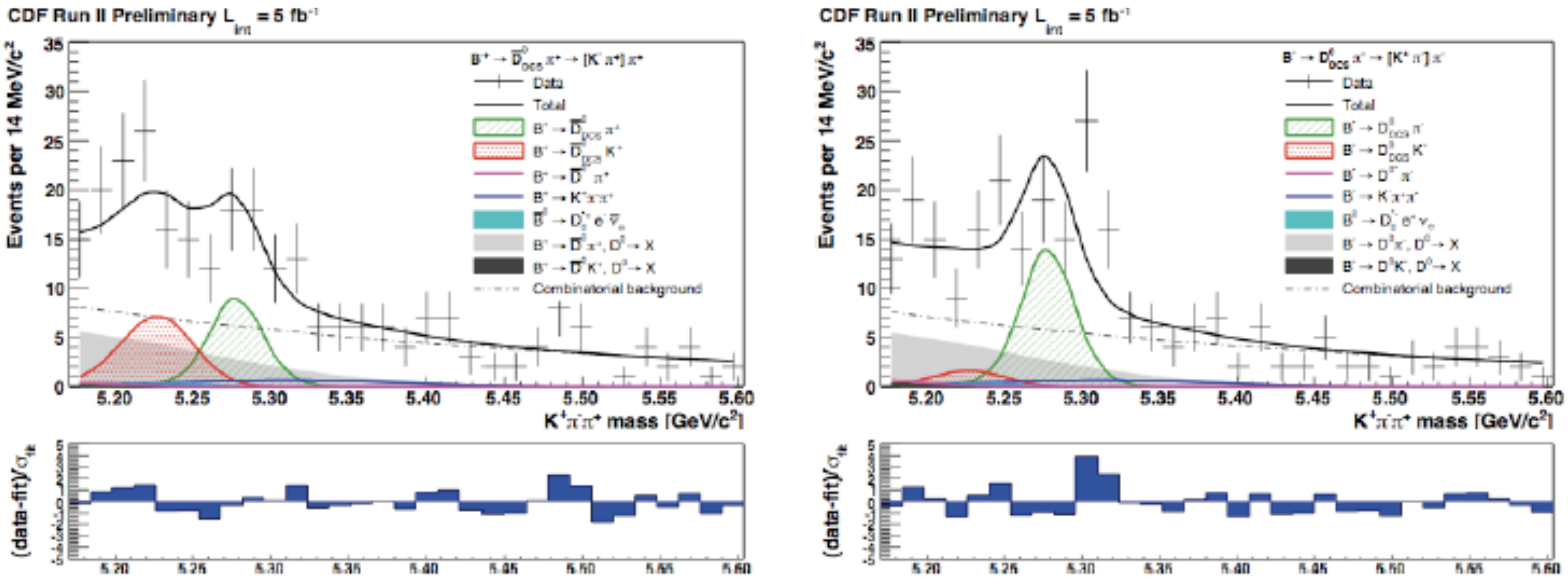
Belle with 772×10^6 $B\bar{B}$: arXiv:1103.5951

$$\mathcal{R}_{DK} = (\ 1.63\ ^{+0.44}_{-0.41}\ (\text{stat})\ ^{+0.07}_{-0.13}\ (\text{syst})) \times 10^{-2}$$

$$\mathcal{A}_{DK} = -0.39\ ^{+0.26}_{-0.28}\ ^{+0.04}_{-0.03}$$

preliminary

CDF: ADS analysis of $B^- \to D^0 K^-$ decays



Yield ($B \to D_{DCS}K$) = 34 ± 14 (5 fb^{-1})
Yield ($B \to D_{DCS}\pi$) = 73 ± 16 (5 fb^{-1})

Significance for all DCS signals ($D_{DCS}\pi + D_{DCS}K$) > 5 σ

$R_{ADS}(K) = r_D^2 + r_B^2 + 2r_B r_D \cos(\delta_B+\delta_D) \cos\gamma$

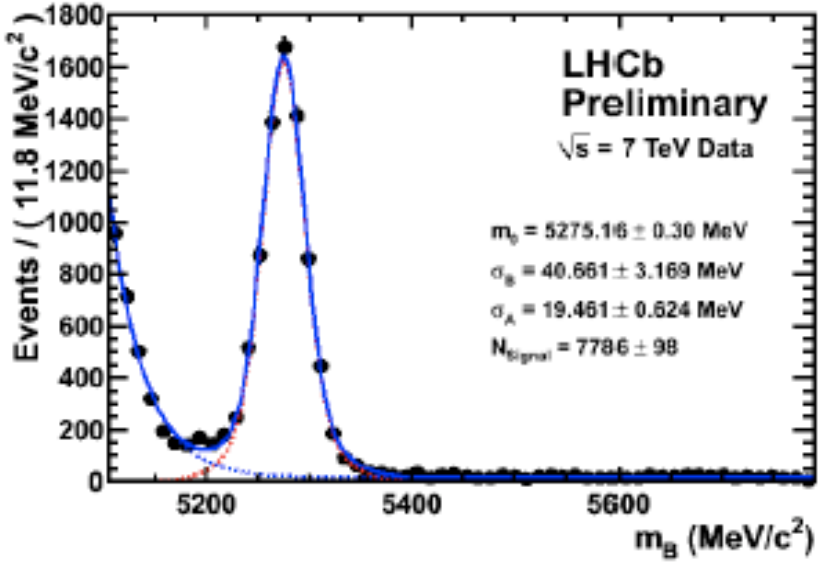
$A_{ADS}(K) = 2r_B r_D \sin(\delta_B+\delta_D)\sin\gamma / R_{ADS}(K)$

$$R_{ADS}(\pi) = 0.0041 \pm 0.0008(stat) \pm 0.0004(syst)$$
$$A_{ADS}(\pi) = 0.22 \pm 0.18(stat) \pm 0.06(syst)$$
$$R_{ADS}(K) = 0.0225 \pm 0.0084(stat) \pm 0.0079(syst)$$
$$A_{ADS}(K) = -0.63 \pm 0.40(stat) \pm 0.23(syst)$$

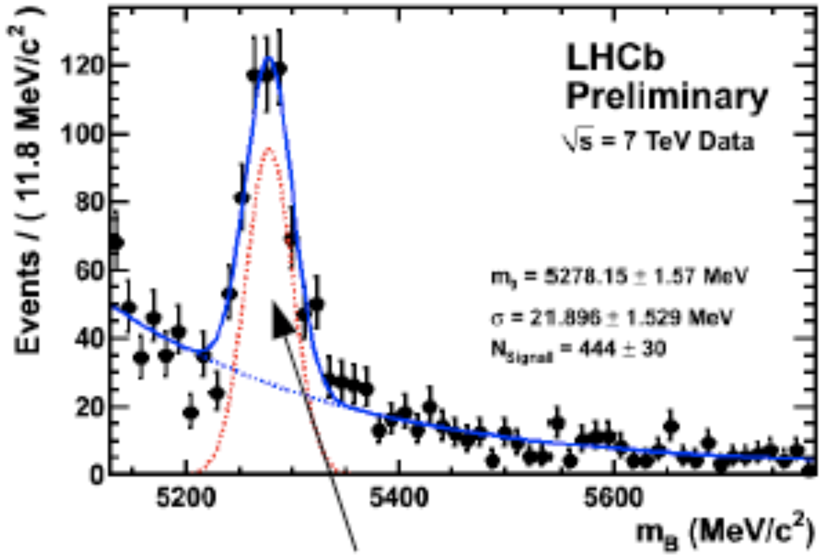
CDF results (with 5 fb^{-1} data sample) competitive with B-factories

LHCb yields in $B^+ \to D\pi^+$ & $B^+ \to DK^+$
(LHCb takes shape !)

$B^\pm \to D\pi^\pm$ with $D \to \pi K$

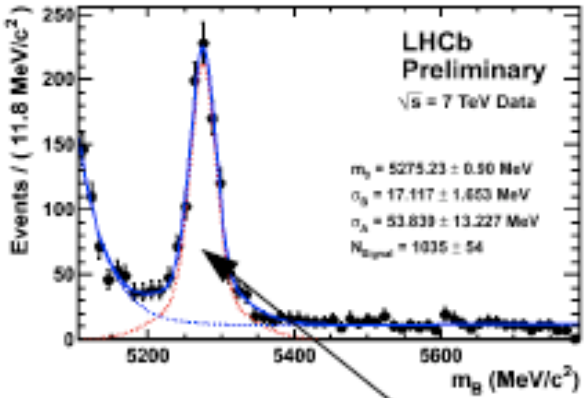


$B^\pm \to DK^\pm$ with $D \to \pi K$

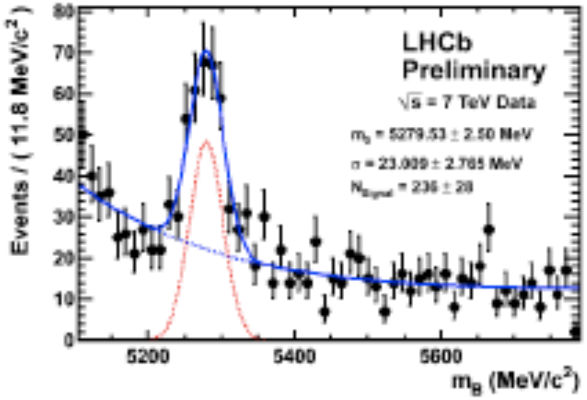


LHCb yield: 444 ± 30 / 34 pb^{-1}
CDF yield: 516 ± 37 / fb^{-1}

$B^\pm \to D\pi^\pm$ with $D \to KK$



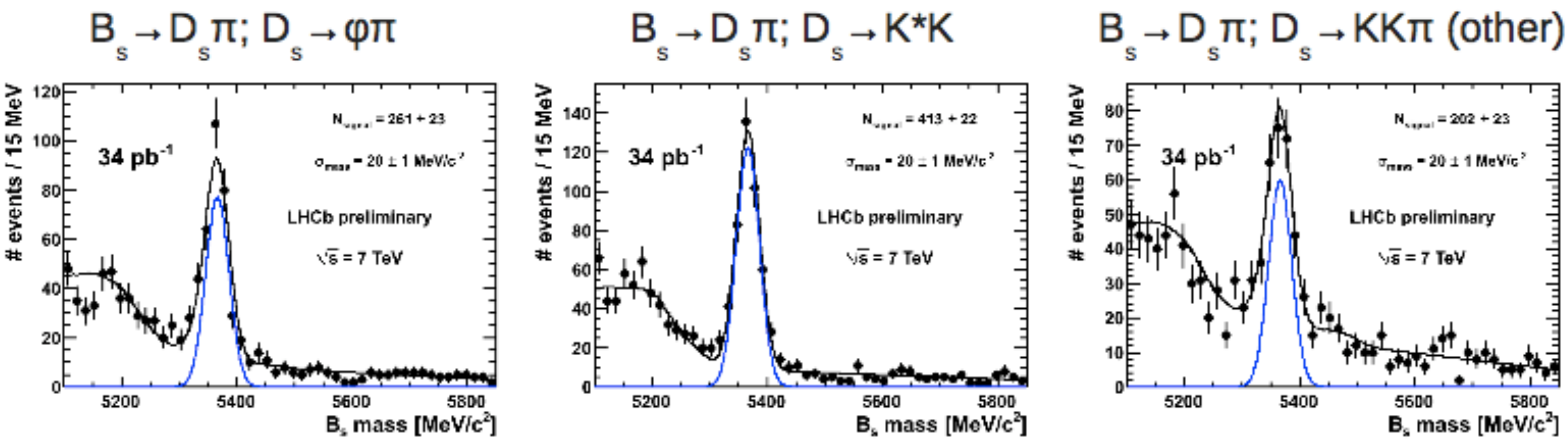
$B^\pm \to D\pi^\pm$ with $D \to \pi\pi$



