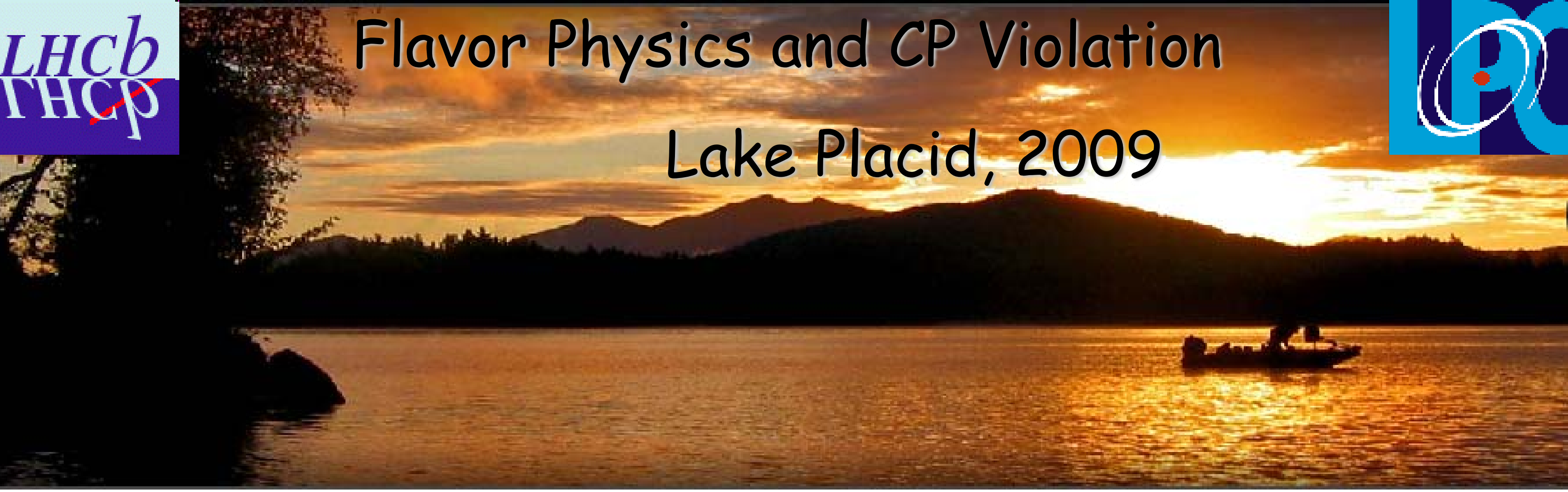

Flavor Physics Techniques and Sensitivities at LHCb

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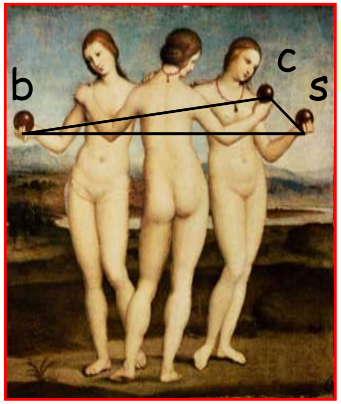
Laboratoire de Physique Corpusculaire de Clermont-Ferrand
Université Blaise Pascal & IN2P3/CNRS

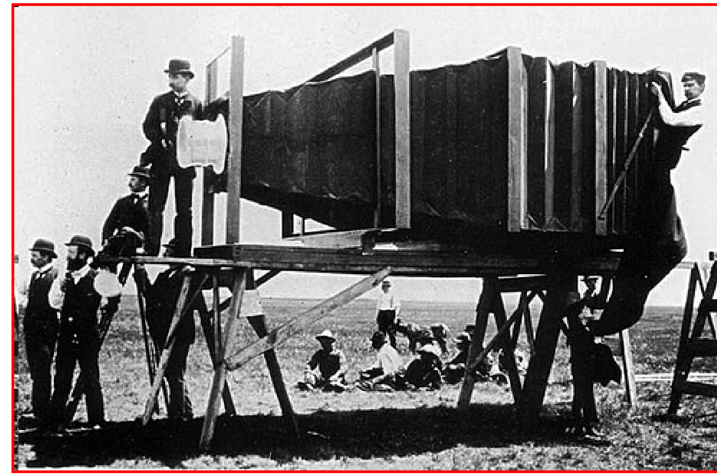
On behalf of the LHCb collaboration

Outline



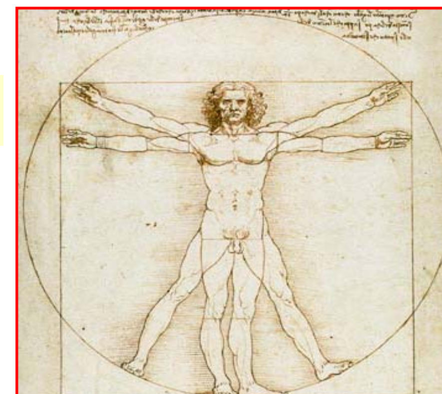
1- Flavour physics : state of the art

2- The LHCb detector

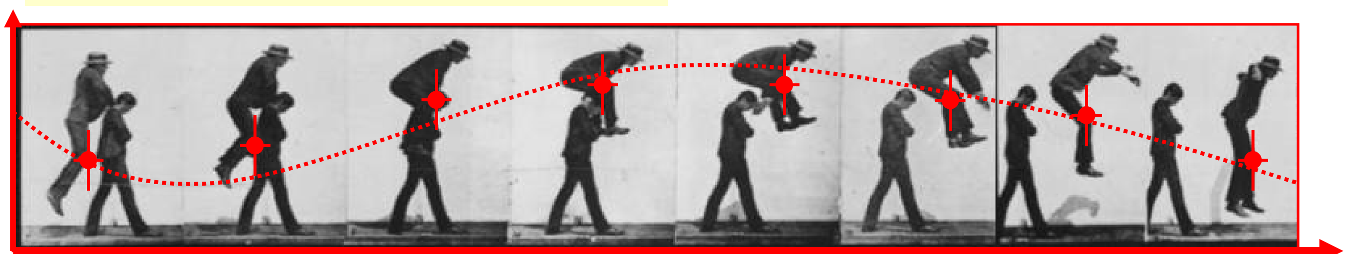


3- LHCb trigger strategy

4- Resolving the event topology



5- Probing the decay dynamics



I- CKM metrology : state of the art

Quark flavour physics described
by the KM mechanism within Standard Model

Current flavour data is consistent with this scheme

CKM metrology lesson :

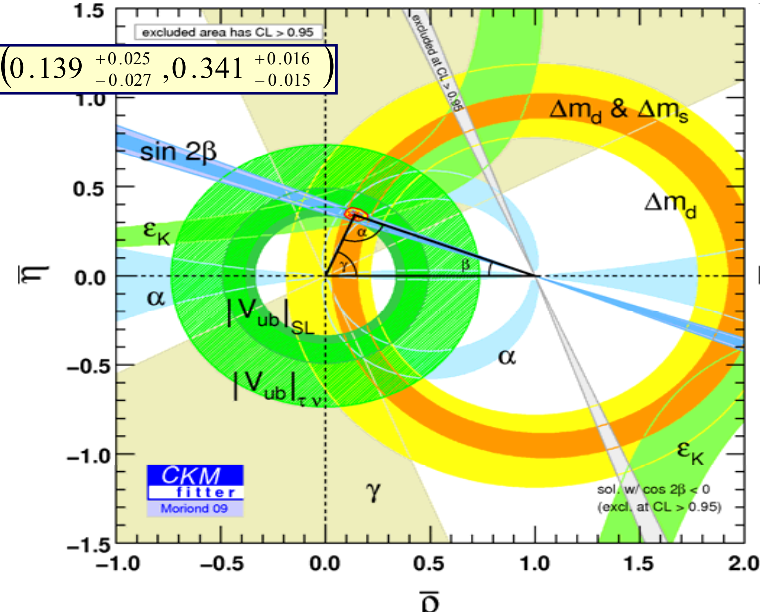
The KM mechanism IS the dominant source of CP violation in the B_d and B_s system

$B_{(s)}$ Unitarity triangles apex :

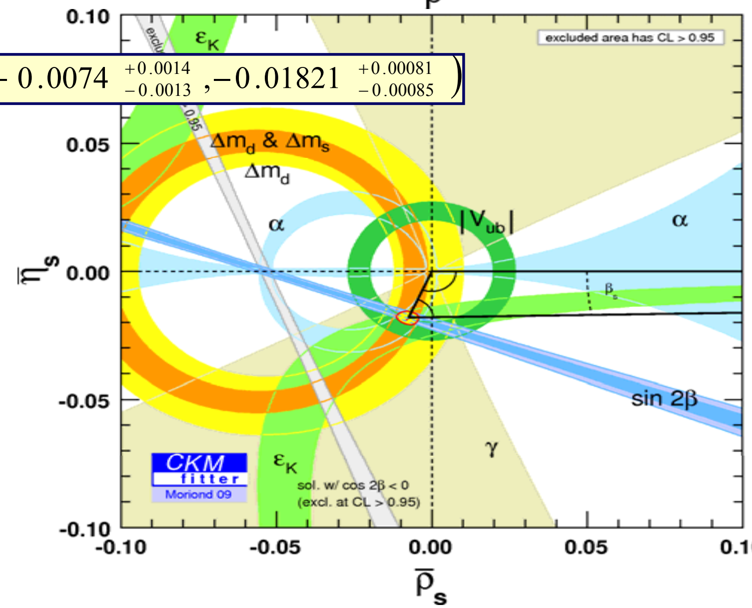
$$\frac{\sigma_{\bar{\eta}}}{\bar{\eta}} \approx \frac{\sigma_{\bar{\eta}_s}}{\bar{\eta}_s} \approx 4.5\%$$

$$\frac{\sigma_{\bar{\rho}}}{\bar{\rho}} \approx \frac{\sigma_{\bar{\rho}_s}}{\bar{\rho}_s} \approx 18\%$$

$$(\bar{\rho},\bar{\eta}) = \left(0.139\,^{+0.025}_{-0.027}, 0.341\,^{+0.016}_{-0.015}\right)$$



$$(\bar{\rho}_s,\bar{\eta}_s) = \left(-0.0074\,^{+0.0014}_{-0.0013}, -0.01821\,^{+0.00081}_{-0.00085}\right)$$



I- CKM metrology : state of the art

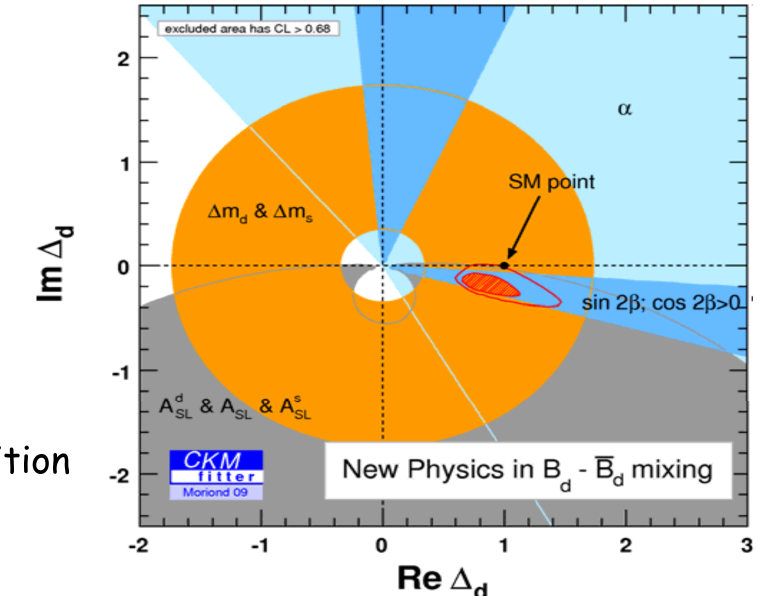
… but still room for sizeable contribution from New Physics