LHCb yield: 1035 ± 54 / 34 pb^{-1}
CDF yield: 718 ± 36 / fb^{-1}

LHCb prospects for γ measurement in $B_s \to D_sK$

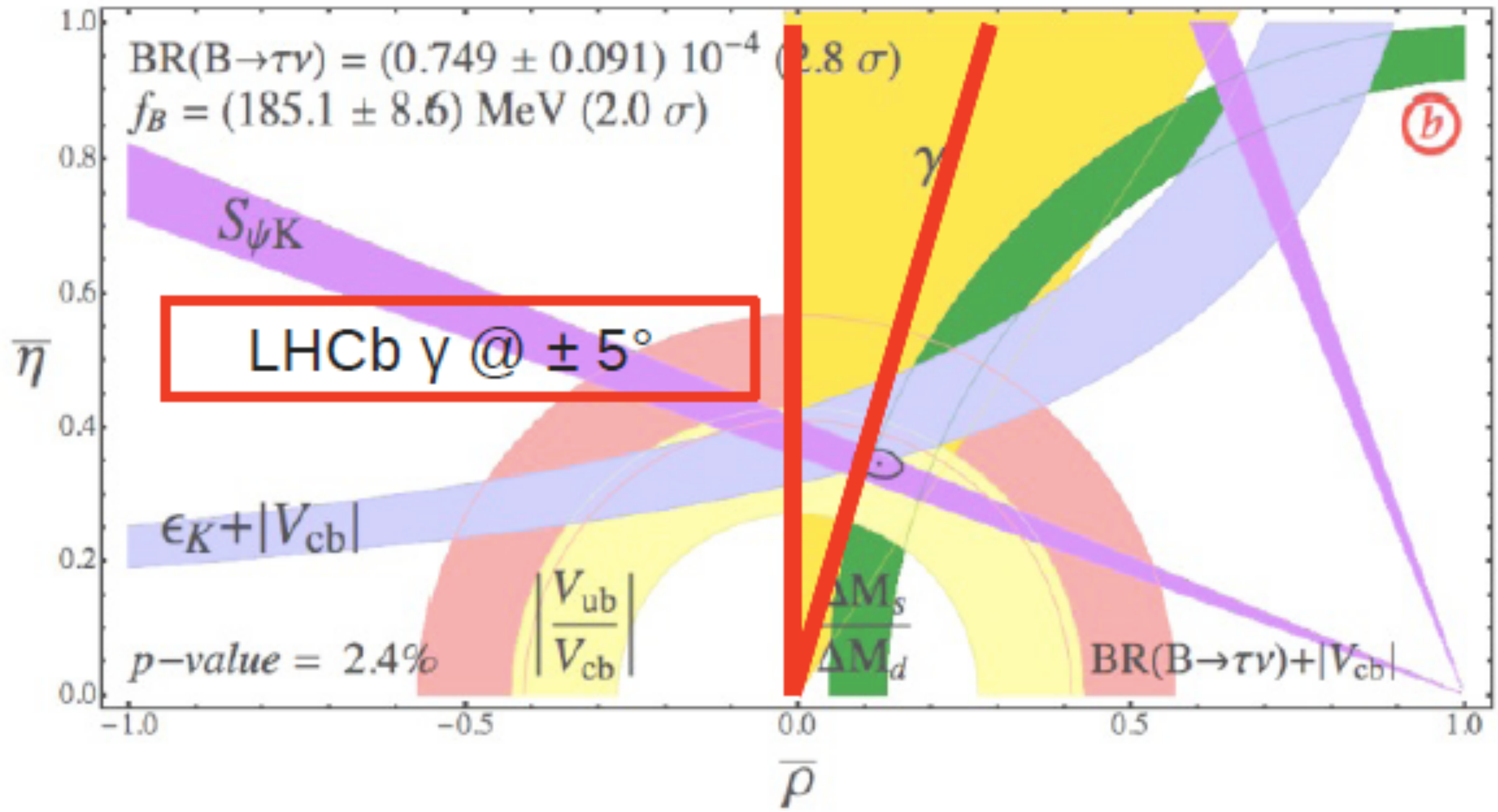
Large signals for $B_s \to D_s\pi$ useful for Δm_s measurement



- *D_sK final state under study*
- *Expect world's first time-dependent CPV analysis for $B_s \to D_sK$ analysis in 2011*

Combined estimated sensitivity for γ in 2011/2012 Run is ~5°

LHCb measurement of γ may hint to New Physics within next two years !



But I doubt that it will be conclusive with current theor. uncertainties
Higher accuracy in γ (~1°) is definitely required here !

Box Diagrams (B_s mixing phase)

$\phi_s^{J/\psi\phi}$ = **$-2\beta_s$** *in SM is the B_s meson counterpart of 2β*

penguin contribution ≤ 10^{-3}

$\phi_s^{J/\psi\phi}$ *is not really constrained so far*

Theoretical uncertainty is very small: *$-2\beta_s$ = - 0.0368±0.0017 (CKMfitter 2007)*

Results from TEVATRON

- CDF: based on **5.2 fb^{-1}** with improved particle Id, NN, flavour tagging (SST) and contribution of S-wave included.
- DØ: based on **6.1 fb^{-1}** with improved selection and no same side tagger anymore.

CDF *(assuming no CPV)*

τ_s = 1.53 ± 0.025 (stat.) ± 0.012 (syst.) ps

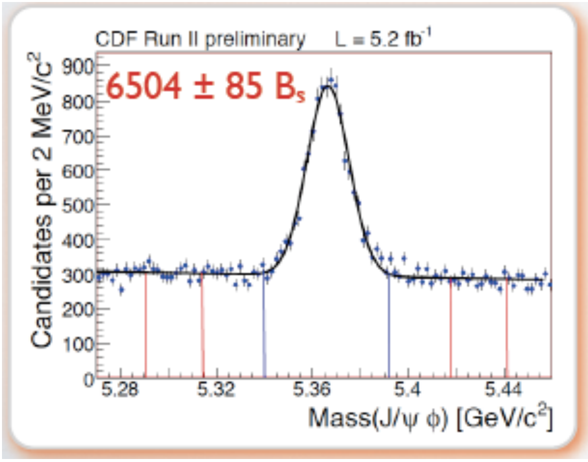
$\Delta\Gamma_s$ = 0.075 ± 0.035 (stat.) ± 0.01 (syst.) ps^{-1}

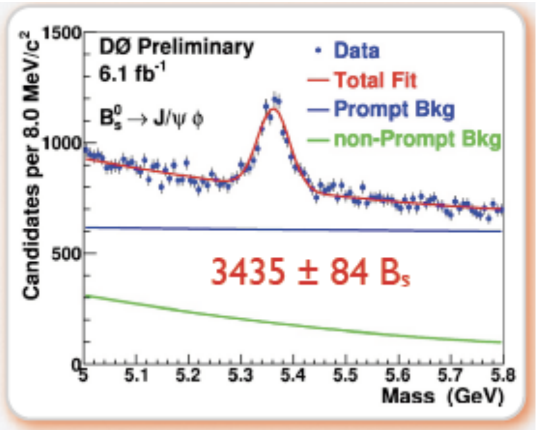
D0

τ_s = 1.47 ± 0.04 (stat.) ± 0.01 (syst.) ps

$\Delta\Gamma_s$ = 0.15 ± 0.06 (stat.) ± 0.01 (syst.) ps^{-1}

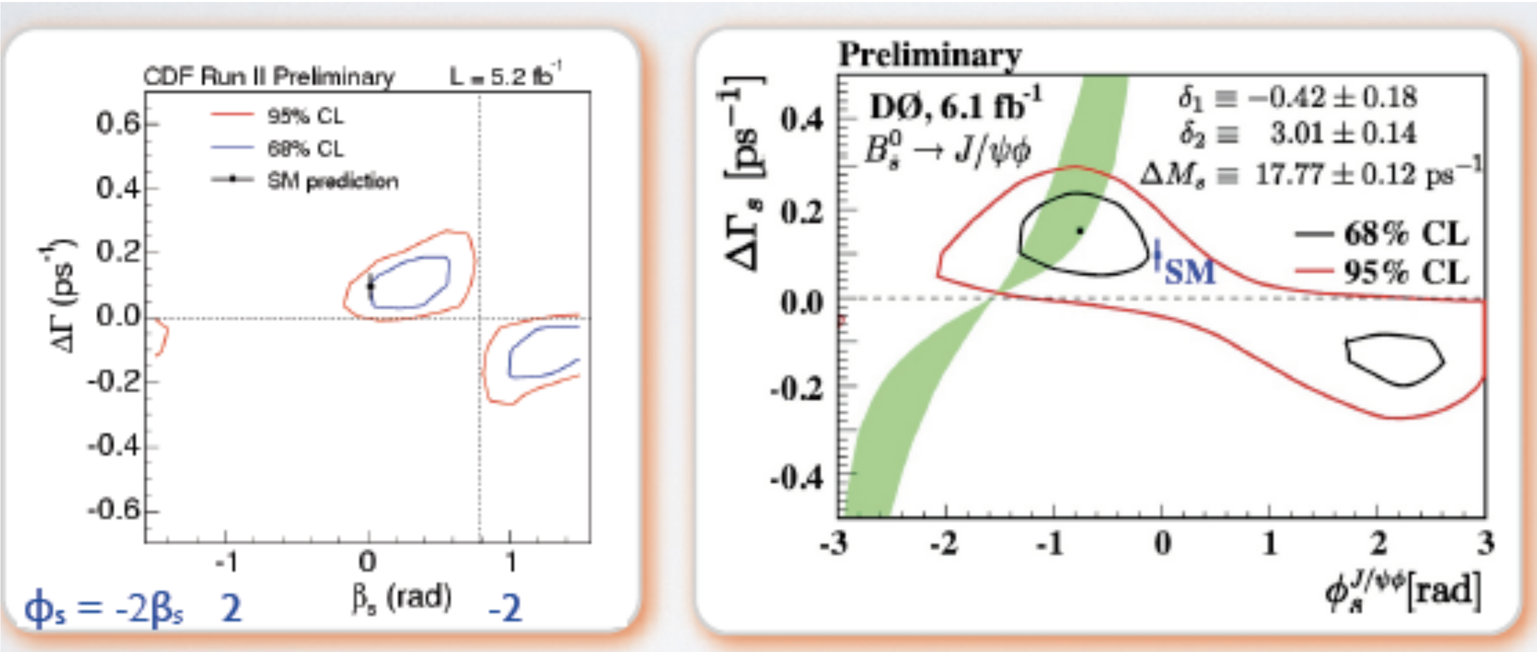
ϕ_s = -0.76 ± 0.37 (stat.) ± 0.02 (syst.)





In both analyses a contribution from S-wave ($B_s \rightarrow J/\psi f^0$) found to be non-significant

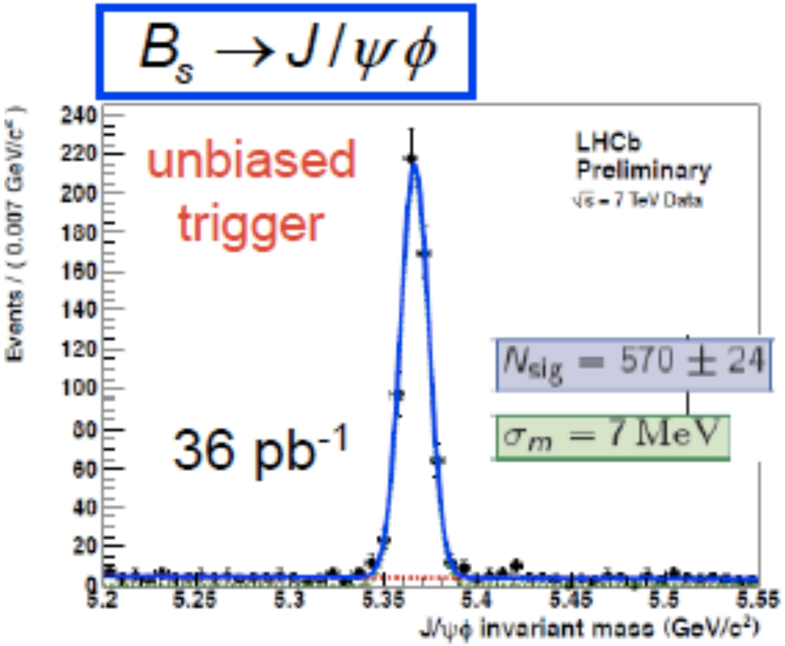
TEVATRON: ϕ_s from B → J/ψφ



$\phi_s \in [-\pi, -1.78] \cup [-1.36, 0.26] \cup [2.88, \pi]$ @ 95 % C.L.
0.8σ deviation from SM central point

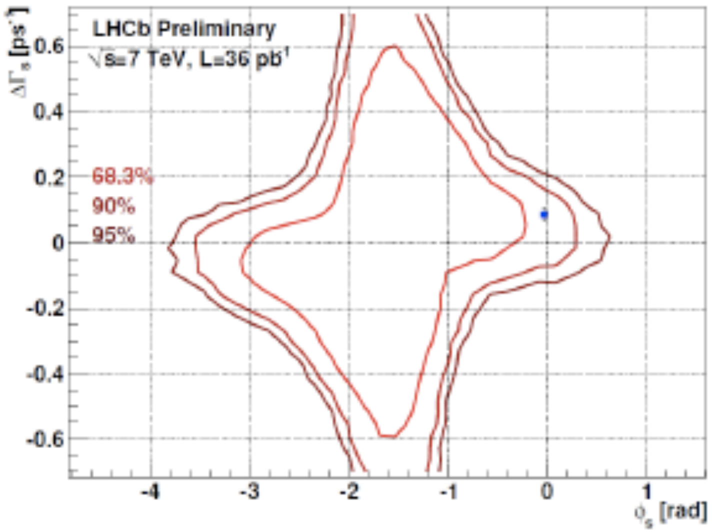
$\phi_s \in [-1.65, 0.24]$, $\Delta\Gamma_s \in [0.014, 0.263]$ ps^{-1}
and $\phi_s \in [1.14, 2.93]$, $\Delta\Gamma_s \in [-0.235, -0.040]$ ps^{-1} @ 95 % C.L.
1.1σ deviation from SM central point

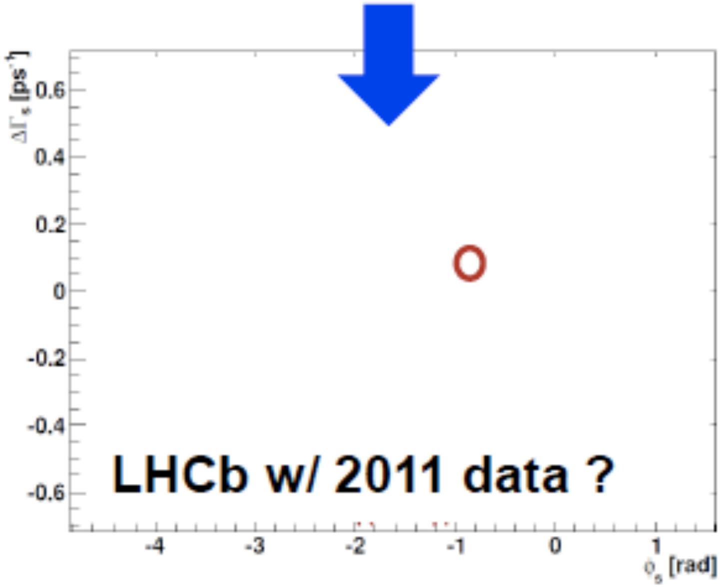
LHCb: ϕ_s from B → $J/\psi\phi$



	LHCb 36 pb^{-1}	CDF 5.2 fb^{-1}
$B_s \to J/\psi\,\phi$	836	6500
Proper time resolution	50 fs	100 fs
OS tagging power	$2.2 \pm 0.5\%$	$1.2 \pm 0.2\%$
SS tagging power	work ongoing	$3.5 \pm 1.4\%$

$\phi_s \in$ [-2.7, -0.5] rad at 68% CL
$\phi_s \in$ [-3.5, 0.2] rad at 95% CL





SS tagging will significantly improve sensitivity
→Exciting prospects for the nearest future
Expect $\sigma(\phi_s) \sim 0.1$ with about 1 fb^{-1}

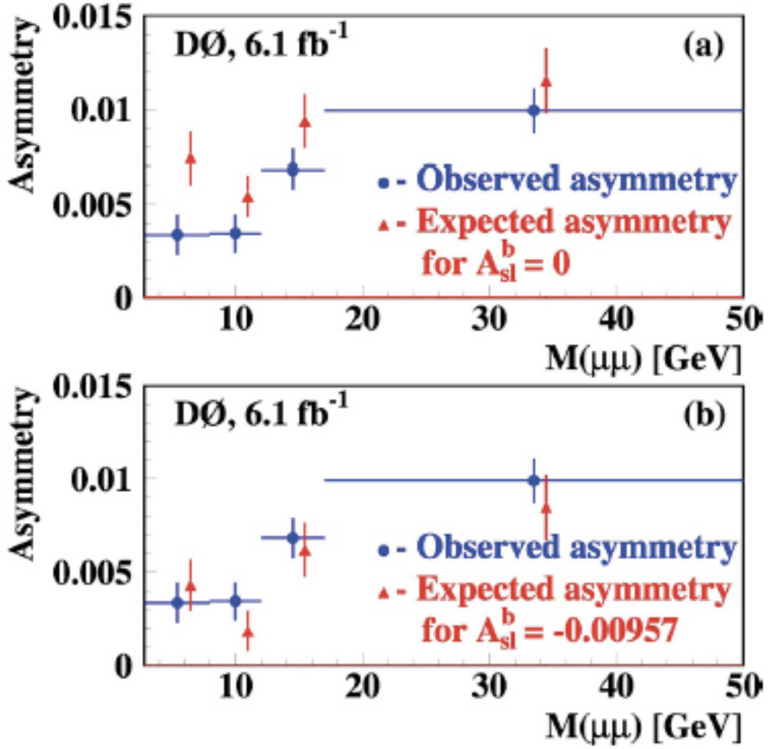
Summary of Tevatron results on A_{SL}

- **CDF analysis (using muon IP cut) is underway**
  Expected stat. accuracy for 6 fb^{-1} is 70% worse than in D0 (no IP cut)

Measurement of $\overline{\chi}_b = \frac{\Gamma(B^0 \to \bar{B}^0 \to \ell^+ X)}{\Gamma(B \to \ell^\pm X)} = f_d\chi_d + f_s\chi_s$ *is important cross-check towards A_{SL}*

New CDF result: $\overline{\chi} = 0.126 \pm 0.008$ *is entirely consistent with LEP:* $\overline{\chi} = 0.1259 \pm 0.0042$
(probable cause of the previous discrepancy – "ghost" muons not properly accounted in MC)

Presented at BEAUTY 2011



- **D0 analysis**

$$A^b_{sl} = (-0.957 \pm 0.251\,(\mathrm{stat}) \pm 0.146\,(\mathrm{syst}))\,\%$$

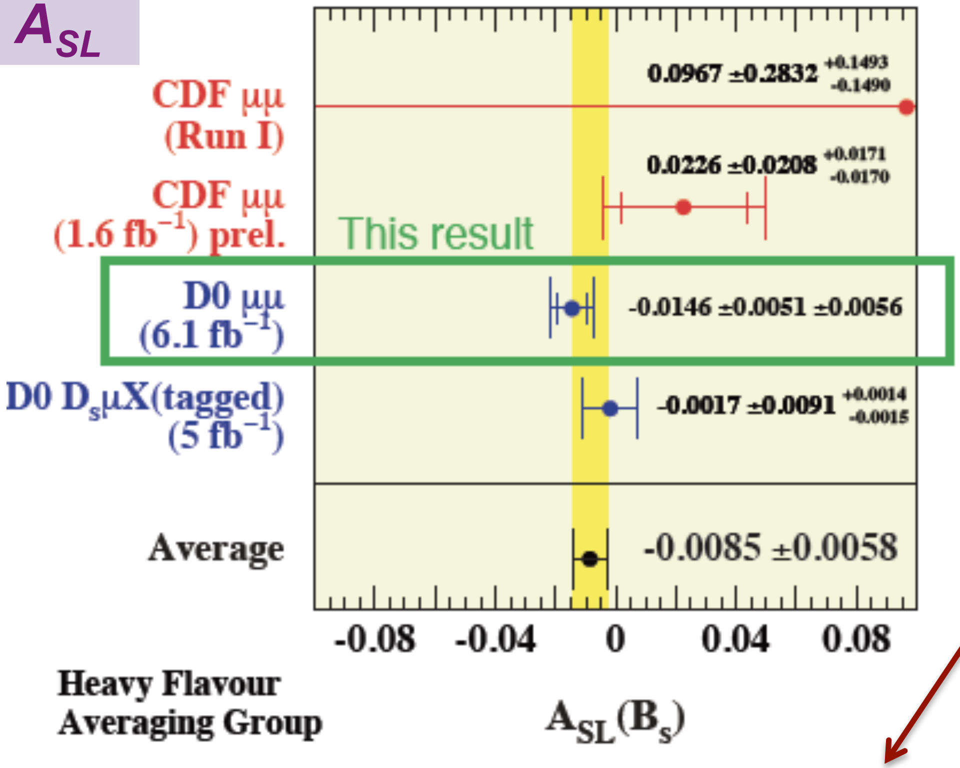
$$A^b_{sl}\,(\mathrm{SM}) = (-2.3^{+0.5}_{-0.6}) \times 10^{-4}$$

Additional cross-check:

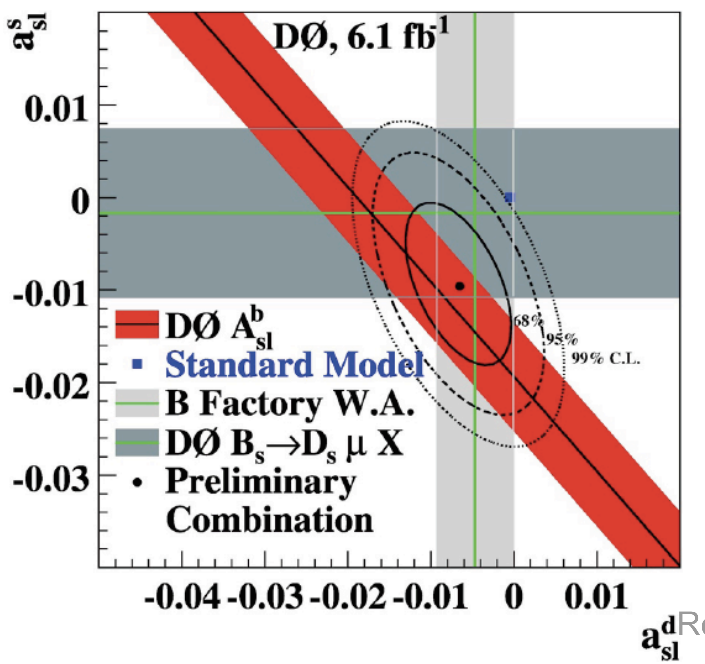
A_{SL} as a function of $M(\mu\mu)$
<u>Note:</u> D0 $M(\mu\mu) > 2.8\ GeV/c^2$
CDF $M(\mu\mu) > 5\ GeV/c^2$