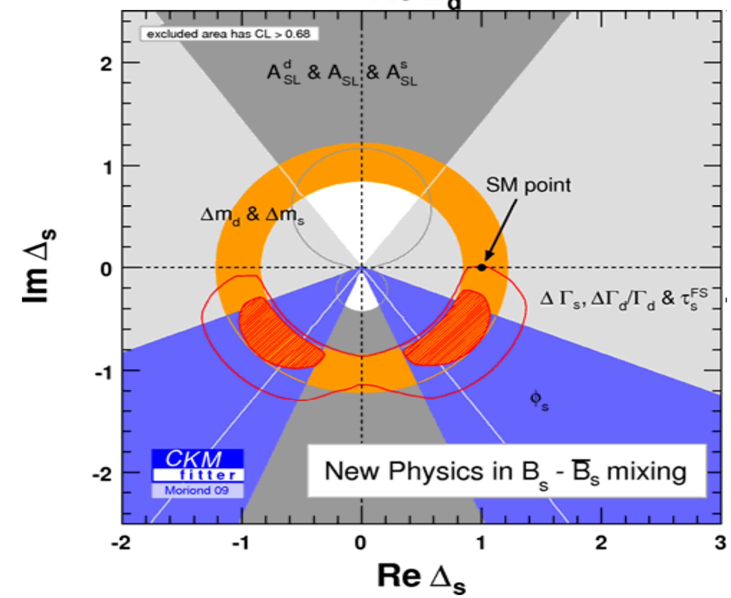
e.g. : model independent parametrization for NP in ΔF=2 transition

$$\langle B_q^0 | M_{12}^{SM+NP} | \overline{B}_q^0 \rangle \equiv \Delta_q^{NP} \cdot \langle B_q^0 | M_{12}^{SM} | \overline{B}_q^0 \rangle$$

$$\Delta_q^{NP} = \mathrm{Re}(\Delta_q) + i\ \mathrm{Im}(\Delta_q) = |\Delta_q| e^{i\phi^{\Delta_q}} = r_q^2 e^{2i\theta_q} = 1 + h_q e^{2i\sigma_q}$$

The prefered (SM+NP) Δ^{NP} value is currently ~ 2σ from SM for both B_d and B_s systems

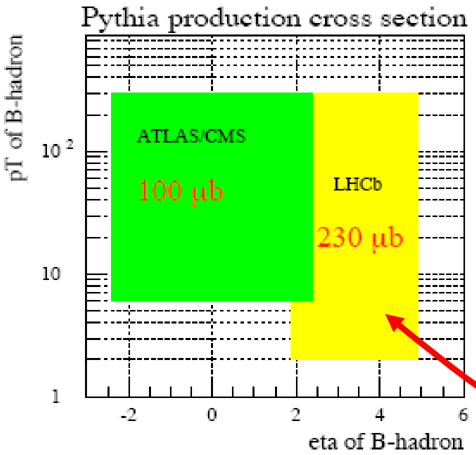


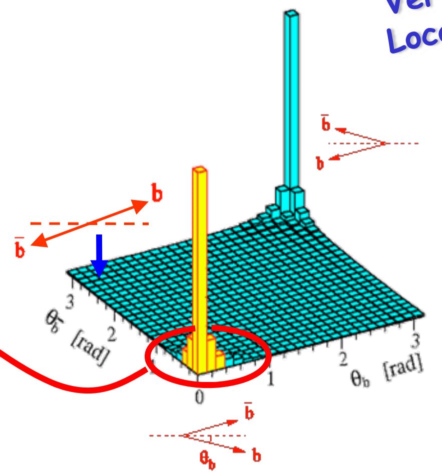


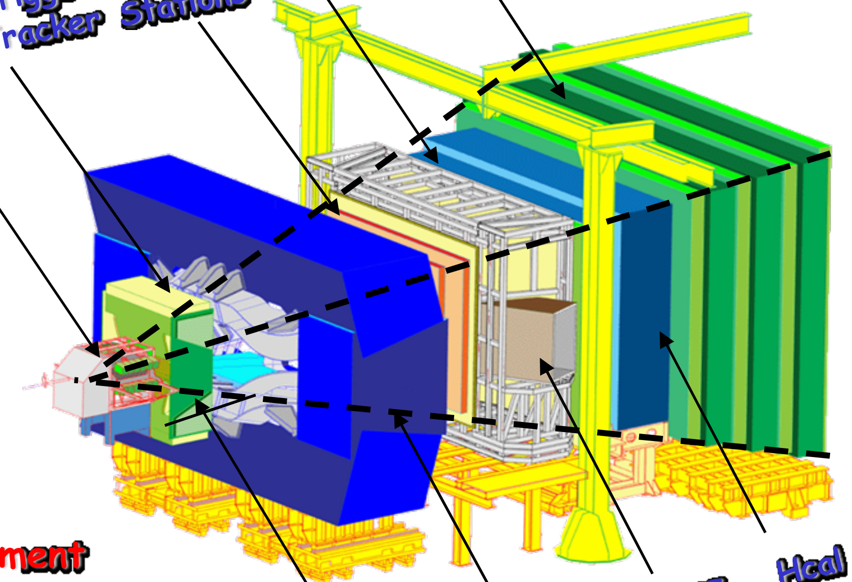
[FPCP09 Update of CKM fits on Monday in Valentin Niess talk]

II - The LHCb detector

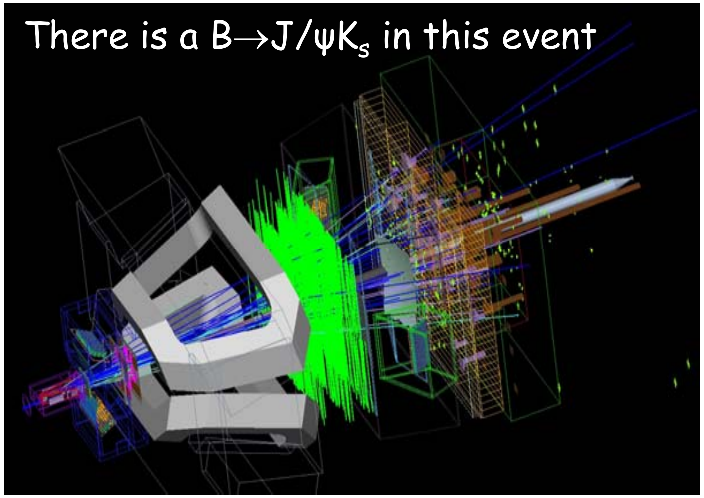
- LHCb detector : single arm forward spectrometer
  - $1.9 < \eta < 4.9$







- Main challenge :
  - Perform precision measurements in hadronic environment



- Large multiplicity : ~30 particles for hard pp collisions
- Background from high inelastic X-section of 80 mb
- Small Branching Ratio for B meson decay

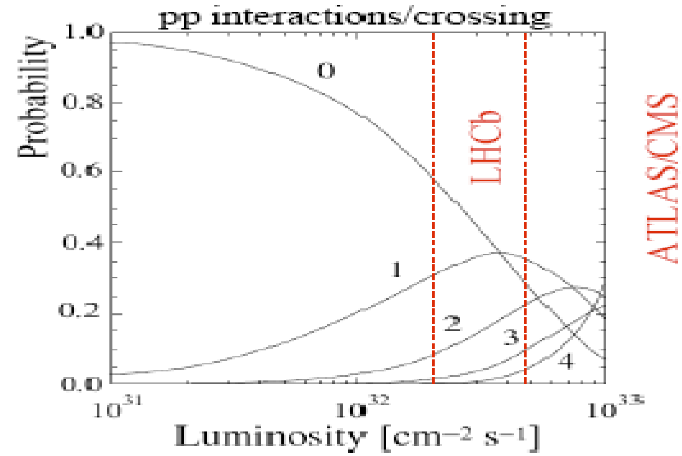
... but ...

- 100 kHz bb rate
- Access to all b species : B_d, B_u, B_s, B_c, Λ_b, Ξ_b...

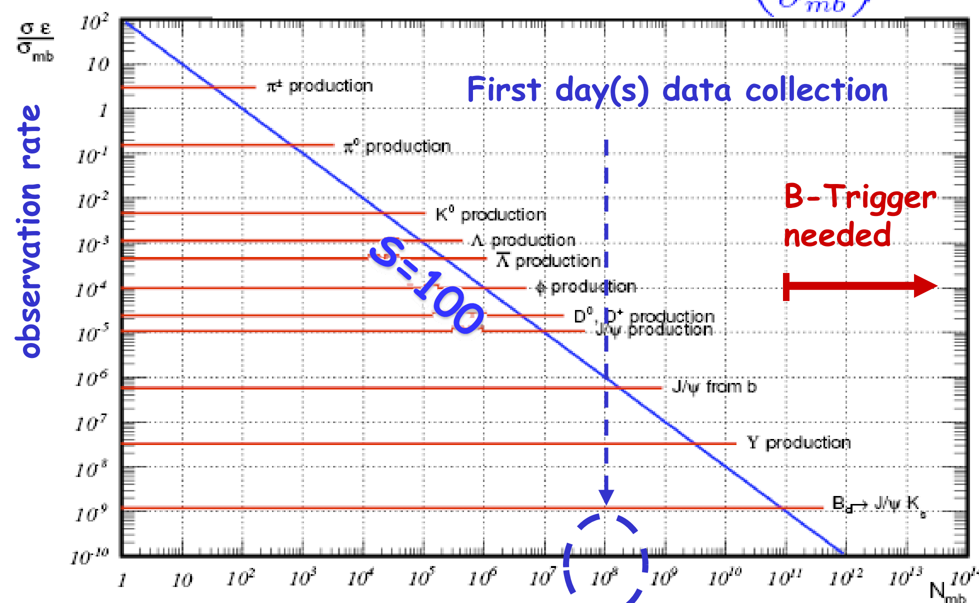
LHCb environment at LHC

- Nominal LHC conditions
  - ô s = 14 TeV
  - Crossing rate 40 MHz
  - bunch filling ~ 75%
  - Optimize for single pp-interactions
    → less focusing for LHCb : $L = 2 \times 10^{32}\ cm^{-2} s^{-1}$
  - Nominal year : $\int L\, dt = 2 fb^{-1}$
    → 10^{12} bb produced
- 2009/2010 operations
  - ô s = 8-10 TeV
  - bunch filling up to 12%
  - up to $L = 1.9 \times 10^{32}\ cm^{-2} s^{-1}$
  - first year : $\int L\, dt = 200\ pb^{-1}$