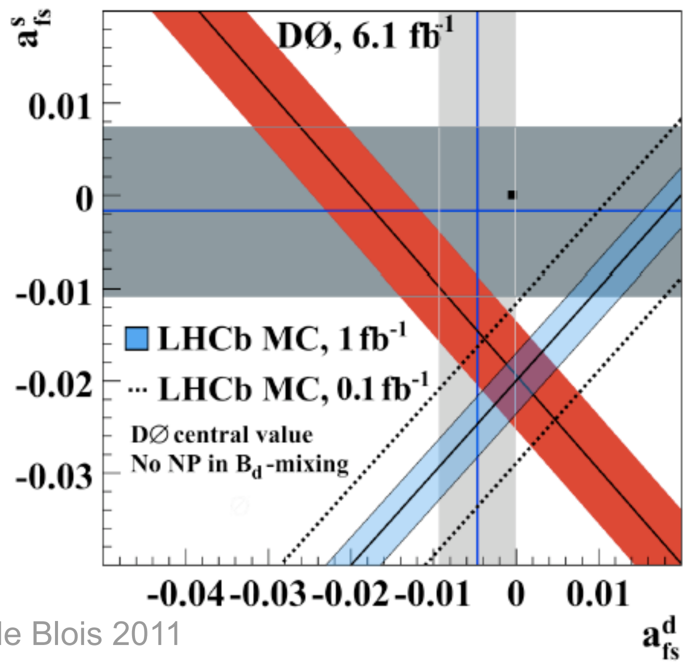
Future prospects on A_{SL}

- *CDF measurement*
- *D0 update (with 9 fb^{-1}) IP cut and improved data selection*
- *LHCb measurement (with 1 fb^{-1})*



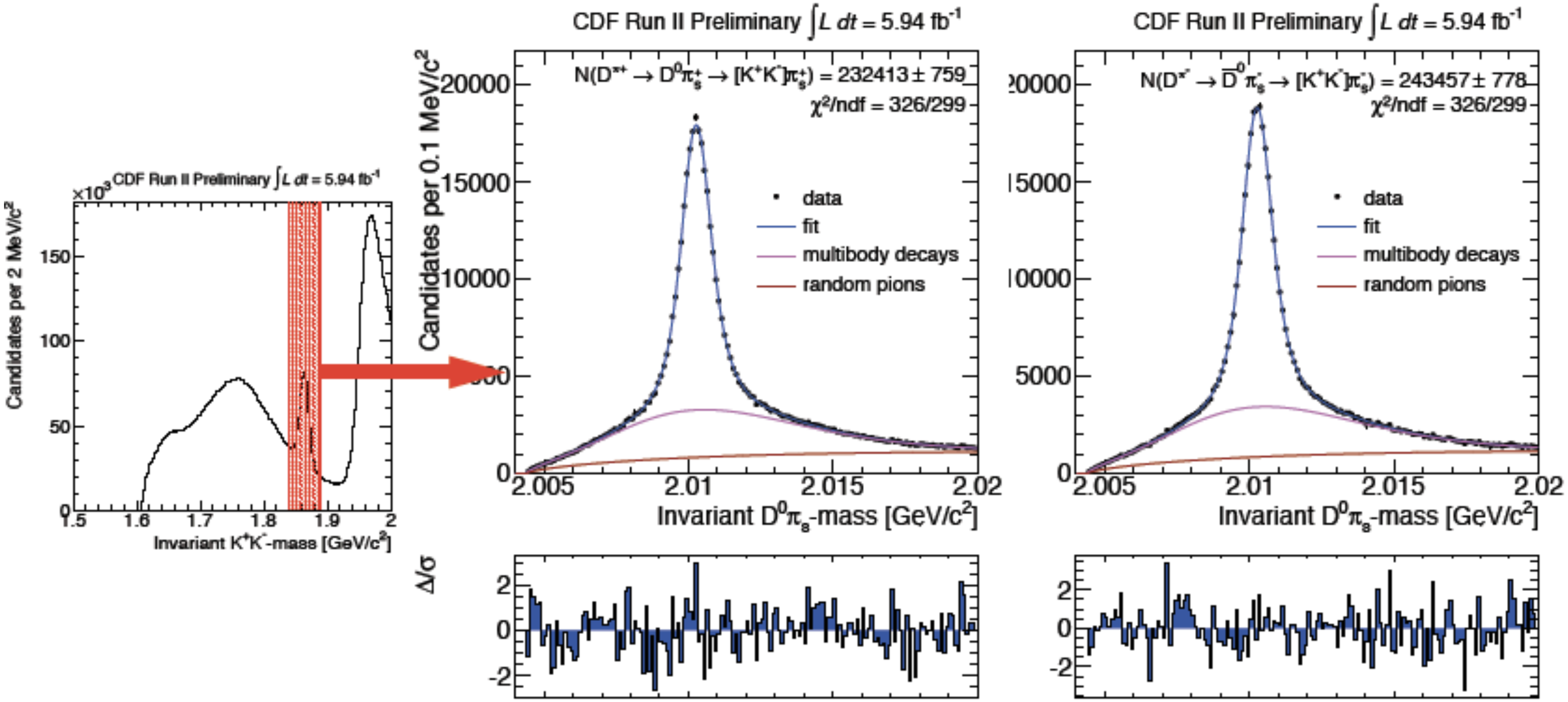
NB: This is MC, scaled to real data





CPV in charm

$$A_{CP}(D^0 \to h^+h^-) = \frac{\Gamma(D^0 \to h^+h^-) - \Gamma(\bar{D}^0 \to h^+h^-)}{\Gamma(D^0 \to h^+h^-) + \Gamma(\bar{D}^0 \to h^+h^-)}$$



$\sim 476\,000\ D^\star$-tagged $D^0 \to KK$

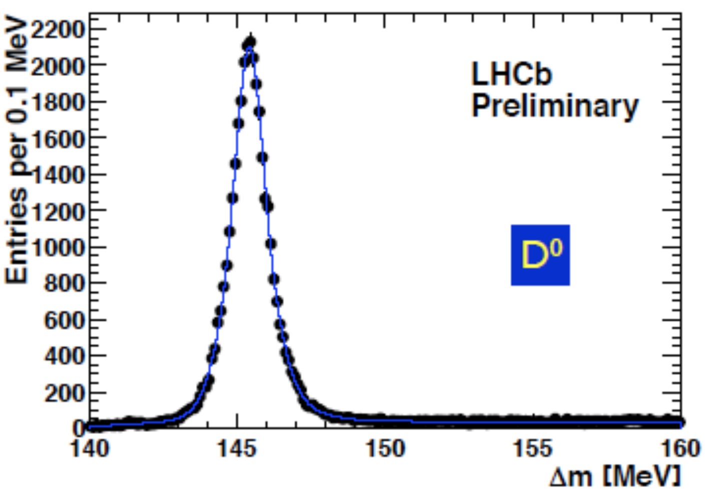
CDF world's most precise measurement:

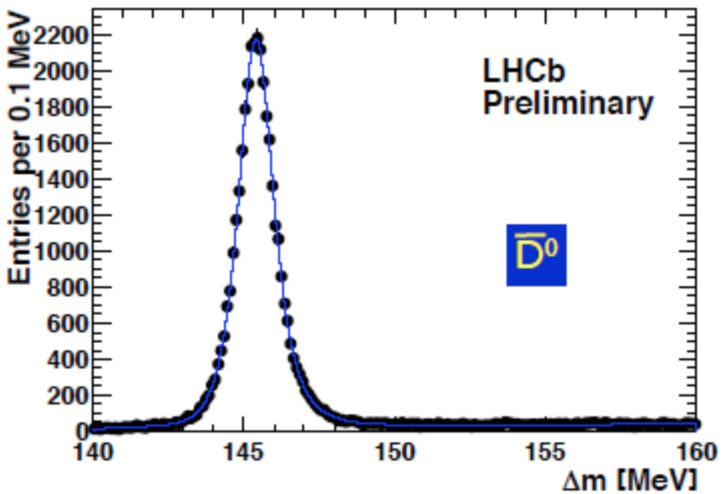
$A_{CP}(D^0 \to \pi^+\pi^-) = (+0.22 \pm 0.24 \pm 0.11)\%$

$A_{CP}(D^0 \to K^+K^-) = (-0.24 \pm 0.22 \pm 0.10)\%$

LHCb prospects (charm)

Excellent prospects for CPV studies: Expect about a few millions tagged $D^0 \rightarrow KK$ with $L \sim 1\ fb^{-1}$





Sample sizes in low multiplicity decay modes with low mis-tag rate already similar to those of B-factories !

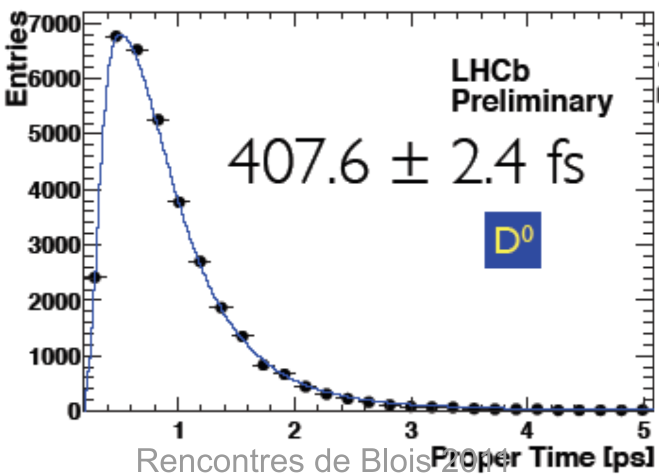
A_Γ is well in progress !