Minimum bias trigger in early running

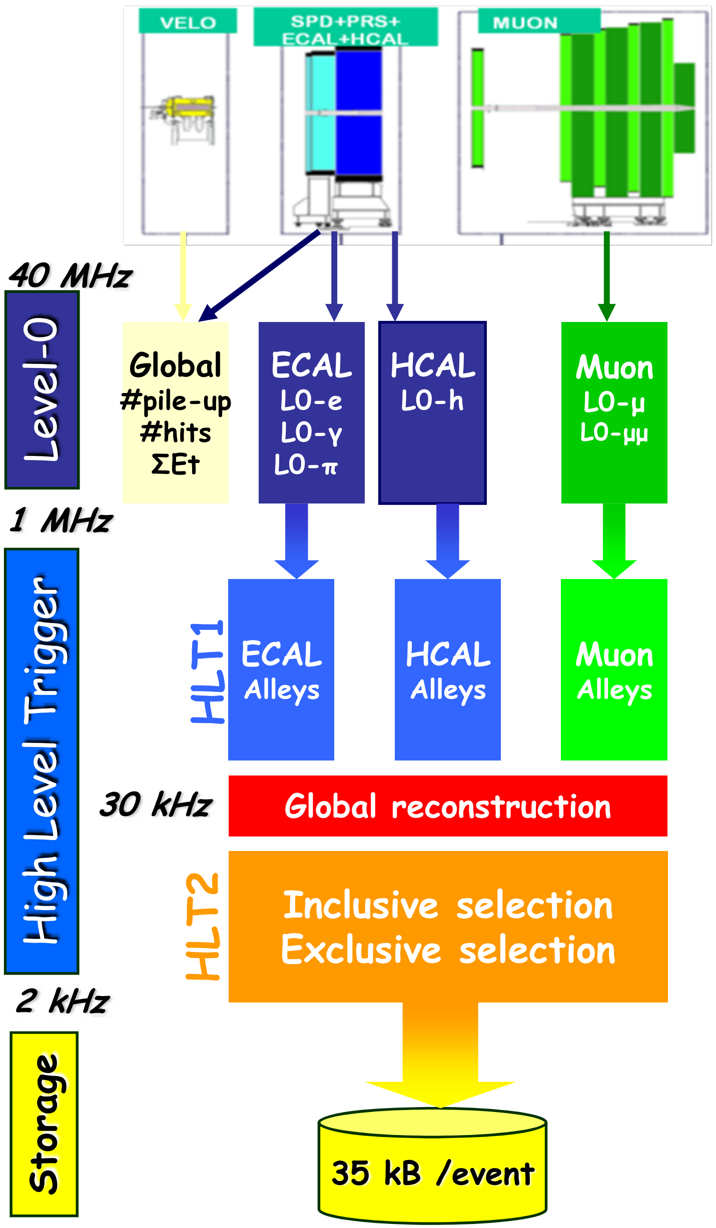


$$\log_{10} N_{mb} = \log_{10} S - \log_{10}\left(\frac{\sigma\varepsilon}{\sigma_{mb}}\right)$$



« Minibias statistics to perform a 10% measurement »

III- The LHCb Trigger



Level-0 Trigger (Hardware)

- Fully synchronous (40 MHz) custom electronics
  - Visible interaction rate 10 MHz → 1MHz

- Identification of highest P_T : h, e, γ, π and μ candidates
  - typical threshold : μ ~ 1 GeV/c - h, e, γ, π ~ 3-4 GeV/c
  - typical bandwdith : Hadron/Ecal/Muon ~ 700/200/100 kHz

High-Level Trigger (Software)

- 2000 multi-processor boxes farm.

- **HLT1 :**
  - confirm L0 candidates with more info (tracking, Velo)
  - add impact parameter and lifetime cuts

- **HLT2 :**
  - global event reconstruction + selections

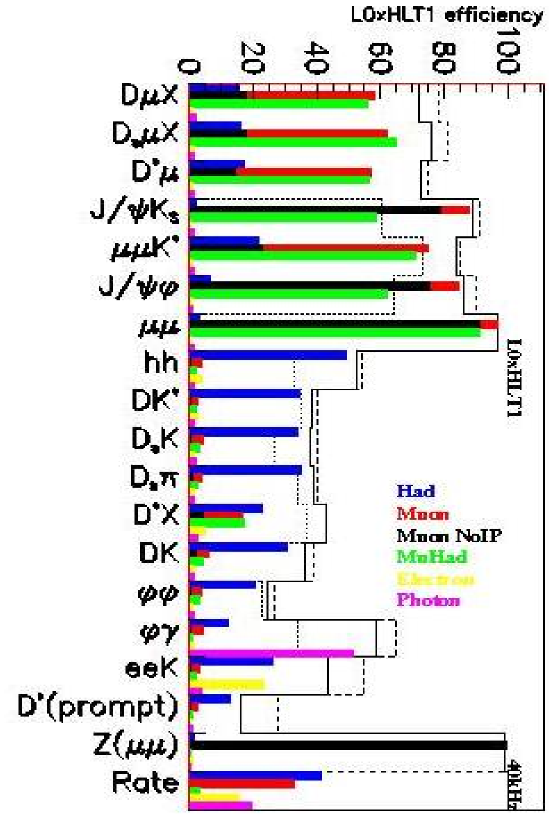
Storage @ 2 kHz

Triggering strategy

- Trigger performance

	e(L0)	e(HLT)	e(total)
Hadronic	50%	80%	40%
Electromagnetic	70 %	60%	40%
Muon	90%	80%	70%

e corrected for acceptance and selection

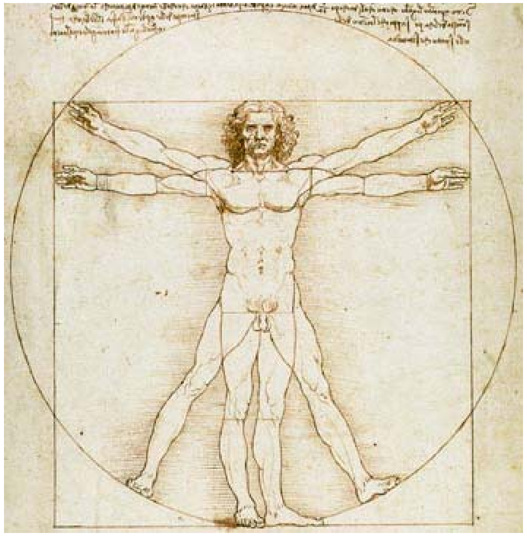


- Trigger output rate: 2kHz

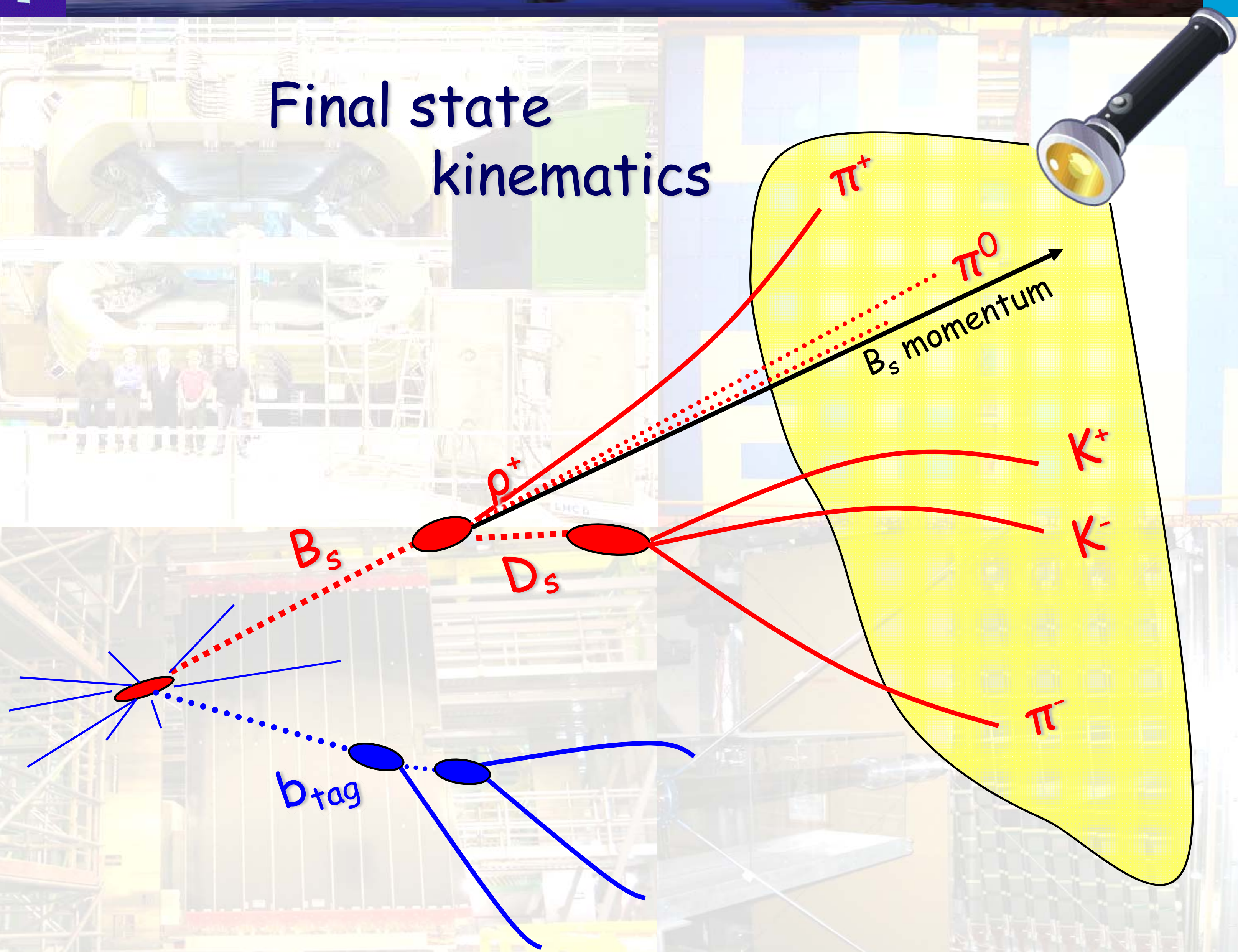
HLT rate	Event type	Purpose
200 Hz	Exclusive B selections	B (core program)
900 Hz	Inclusive b (e.g. b→μ) opposite-B unbiased	Trigger efficiency data mining
600 Hz	High mass di-muons *lifetime unbiased*	J/ψ(μμ) , $B_{(s)}$-> J/ψ(μμ) X Proper time resolution, alignment, momentum calibration
300 Hz	Inclusive D* *PID unbiased*	Charm physics PID performance

IV- Resolving the event topology

- kinematics reconstruction
- particle identification
- proper-time measurement
- flavour tagging

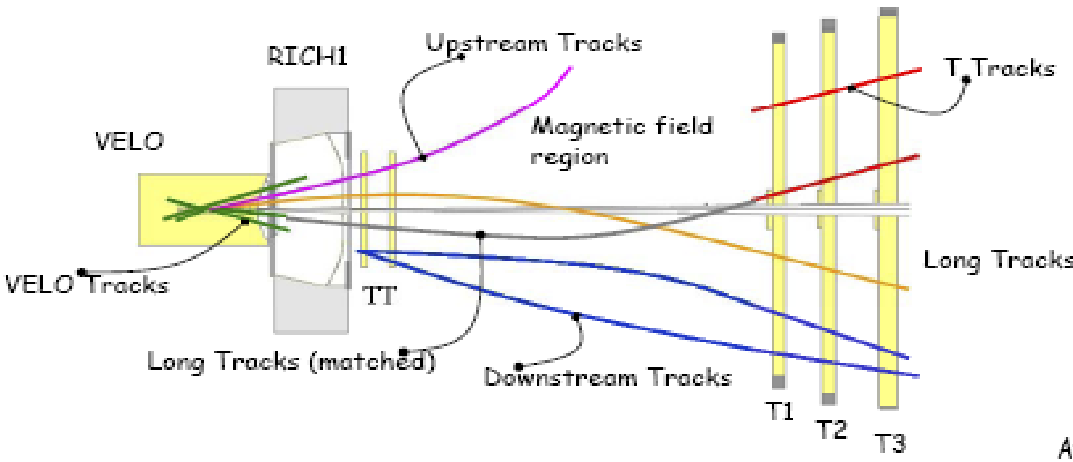


Resolving the event topology



Resolving the event topology

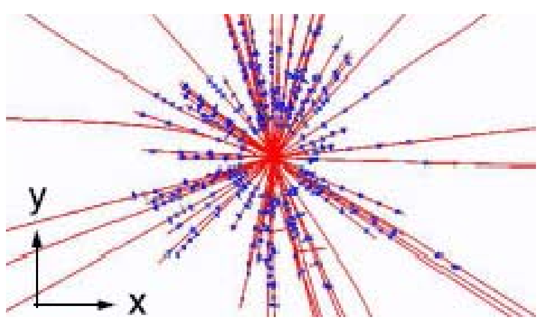
- Tracking
  - track configurations in LHCb spectrometer

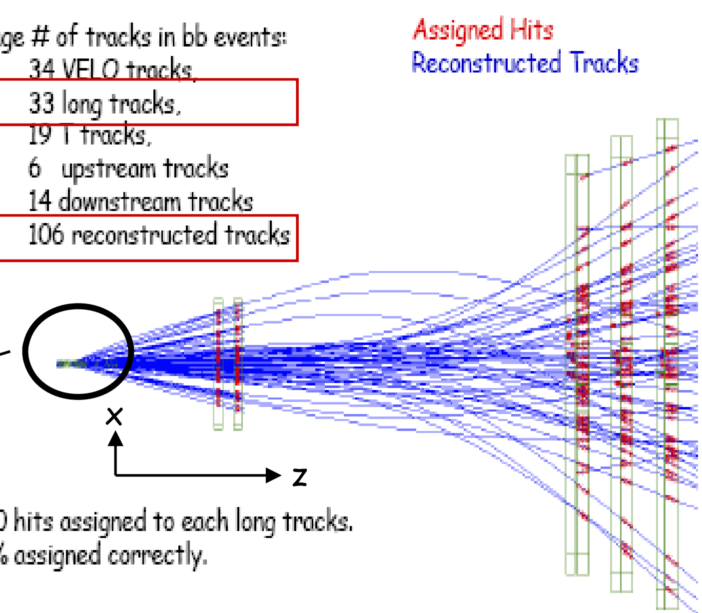


Velo tracks:	→	Used to find primary vertex.
Long tracks:	→	Used for most physics studies: B decay products.
T tracks:	→	Improve RICH2 performance.
Upstream tracks:	→	Improve RICH1 performance, moderate p estimate.
Downstream tracks:	→	Enhance K_s finding.

Average # of tracks in bb events:

	34 VELO tracks,
	33 long tracks,
	19 T tracks,
	6 upstream tracks
	14 downstream tracks
Total	106 reconstructed tracks

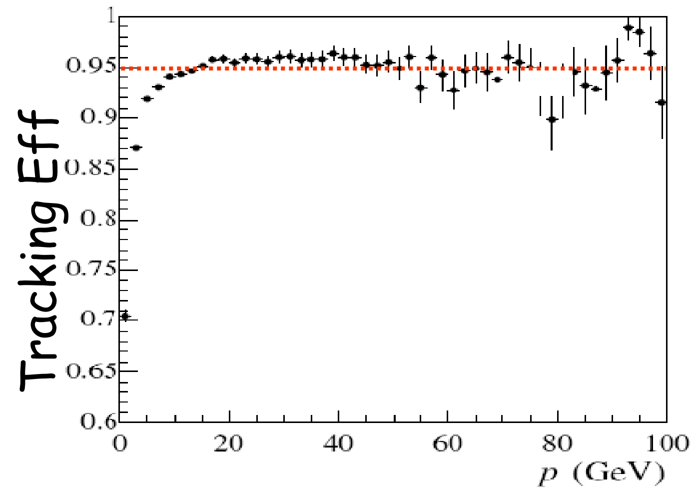


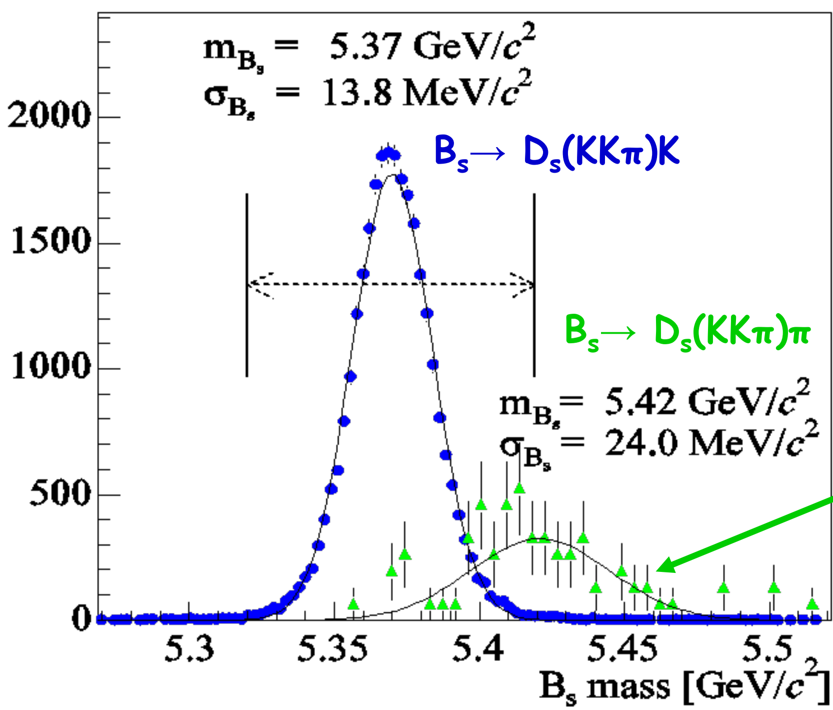


20-50 hits assigned to each long tracks.
98.7% assigned correctly.

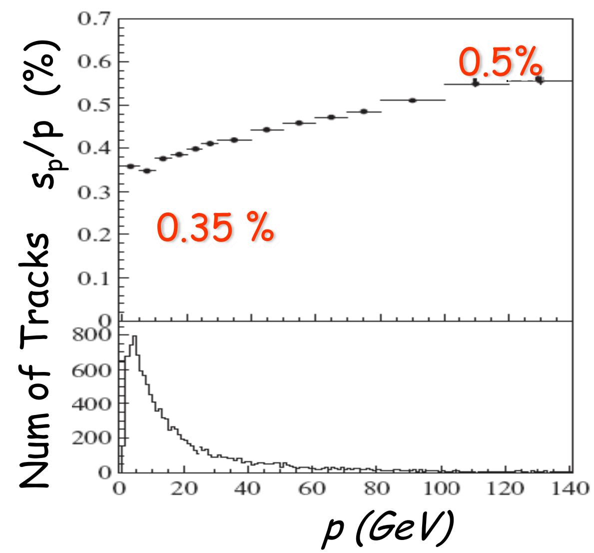
Resolving the event topology

- Expected tracking performances
  - Efficieny > 95% for tracks crossing the whole detector
  - $\delta p/p$: 0.3-0.5%
  - B mass resolution 10-20 MeV/c²



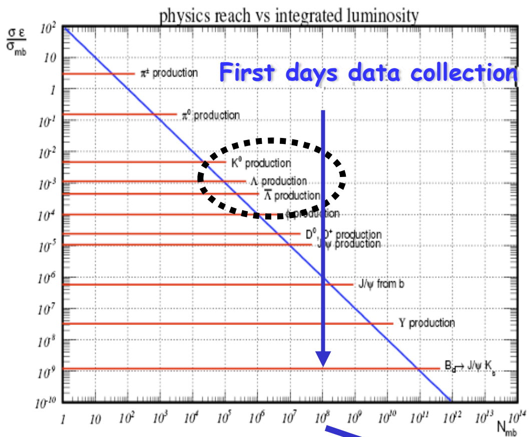


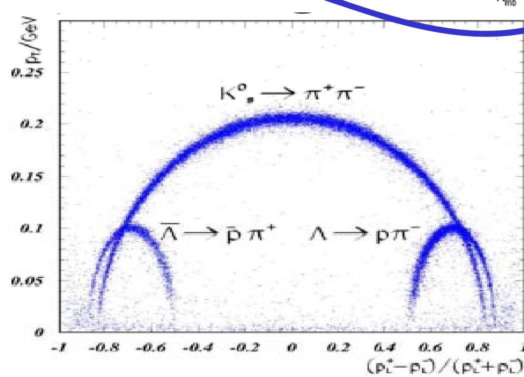
Remaining background from mis-ID $D_s\pi$ suppressed thanks to good mass resolution

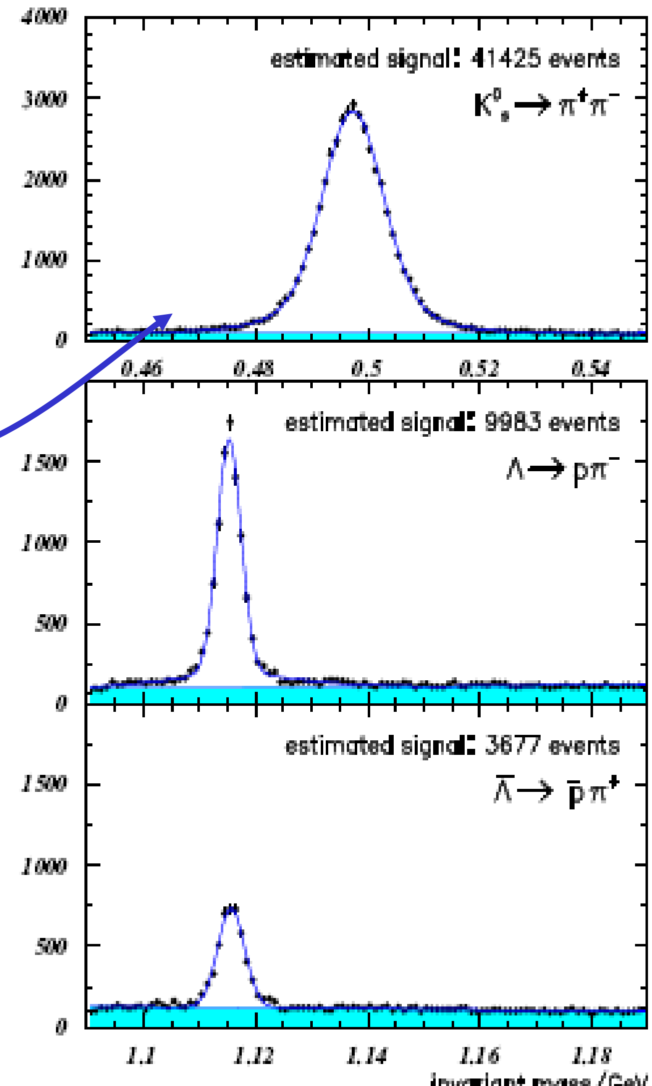


Resolving the event topology

- Strange V0 reconstruction
  - Plenty of $K_s \to \pi\pi$ and $\Lambda \to p\pi$ to be produced in pp collisions
  - Will be used for alignment, tracking and PID calibration with first data
  - e.g 95% purity with kinematical and vertex cuts only
    - clean & unbiased sample for RICH PID calibration
- Also useful in many analysis
  - $B \to J/\psi K_s$, $B^- \to D(K_s\pi^+\pi^-)K^-$, …
  - $\Lambda_b \to \Lambda\gamma$, $\Lambda_b \to \Lambda J/\psi$, …