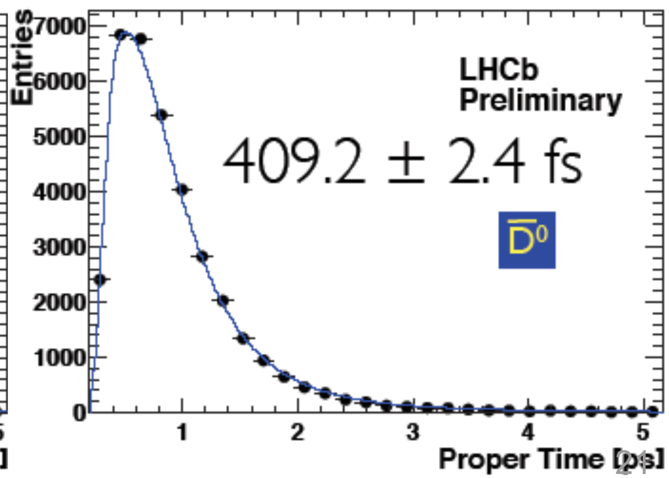
$$A_\Gamma = \frac{\tau\left(\overline{D}^0 \rightarrow K^- K^+\right) - \tau\left(D^0 \rightarrow K^- K^+\right)}{\tau\left(\overline{D}^0 \rightarrow K^- K^+\right) + \tau\left(D^0 \rightarrow K^- K^+\right)}$$

$$\approx \frac{A_M}{2} y \cos\phi - x \sin\phi$$

Control channel: (A_Γ in $D \rightarrow K\pi$)

$A_\Gamma = (-2 \pm 4) \times 10^{-3}$



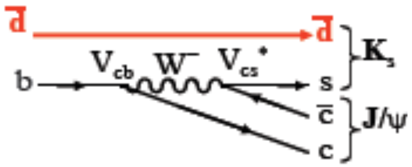


Penguin Diagrams: $B_{d,s}$

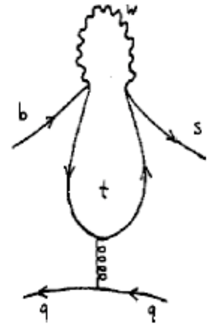
In B_d sector:

from $B \rightarrow J/\psi K^0$ (tree)

$\sin(2\beta) = 0.655 \pm 0.024$

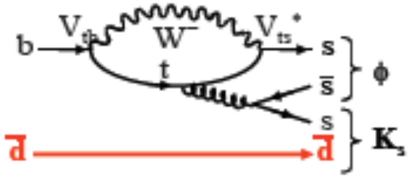


sin2β

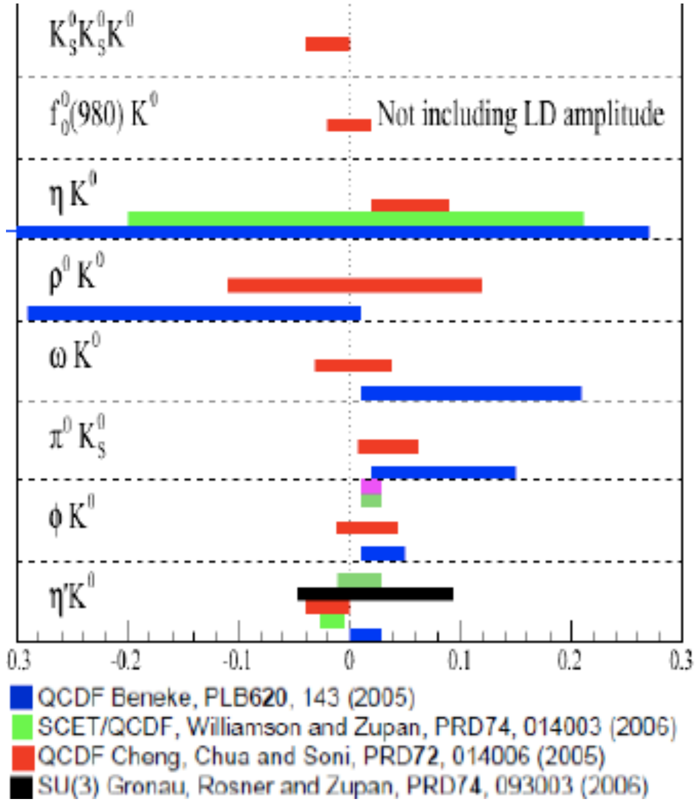


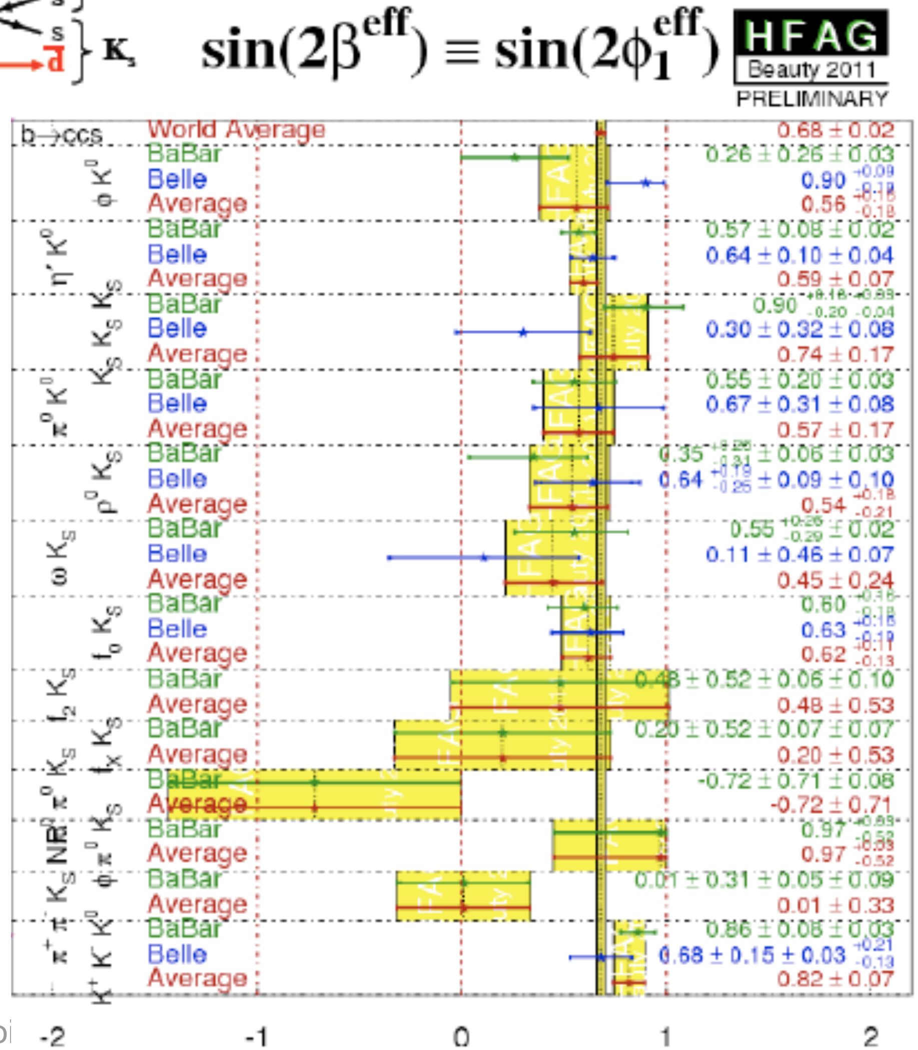
from $B \rightarrow \phi K_S$ (penguin)

$\sin(2\beta) = 0.56^{+0.16}_{-0.18}$

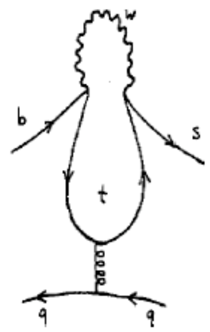


For most of the $s\bar{s}s$ final states theory predicts larger value of $\sin(2\beta)$ in SM



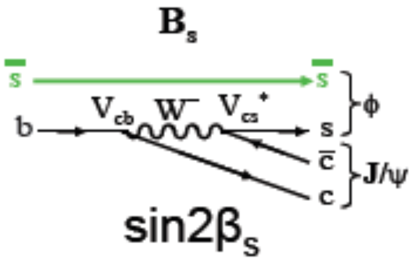


Penguin Diagrams: $B_{d,s}$

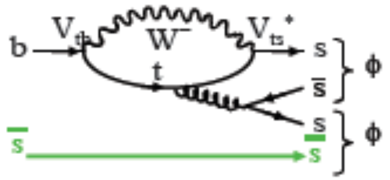


In B_s sector:

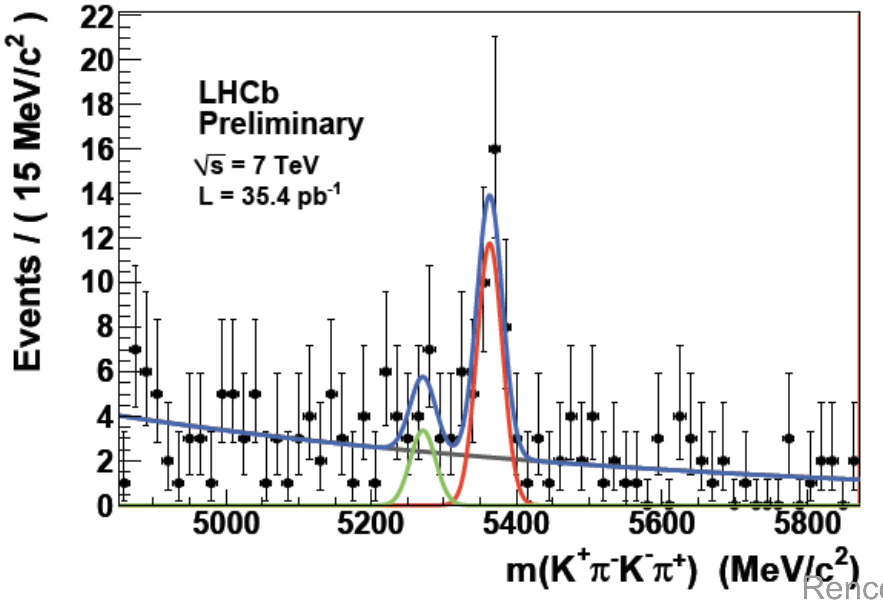
tree



penguin



- *CPV study in $B_s \rightarrow \phi\phi$ requires very large data samples (~50 fb^{-1} at LHC)*
- *Use other similar decays → First observation of $B_s \rightarrow K^*K^*$ by LHCb*



$BR(B_s \rightarrow K^*K^*) = (1.95 \pm 0.47 \pm 0.66 \pm 0.29) \times 10^{-5}$

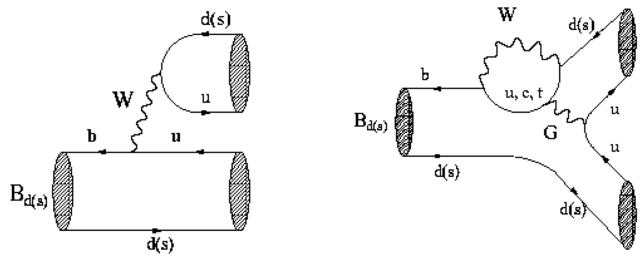
on the upper side of expectations
(compare to $B_d \rightarrow K^*K^*$ observed by BELLE)