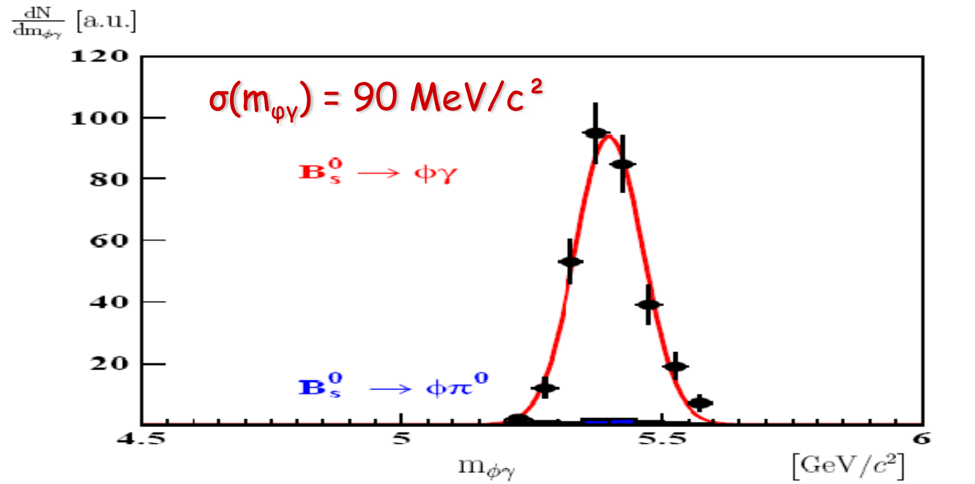


- K_s / Λ reconstruction
  - Reconstruction efficiency ~60%
  - ~1/3 long tracks pair – ~ 2/3 downstream tracks pair
  - Mass resolution of few MeV/c^2

[More details in the poster session : « LHCb V0 decays with first data » (Popovici Bogdan)]

Resolving the event topology

- Electromagnetic particles reconstruction
  - Ecal resolution : $\sigma_E/E = 10\%/\sqrt{E} \oplus 1\%$
  - Granularity : 1-3 Moliere radius
  - Material before Calorimeters : $0.7\ X_0$
- Photon reconstruction
  - Reconstruction efficiency ~ 70%
  - Radiative B decay mass resolution : 90 MeV/c²



- Neutral pion reconstruction
  - for $E_T < 2$ GeV the photons from π are well separated

    $\sigma(m_{\gamma\gamma})$ = 10 MeV/c²

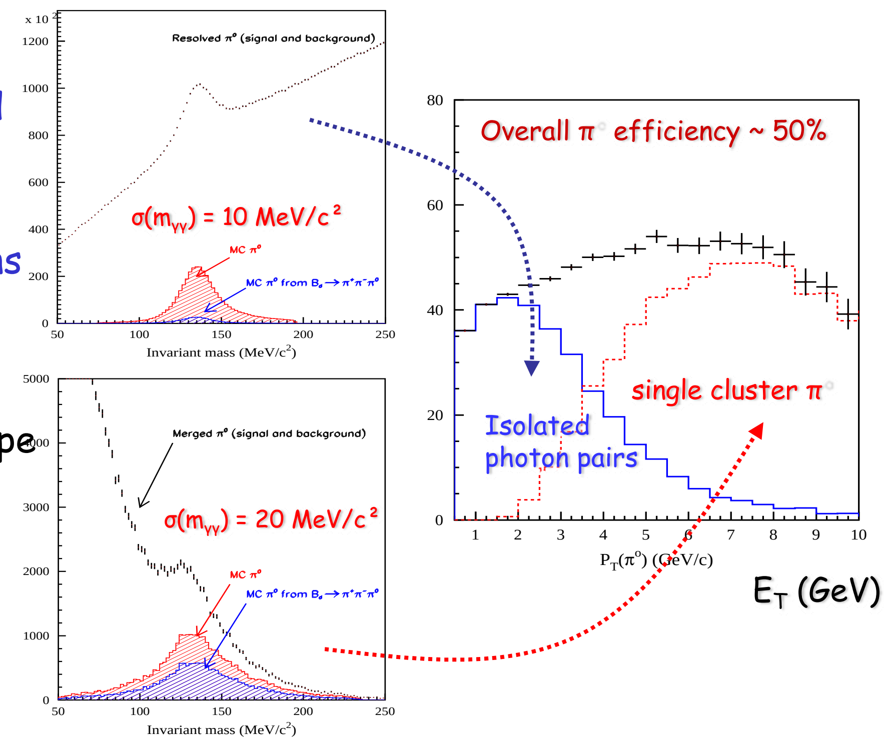
  - At higher energy the distance between the two photons becomes of the order of the Ecal pad size

    → 'single Ecal cluster' π s

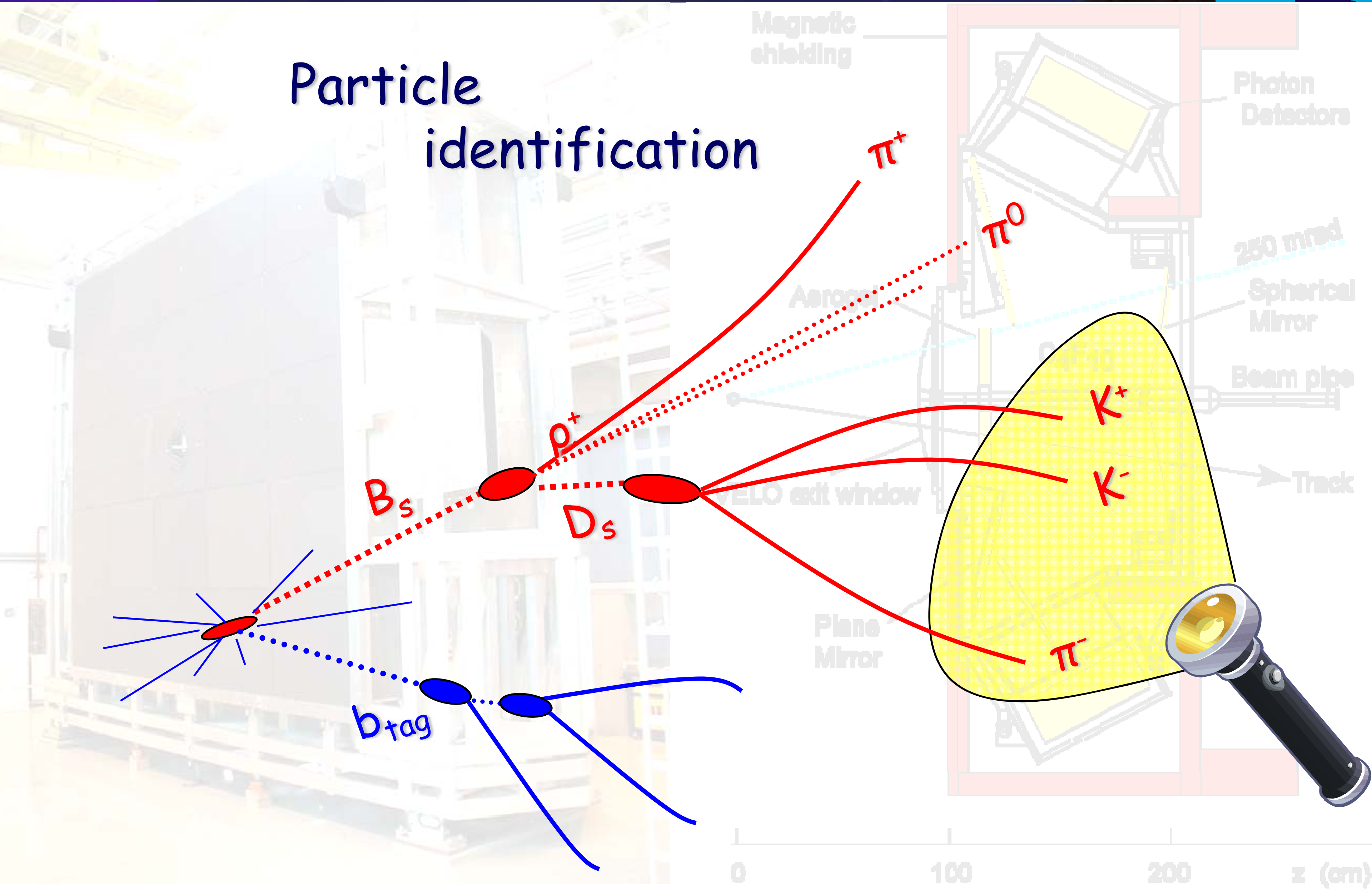
    → dedicated reconstruction of interleaved photon showers based on the expected photon transveral shape

    $\sigma(m_{\pi^0})$ = 20 MeV/c²

    → important for physics : e.g. represents 50% of π from $B_d \to \pi^- \pi^+ \pi$



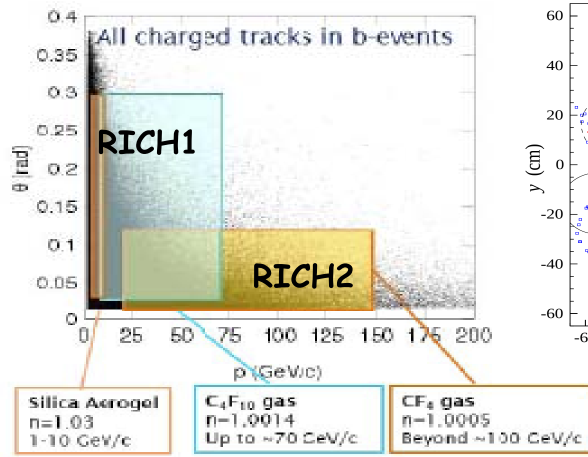
Resolving the event topology

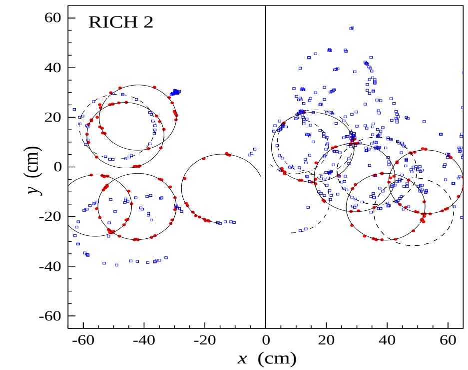


Resolving the event topology

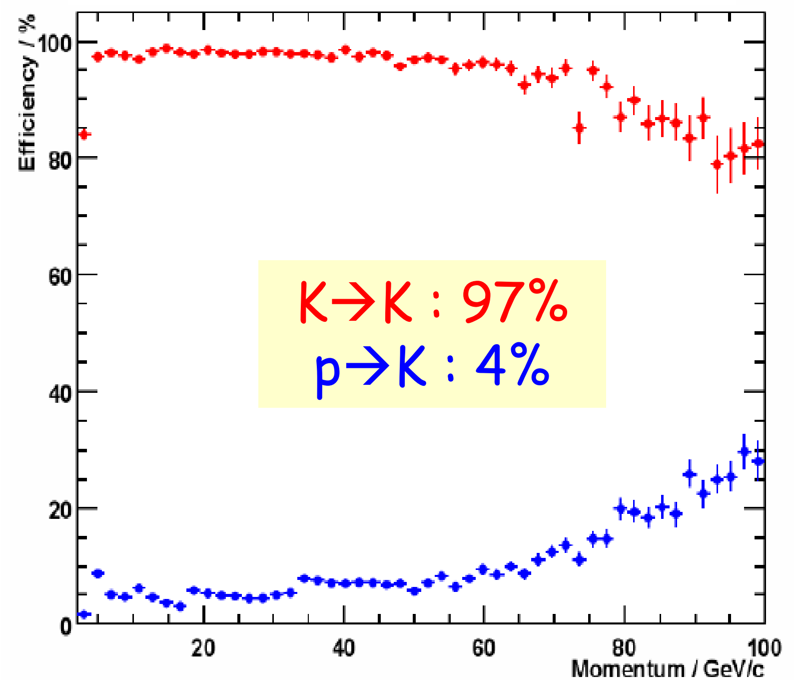
- Hadron identification

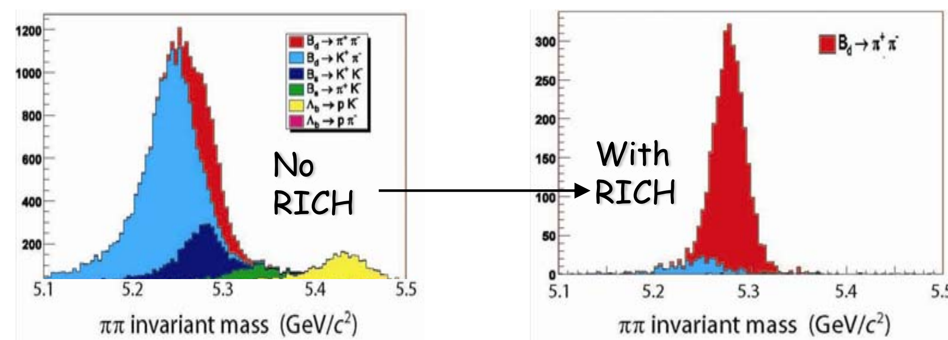
Two RICH detectors with 3 radiators allow for a good identification over a wide momentum range

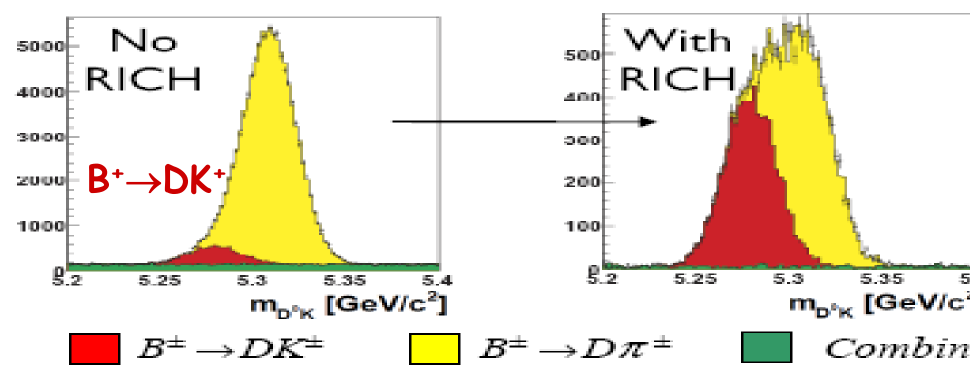




Efficient π-K separation in 2-100 GeV/c range







Resolving the event topology

▪ Lepton identification

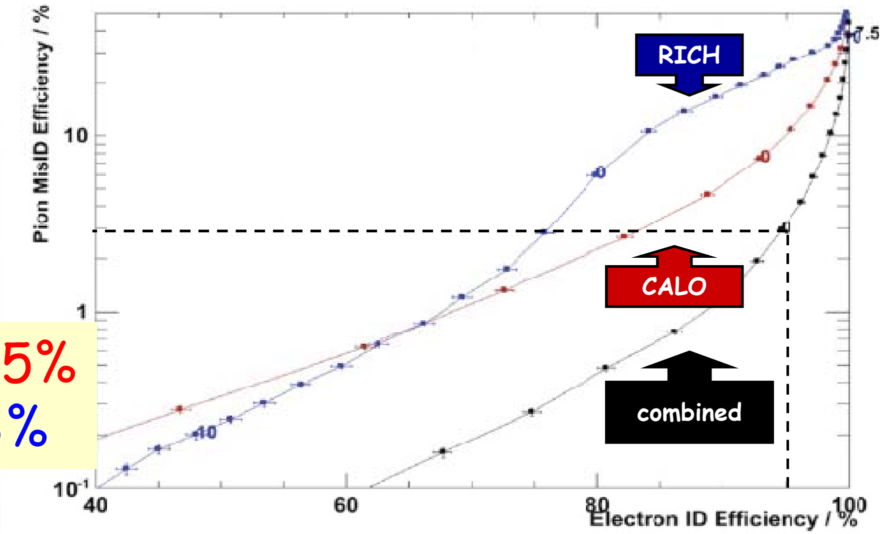
• Electron-ID

Efficient e-ID from calorimeter:

- track-Ecal matching (geometrical + E/p)
- Preshower deposit
- Associated Bremstrahlung

e→e : 95%

π→e : 3%



Useful in many physics analysis :

- $B_s \to K^*ee$, J/Psi(ee)
- B-tagging

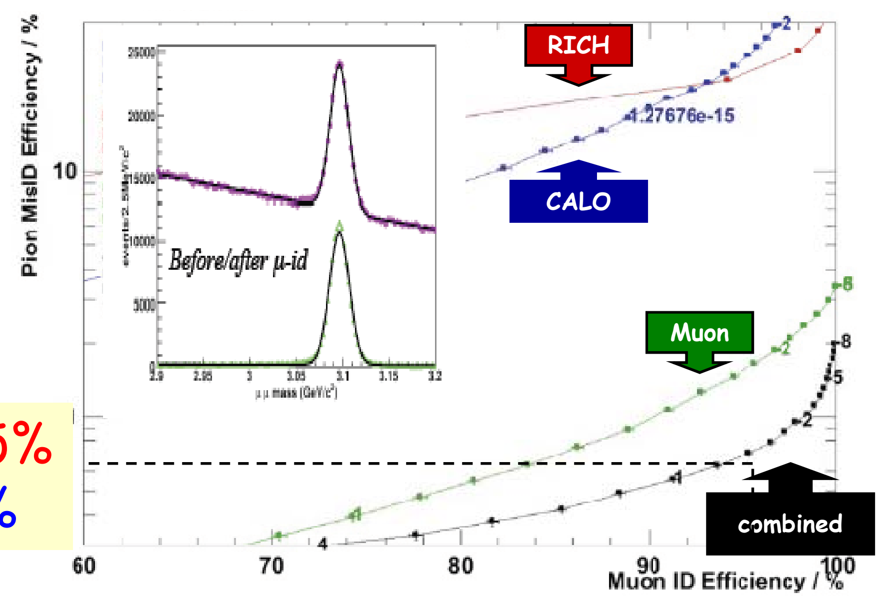
• Muon-ID

Mostly from muon chambers :

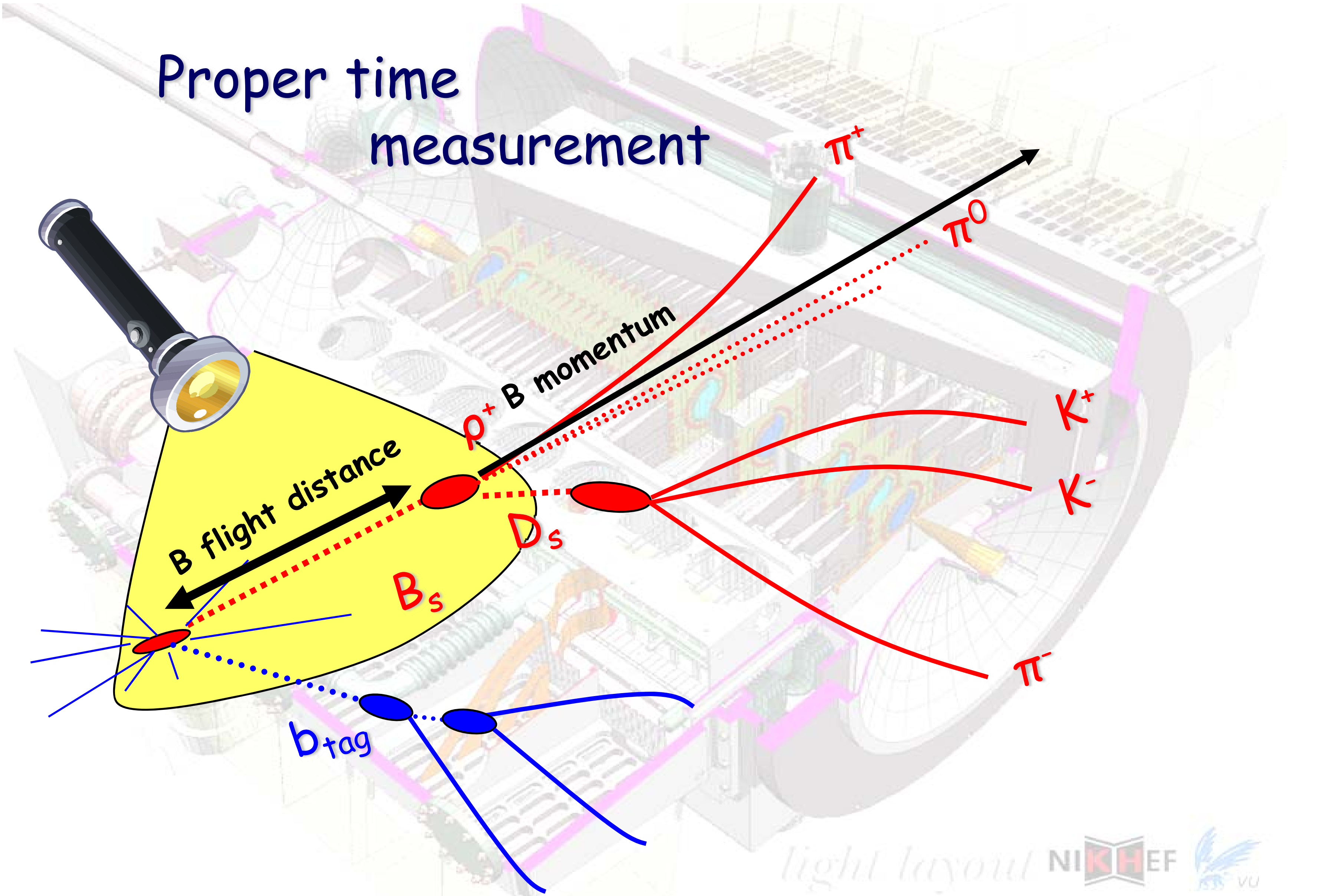
- $B_s \to \mu\mu$, $B_s \to K^*\mu\mu$
- J/Psi(μμ),
- B-tagging