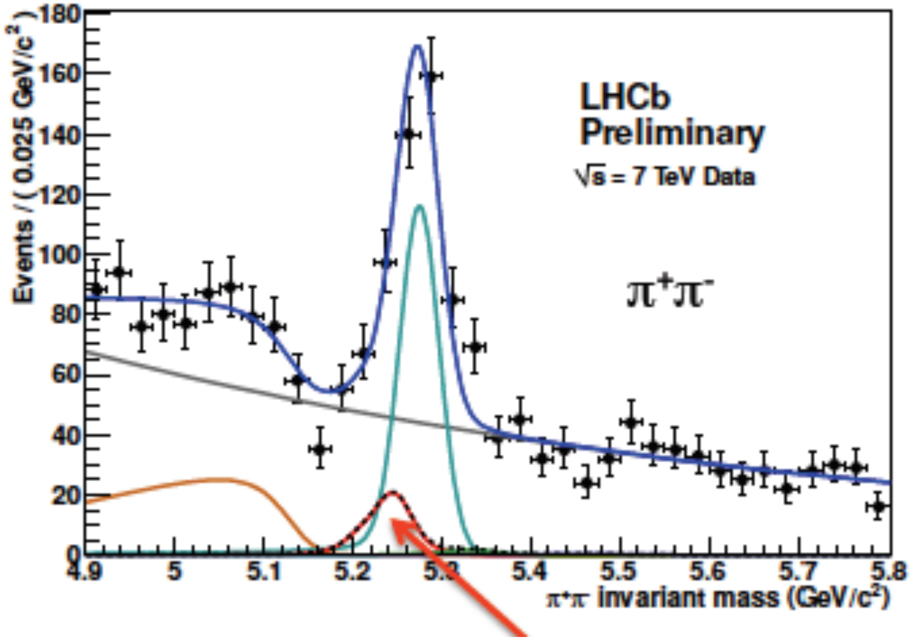
Penguin Diagrams

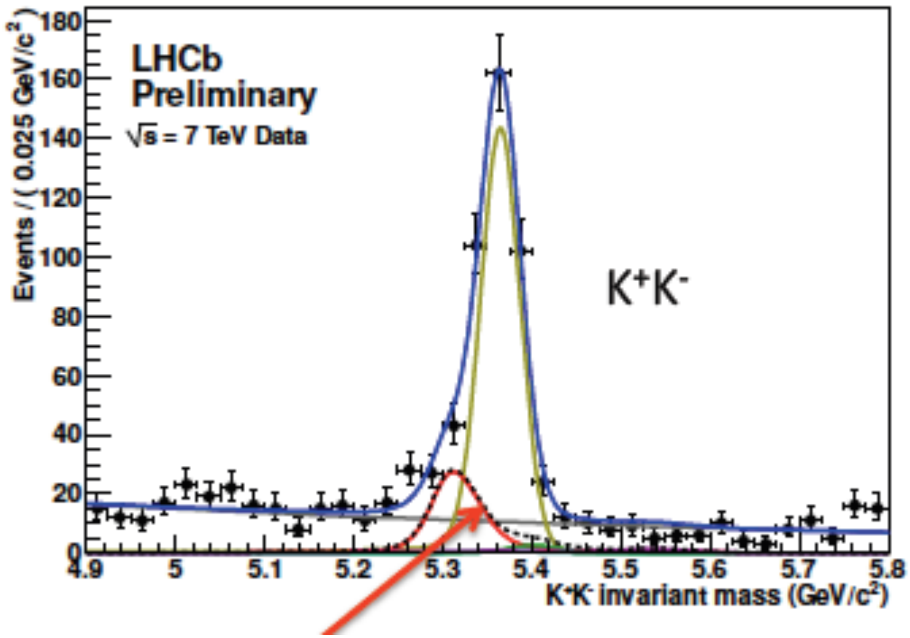
Meanwhile make a test with $B \rightarrow \pi\pi$ and $B_s \rightarrow KK$

Large penguin contribution in both $B_s \rightarrow KK$ & $B_d \rightarrow \pi\pi$
→ Sensitive to NP effects in time-dependent CP asymmetries (exploit U-spin symmetry)

R.Fleischer, Phys.Lett. B459, 306 (1999)





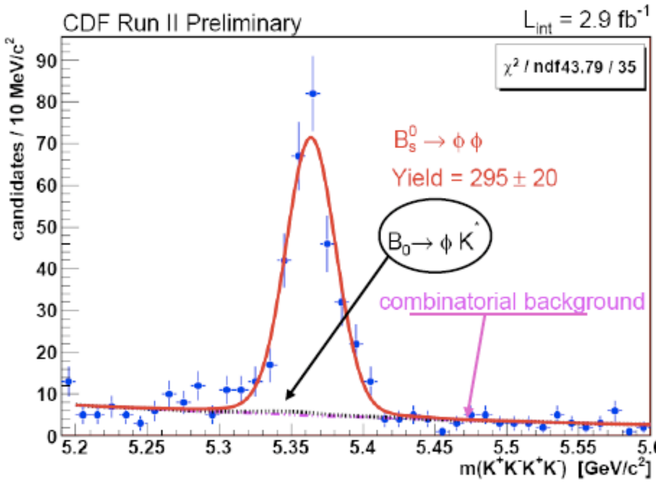


- *LHCb yields: 275±24 $B_d \rightarrow \pi^+\pi^-$ & 333 ± 21 $B_s \rightarrow K^+K^-$ in 37 pb^{-1}*
  c.f. CDF in 1 fb^{-1} 1121±63 $B_d \rightarrow \pi^+\pi^-$ and 1307±64 $B_s \rightarrow K^+K^-$

- *Expect first time-dependent measurements in 2011/2012*
  (including measurement of B_s lifetime in CP-even K^+K^- final state

CDF: First search for CPV in $B_s \rightarrow \phi\phi$

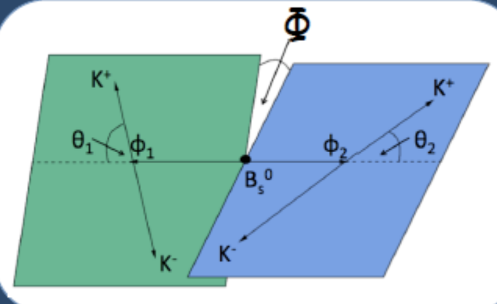
Look for asymmetry in the distributions of CP-odd variables (triple-products) → Ingenious way to measure CPV with low stat. samples before any tagged analysis !



Experimentally accessed by asymmetry of distribution of two angular functions

$$u = \cos\Phi \sin\Phi \longrightarrow A_{||}A_{\perp}$$

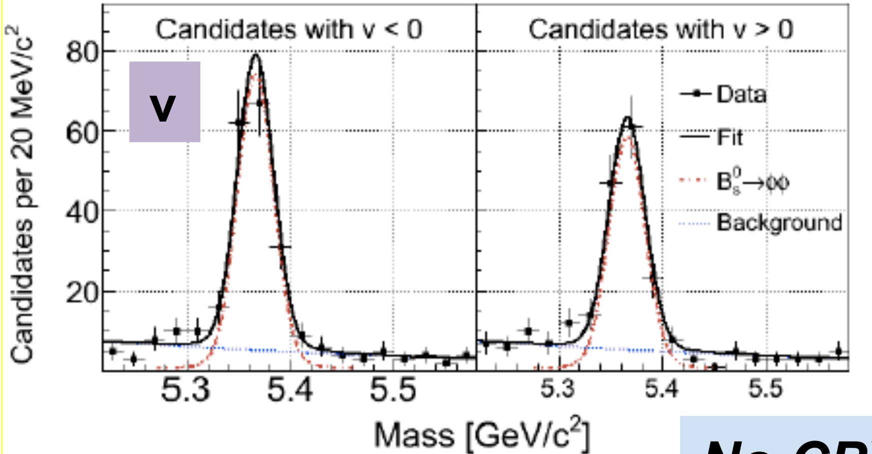
$$v = \begin{cases} \sin\Phi & \text{if } \cos\vartheta_1 \cos\vartheta_2 > 0 \\ \sin(-\Phi) & \text{if } \cos\vartheta_1 \cos\vartheta_2 < 0 \end{cases} \longrightarrow A_0 A_{\perp}$$

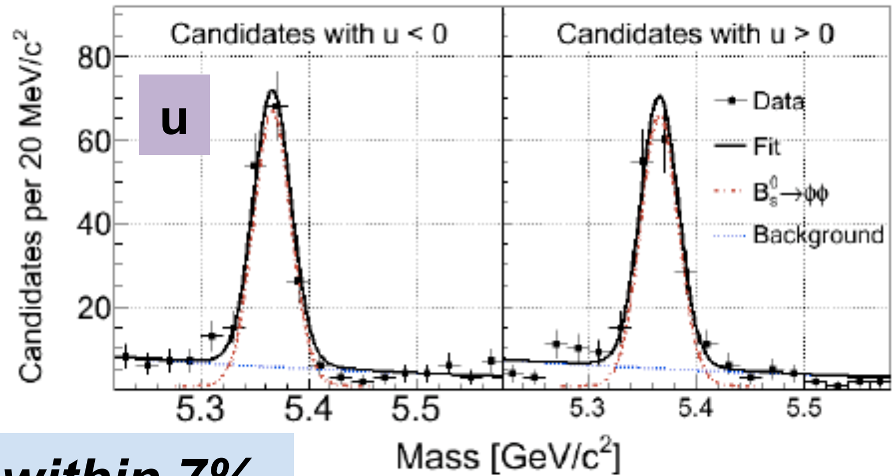


A_u= (-0.8 ± 6.4(stat.) ± 1.8(syst.))%

A_v=(-12.0 ± 6.4(stat.) ± 1.6(syst.))%

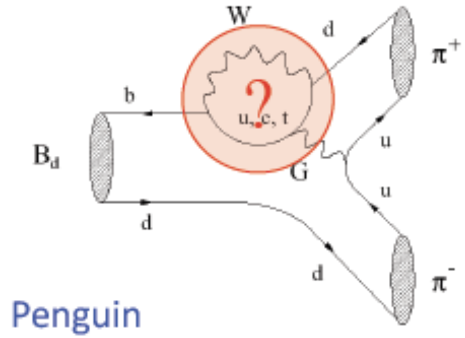
$$\propto \sin\varphi_{weak} \cos\delta_{strong}$$ ≈ 0 in SM





No CPV within 7%

Penguin Diagrams: direct CP violation in $B_{d,s}$

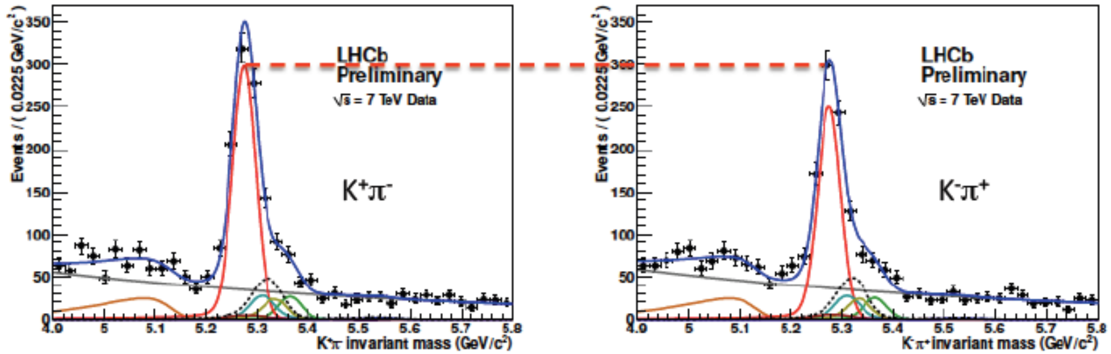


Direct A_{CP} in 2-body B decays have been measured by the B-factories and CDF

- *CP violation is well established in $B^0 \rightarrow K^+\pi^-$ (Average A_{CP}=$-0.098\pm^{0.012}_{0.011}$)*
- *$A_{CP}(B_s \rightarrow \pi^+K^-) = 0.39\pm0.15\pm0.08$ (CDF with 1 fb^{-1})*

As seen by LHCb:

Raw CP asymmetry in $B^0 \rightarrow K\pi$ decays: -0.086 ± 0.033

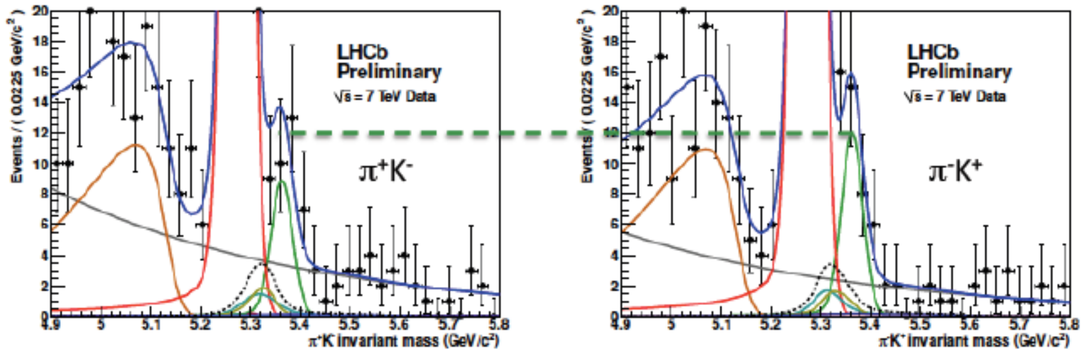


LHCb preliminary:

$$A_{CP}(B^0 \to K^+\pi^-) = -0.074 \pm 0.033 \pm 0.008$$

$$A_{CP}(B^0_s \to \pi^+K^-) = 0.15 \pm 0.19 \pm 0.02$$

Raw CP asymmetry in $B_s \rightarrow \pi K$ decays: 0.15 ± 0.19



Penguin Diagrams (prospects with charm): LHCb

- *Time integrated CPV asymmetries in D→hh' decays:* $A_{CP}(f) = \frac{\Gamma(D^0 \to f) - \Gamma(\overline{D}^0 \to \bar{f})}{\Gamma(D^0 \to f) + \Gamma(\overline{D}^0 \to \bar{f})}$

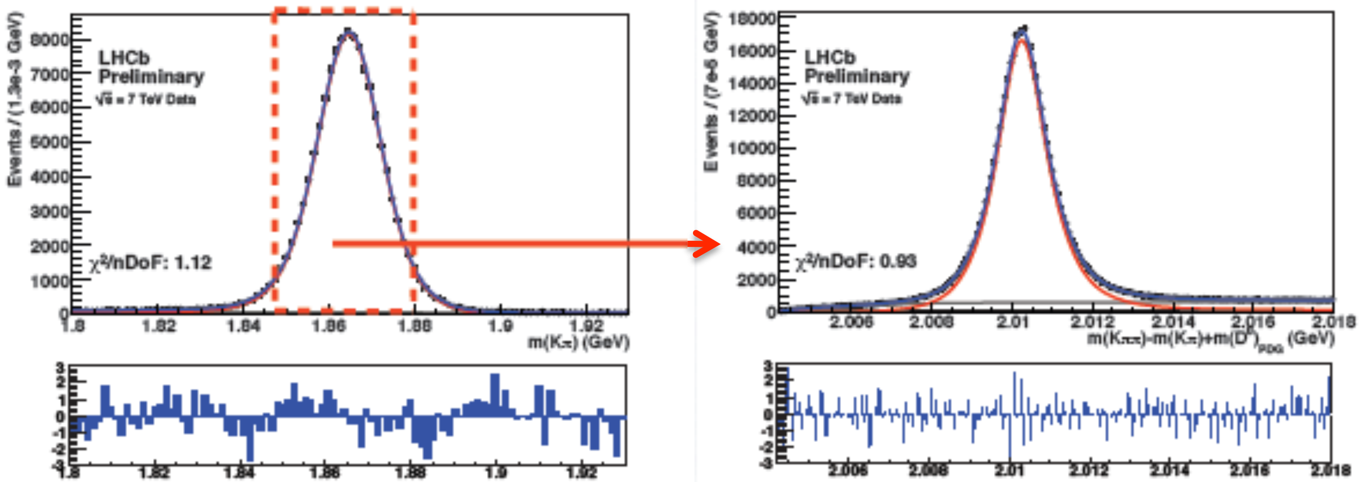
Expect mixing induced CPV to cancel out in the difference as well as many other systematics (e.g. production and tracking asymmetries):

$A_{CP}(KK) - A_{CP}(\pi\pi) = A_{CP}^{RAW}(KK)^* - A_{CP}^{RAW}(\pi\pi)^*$ *(very clean measurement !)*

Sensitivity to penguins is retained !

Measure raw asymmetries in flavour tagged samples

$$A_{CP}^{RAW}(f)^* = \frac{N(D^{*+} \to D^0(f)\pi^+) - N(D^{*-} \to \overline{D}^0(\bar{f})\pi^-)}{N(D^{*+} \to D^0(f)\pi^+) + N(D^{*-} \to \overline{D}^0(\bar{f})\pi^-)}$$



$A_{CP}(KK) - A_{CP}(\pi\pi)$ = -0.275 ± 0.701 ± 0.250)%

Expect a factor 5 better sensitivity with 2011 data

Current status: Rare Decays and their helicity structure

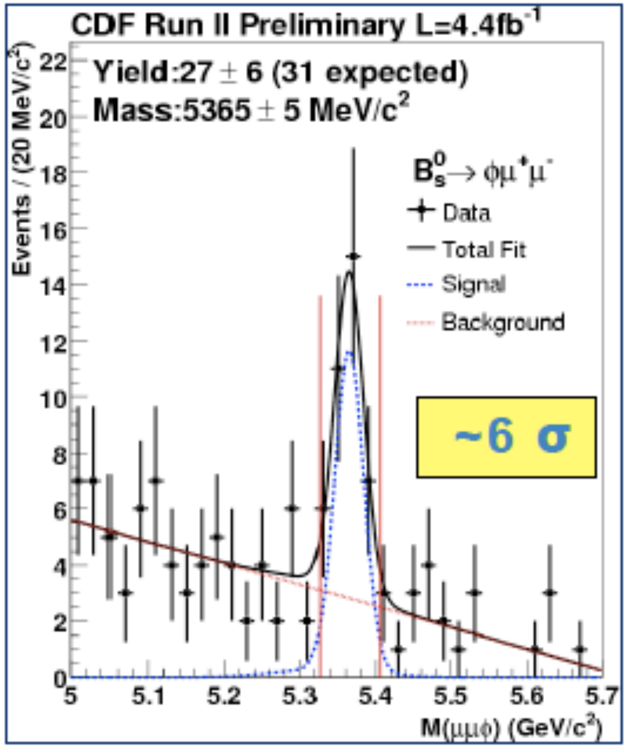
By far not fully representative list of topics:

To measure accurately the rates and perform a search:

- *$B \to \tau\nu$, $K^*\nu\nu$, etc. (e^+e^- factories are unique to study such decays)*
- *$b \to s\gamma$ (e^+e^- -factories)*
- *Search for FCNC at the tree level*
- *Search for $B_{s,d} \to \mu\mu$ (hadron colliders)*

To measure helicity structure of the amplitudes

- *$B_d \to K^*\mu\mu$, $B_s \to \phi\mu\mu$ (possibility of the CPV analysi with larger data sample)*
- *$B_s \to \phi\gamma$, $B \to K^*e^+e^-$, $B_d \to K^*(K_s\pi^0)\mu\mu$*

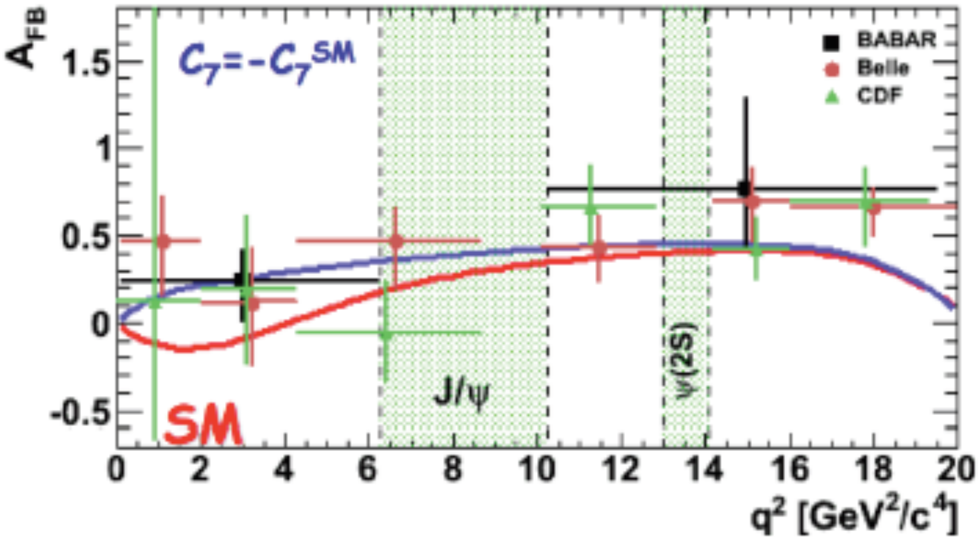


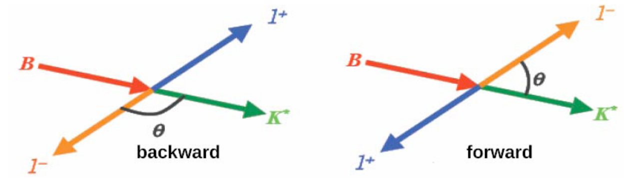
$BR(B_s \to \phi\mu\mu) = [1.44 \pm 0.33(stat) \pm 0.46(syst)] \times 10^{-6}$

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

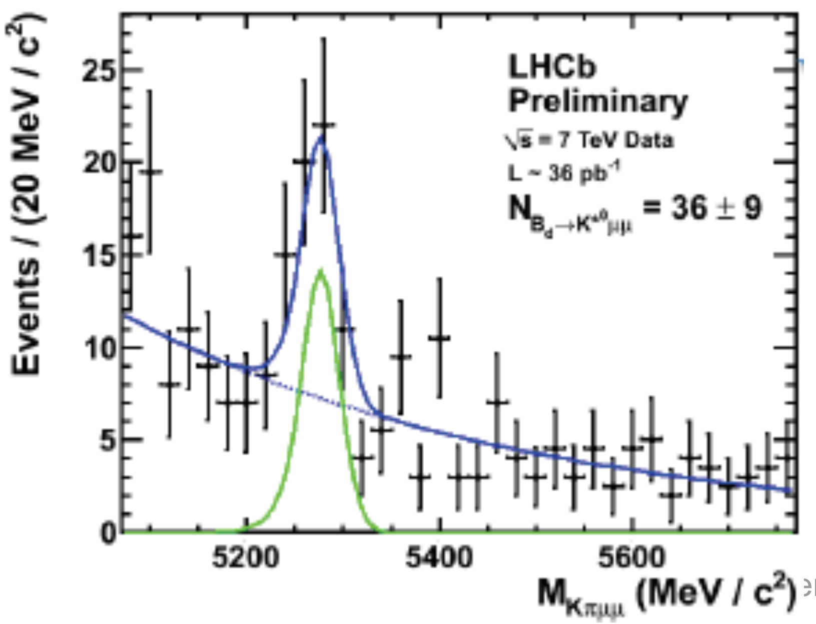
Forward backward asymmetry, A_{FB}, is extremely powerful observable for testing SM vs NP
Intriguing hint is emerging !!!

$$A_{FB}\left(s = m^2_{\mu^+\mu^-}\right) = \frac{N_F - N_B}{N_F + N_B}$$





- *BELLE, BaBar and CDF consistent with each other and SM*
- *Flipped C_7 scenario looks however more favoured from A_{FB} data*



- *With 1 fb^{-1} LHCb expects ~1400 events, and should clarify existing situation. Expected accuracy in **A_{FB} zero crossing point is ~0.8 GeV^2 in 1 fb^{-1}***

$B_s \to \mu\mu$
Current status and prospects

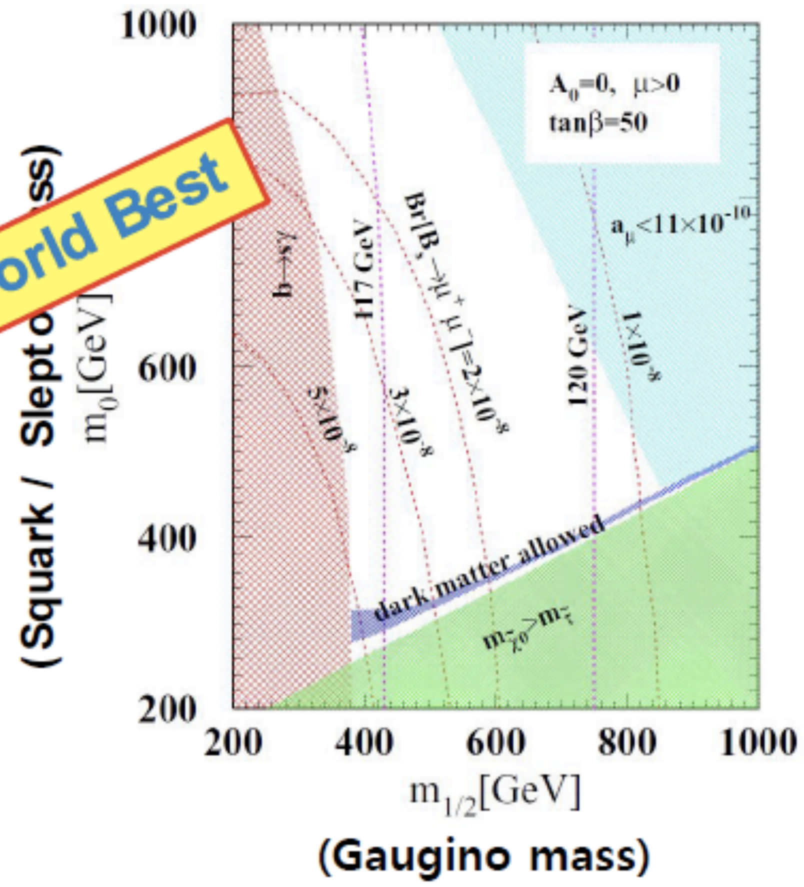
BR($B_s \to \mu\mu$) @ 95% CL

< 4.3×10^{-8} (3.7 fb^{-1})
CDF public note 9892

< 5.1×10^{-8} (6.1 fb^{-1})
PLB 693 539 (2010)

< 5.6×10^{-8} (0.036 fb^{-1})
arXiv:1103.2465v1

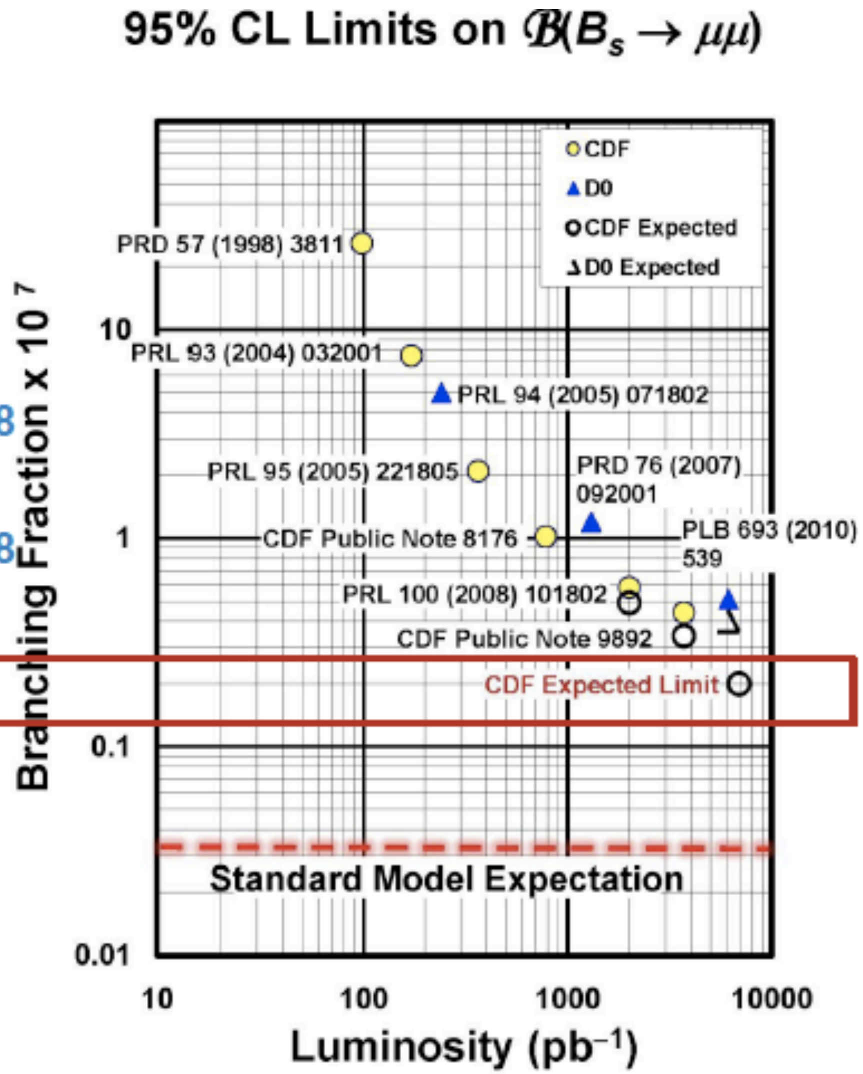
World Best



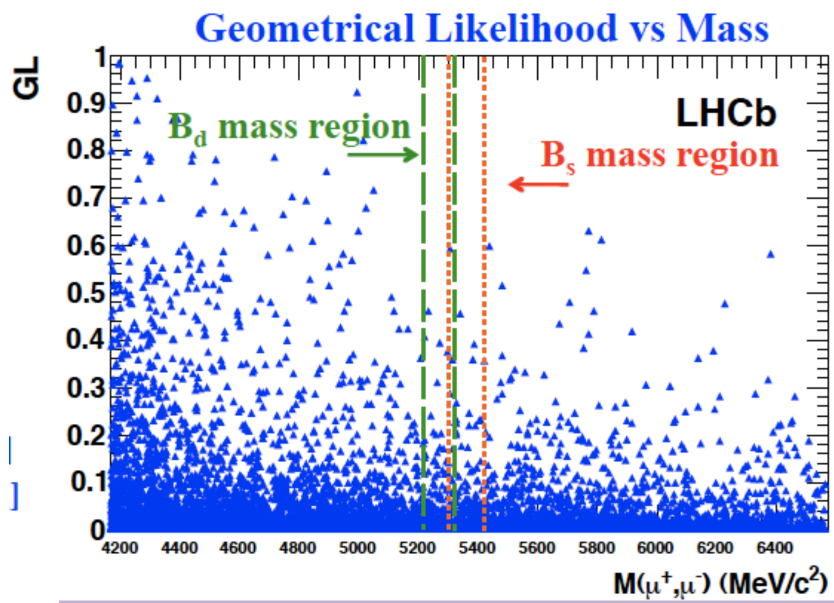
New improved CDF analysis

- *Twice larger data sample ~7 fb^{-1}*
- *Increased muon acceptance*
- *New Neural Network with improved signal efficiency*
- *Better background prediction*

	Expected	Observed
■ 2.0 fb^{-1} :	4.9×10^{-8}	5.8×10^{-8}
■ 3.7 fb^{-1} :	3.4×10^{-8}	4.4×10^{-8}
■ 6.9 fb^{-1} :	$\sim2\times10^{-8}$	



LHCb current limit is based on zero events in the most sensitive GL bins: BR($B_s \to \mu\mu$) < 5.6×10^{-8} @ 95% CL (37 pb^{-1} of 2010 data)



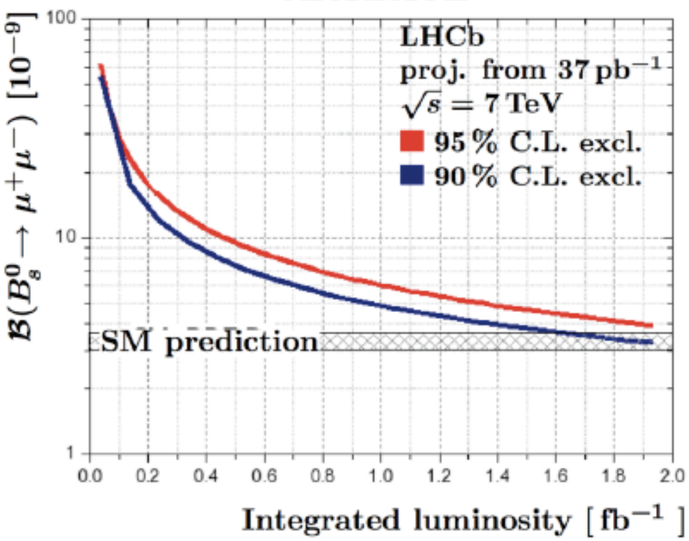
Observed distribution of events

		GL bin			
		[0, 0.25]	[0.25, 0.5]	[0.5, 0.75]	[0.75, 1]
Mass bin (MeV/c^2)	[−60, −40]	39	2	1	0
	[−40, −20]	55	2	0	0
	[−20, 0]	73	0	0	0
	[0, +20]	60	0	0	0
	[+20, +40]	53	2	0	0
	[+40, +60]	55	1	0	0
sum		335	7	1	0
bkg exp.		329	7.36	1.51	0.081

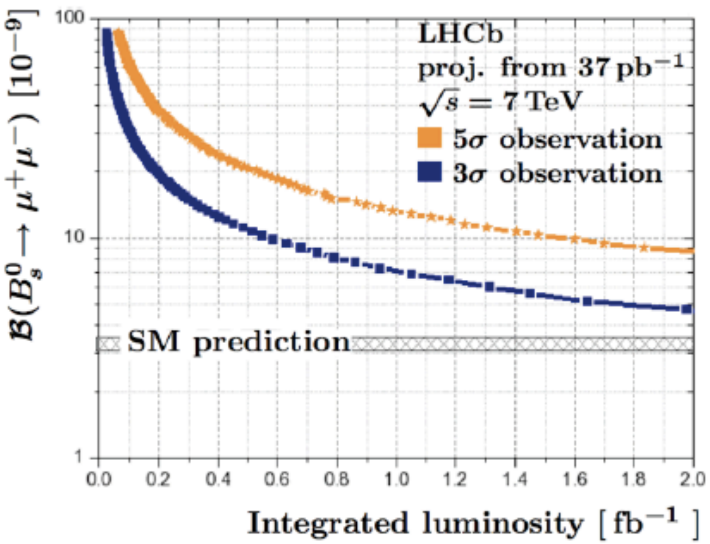
LHCb prospects for the 2011/2012 LHC Run

ATLAS and CMS in particular should be very competitive !!!

exclusion



observation



Very exciting sensitivity expected !

Conclusions

- *Thanks to the excellent performance of the LHC machine and detectors there are exciting prospects in the nearest future !*

  - Increase of LHC data by a factor of ~ 30 / 100 for LHCb / ATLAS & CMS in 2011

- *Also significant updates are expected from CDF / D0 & BELLE / BaBar*

- ***Very interesting sensitivity reach is guaranteed !***

  - $B_s \rightarrow \mu\mu$
  - ϕ_s in $B_s \rightarrow J/\psi\phi$
  - A_{FB} in $B_d \rightarrow K^*\mu\mu$