μ→μ : 95%

π→μ : 1%



Resolving the event topology

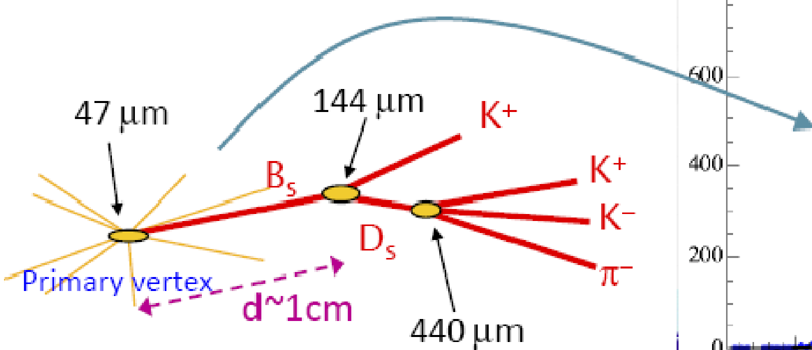


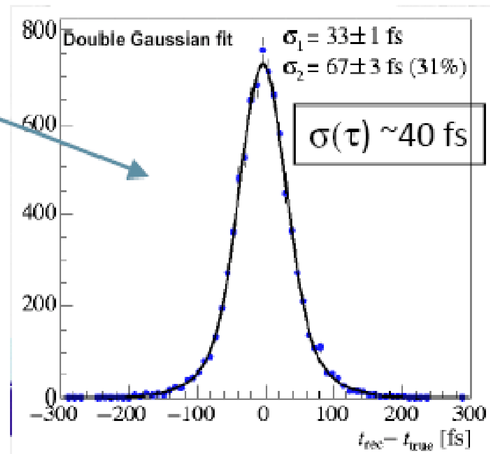
Resolving the event topology

- Flight distance measurement

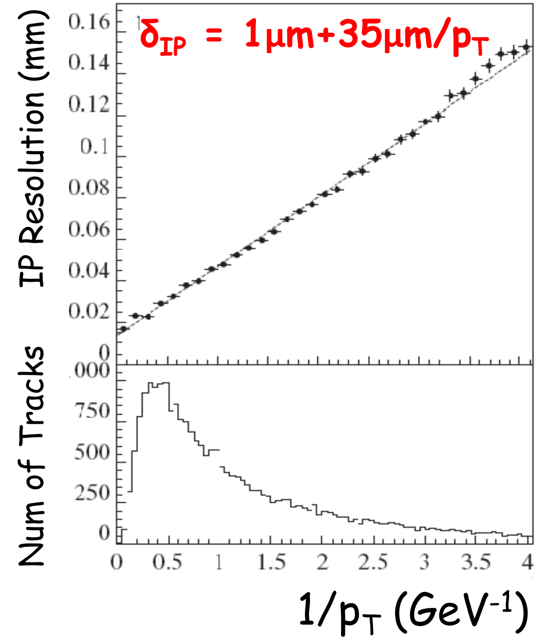
- Vertex Locator (Velo) : silicon strip detector with <10μm hit resolution
- First measurement ~ 8mm from beam. Retractable system for injection.
- Precise IP determination : combinatorial background rejection
- Precise vertexing :

Example: $B_s \to D_s K$





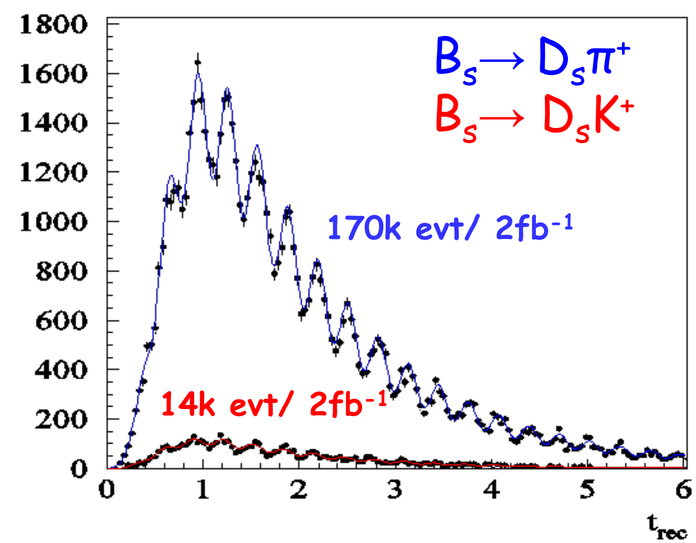
Decay time resolution = 40 fs



- sensitivity to Δm_s from $B_s \to D_s\pi$/ D_sK joint analysis

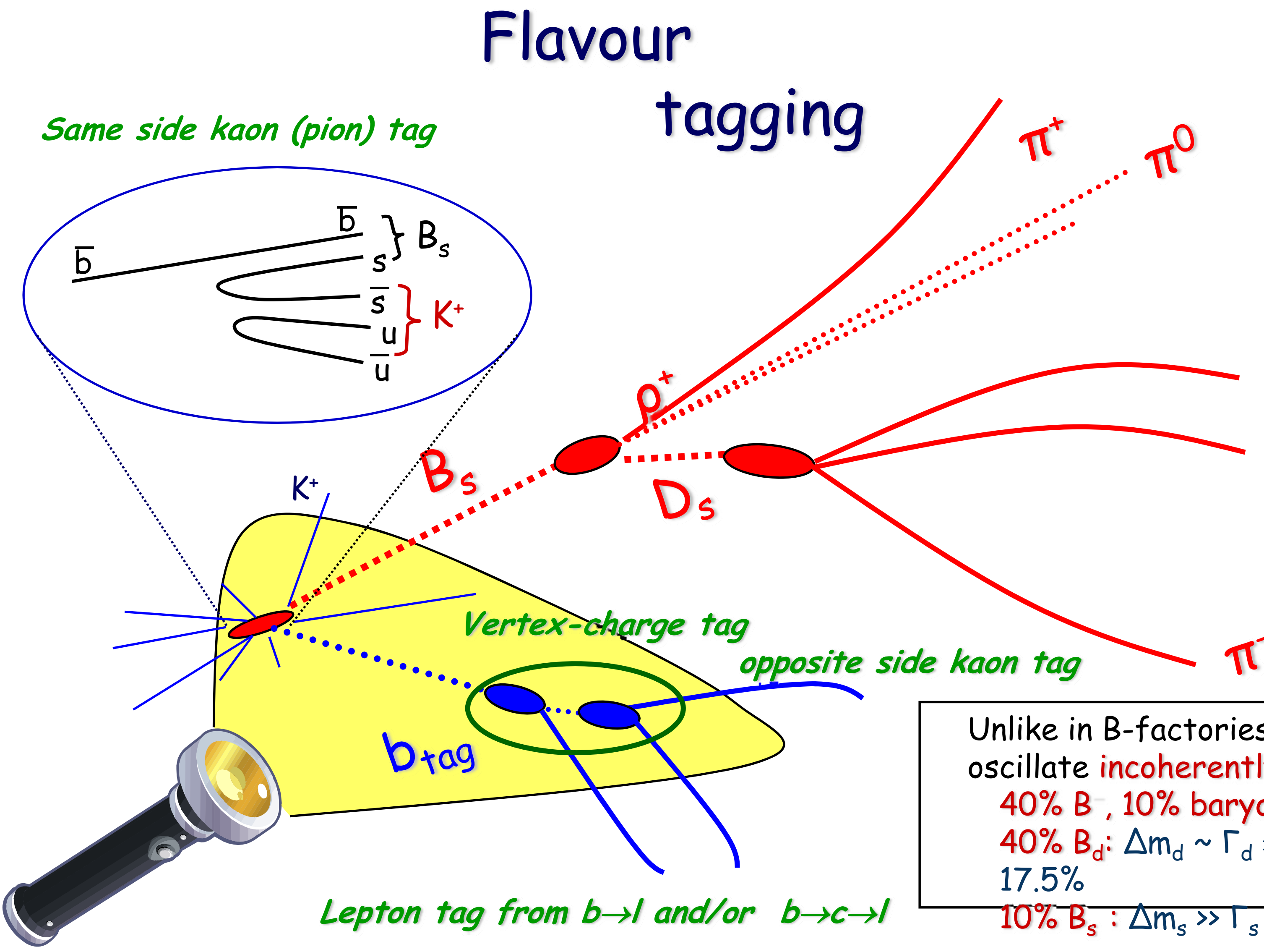
Same topology for $B_s \to D_sK$ and $B_s \to D_s\pi$,
→ combined fit of Δm_s, $\Delta\Gamma_s$ and ω_{tag} together with phase $\gamma+\Phi_s$ arising through the interference between b→c and b→u transitions in $B_s \to D_sK$

$\sigma^{stat}(\Delta m_s) = 0.007\ ps^{-1}$ with 2 fb^{-1}
$\sigma^{stat}(\gamma+\Phi_s) \sim 10$



→ knowledge of the b-flavour at the production is needed

Resolving the event topology



Unlike in B-factories, the *tagging B* can oscillate incoherently :

- 40% B^-, 10% baryons : no oscillation
- 40% B_d: $\Delta m_d \sim \Gamma_d \Rightarrow$ oscillated 17.5%
- 10% B_s : $\Delta m_s \gg \Gamma_s \Rightarrow$ oscillated 50%

Resolving the event topology

- Flavour tagging performance

D = 1-2ω

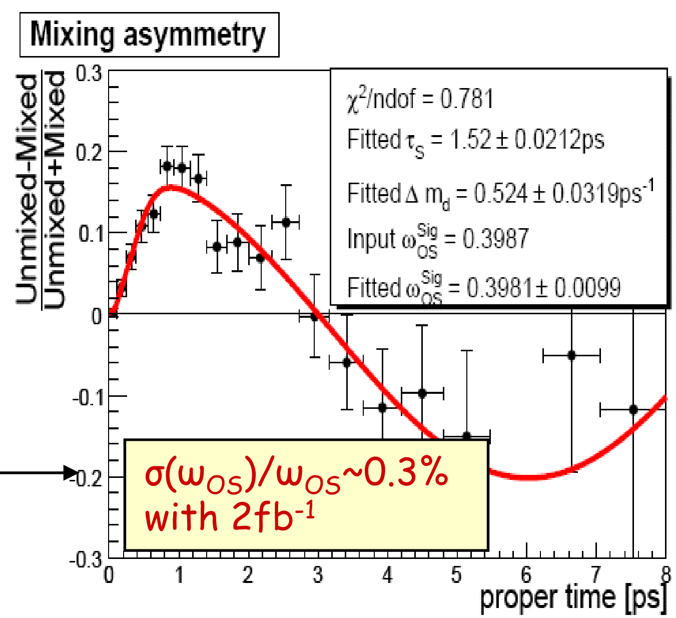
Tagging power	εD^2 (%)
Muon	0.8
Electron	0.4
Kaon	1.3
Jet/vertex charge	1.1
Same side	2.4

- Kaon tagging powerful for LHCb using RICH detectors to identify K fom the "opposite side" $b \to c \to s$
- Combined power for B_s : ε_{eff}~ 7 %
  Lower for B_d : ε_{eff}~ 5 % due to reduced same-side tagging power
- Example : $B_s \to J/\psi\phi$ decay

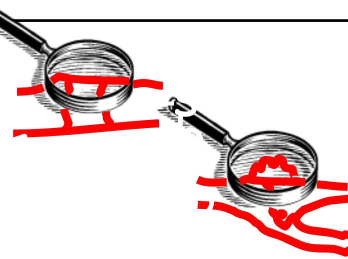
Tagging efficiency	: ε = 55.7%,
Mistag rate	: ω = 33.3%,
Tagging power	: $\varepsilon_{eff} = \varepsilon(1-2\omega)^2$ = 6.2%

- Main control channels
  - $B^+ \to J/\psi K^+$, $B^0 \to J/\psi K^{*0}$ for Opposite Side taggers (unified selection for all $B_{u,s,d} \to J/\psi X$ channels)
  - $B_s \to D_s\pi$ for Same Side kaon

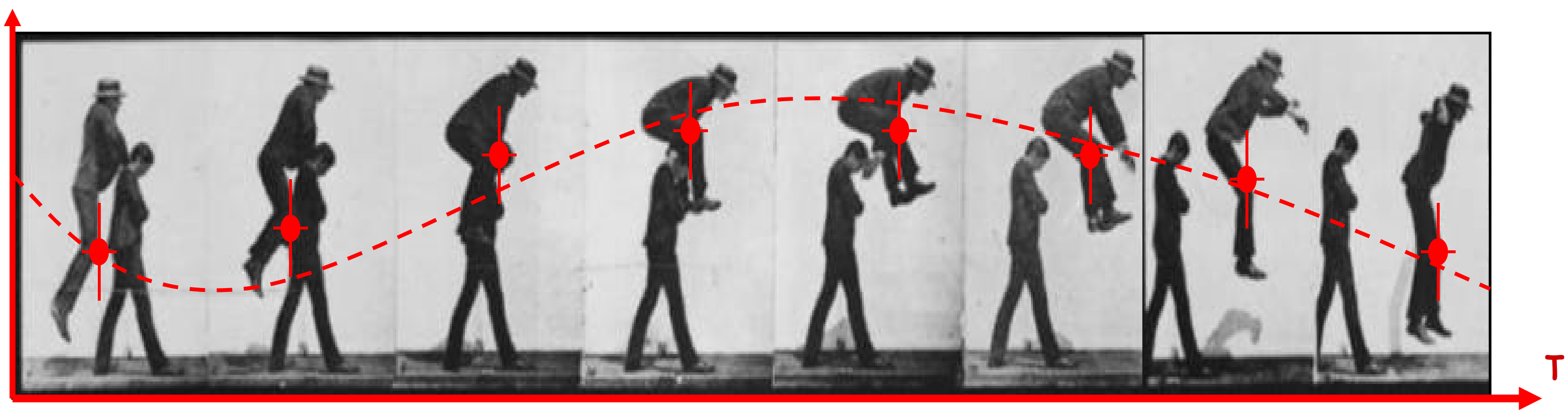
- First results will probably come with opposite side taggers
  - higher statistics in $B_{u,d}$ channels and proper time resolution less crucial
  - Measure ω_{OS} from mixing asymmetry in $B_d \to J/\psi K^*$
  - Fit with 17 free parameters



V- Probing the decay dynamics



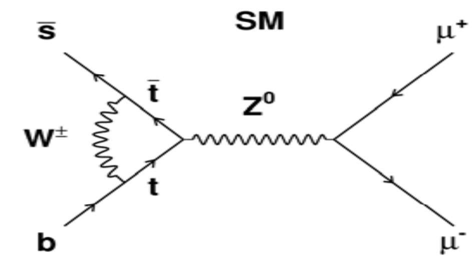
- Branching Ratio of very rare decay : NP in $B_s \to \mu\mu$
- Time-dependent decay rate : photon polarization in $B_s \to \varphi\gamma$
- Dalitz analysis : UT angle γ in $B_u \to D\ K^-$
- Time dependent, flavour tagged, Dalitz analysis : UT angle α in $B_d \to (\rho\pi)$
- Angular analysis : NP in $B_s \to K^* \mu\mu$
- Time dependent, flavour tagged Angular analysis : UT angle β_s in $B_s \to J/\psi\varphi$



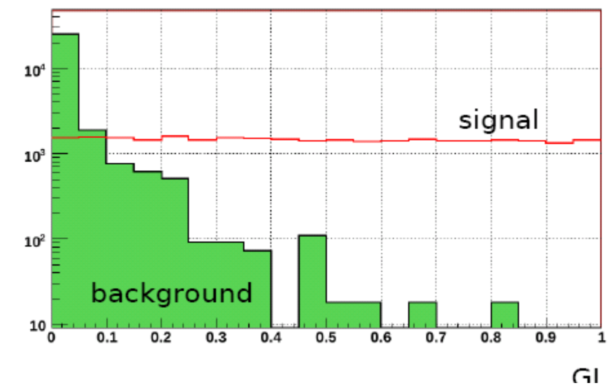
Probing the decay dynamics

The Branching Ratio of the very rare $B_s \to \mu\mu$ decay

- Z-penguin suppressed diagram :
  - SM BR = (3.35 0.32) x 10^{-9}
  - Sensitive to NP, e.g. probe two Higgs doublet models (e.g. MSSM BR ~ $\tan^6\beta/m^4_H$)



- Selection based on 3D likelihood:
  - Geometrical Likelihood (GL) : Impact Parameter, B vertex, Isolation
  - Invariant mass likelihood
  - μ-ID likelihood

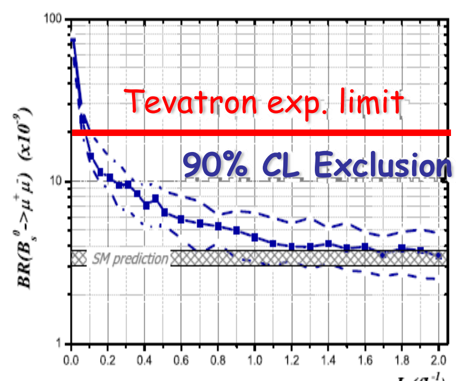


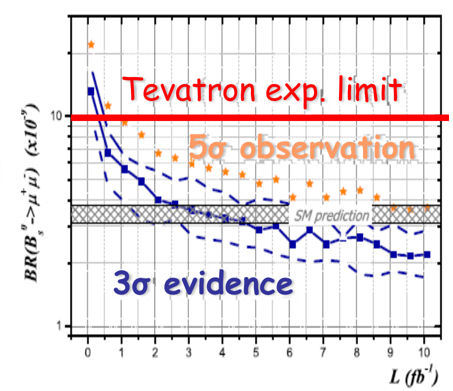
- Selection Likelihood determined from data
  - using sidebands for background
  - using control channels for signal : $B_{(s)} \to h^+h^-$,$B \to J/\psi(\mu\mu)X$

- Use known normalisation channels to derive BR from the event yield
  - get ratio of trigger/tracking efficiency from $B_d \to K^+\pi^-$ / $B_u \to J/\psi(\mu\mu)K^+$
  - main systematics (~ 13%) from hadronization rate $fB_{u,d}$ / fB_s

- Statistical analysis of the Likelihood distribution

Improve 90% CL upper limit with ~ 0.1 fb^{-1}
3σ evidence of SM BR with ~ 2 fb^{-1}
5 σ observation of SM BR with < 10 fb^{-1}





[More details in the poster session : « The LHCb analysis for $B_s \to \mu\mu$ » (Marc-Olivier Bettler)]

Probing the decay dynamics

The photon polarization from the time-dependent decay rate of the $B_s \to \varphi\gamma$ decay

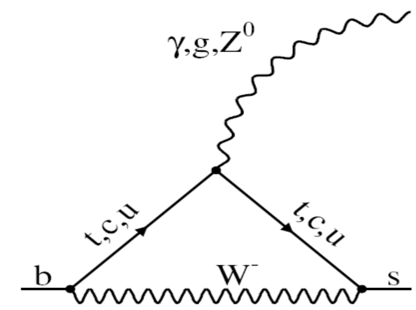
- Time-dependent decay width for radiative $b \to q\gamma$ penguin :

$$\Gamma(\overset{(-)}{B}_q \to f^{CP}\gamma) = |A|^2 e^{-\Gamma_q \tau}\left[\cosh(\Delta\Gamma_q \tau/2) + A_q^{\Delta} \sinh(\Delta\Gamma_q \tau/2) \pm C_q \cos(\Delta m_q \tau) \mp S_q \sin(\Delta m_q \tau)\right]$$

- Within SM for B_s one expects :

$$C_s \approx S_s \approx 0$$
$$A_s^{\Delta} \approx \sin(2\psi) \approx 0.1$$

- Reliable theoretical prediction at NNLO $\to$ probe for NP in loop



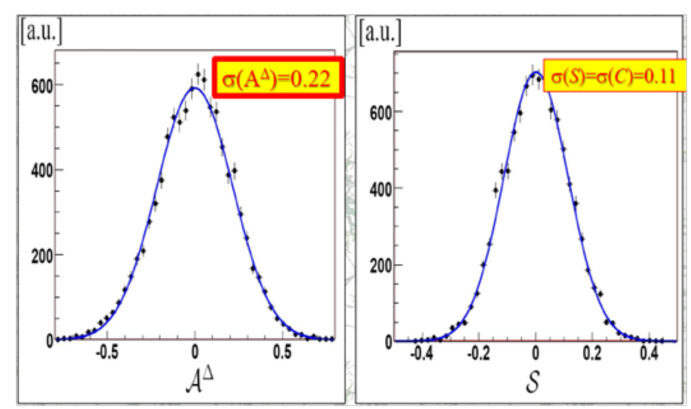
$$b \to s\gamma_L + (m_s/m_b) \times s\gamma_R$$

$$\tan\psi \equiv \left|\frac{\mathcal{A}(\bar{B}_{(s)} \to \Phi^{CP}\gamma_R)}{\mathcal{A}(\bar{B}_{(s)} \to \Phi^{CP}\gamma_L)}\right|$$

Expect 11×10^3 selected signal events / 2 fb^{-1}

B/S < 0.9 @ 90% CL

- Unbinned likelihood fit proper lifetime ⊕ reconstructed mass
  - simultaneous fit of (A^{Δ}, C, S) → tagging involved
  - parametrize background from side-bands
  - acceptance function from control channel ($K^*\gamma$, $J/\psi\varphi$)



$\sigma^{stat}(A^{\Delta}) \sim 0.2$, $\sigma^{stat}(C/S) \sim 0.1$ with 2 fb^{-1}

- Other radiative decays under study :

$B_d \to K^*\gamma$, $B_u \to \varphi K^+\gamma$, $\Lambda_b \to \Lambda\gamma$

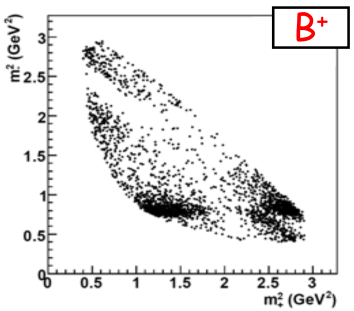
Probing the decay dynamics

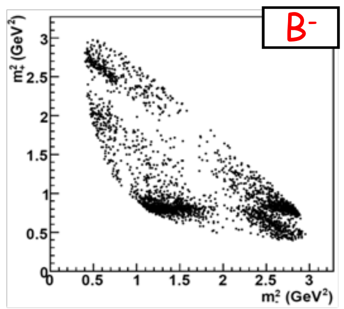
The UT angle γ from the Dalitz analysis of the $B^- \to D / \bar{D}\ K^-$ decay

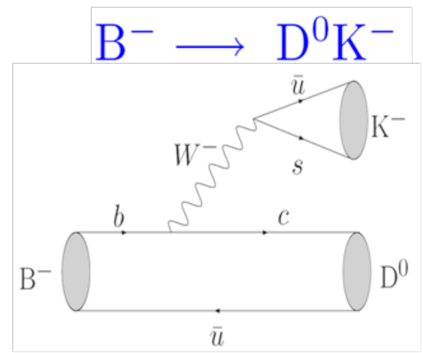
- Interferences between the $b \to c$ and $b \to u$ tree transition for $B^- \to (D / \bar{D})K^-$

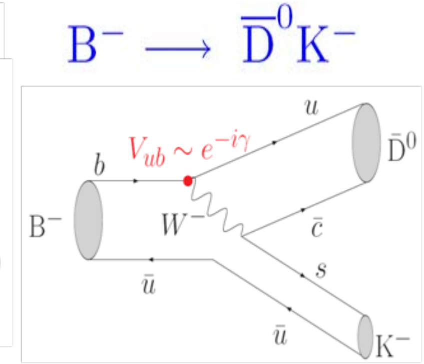
$$\frac{\langle B^- \longrightarrow \bar{D}^0 K^- \rangle}{\langle B^- \longrightarrow D^0 K^- \rangle} = r_B e^{i(\delta_B - \gamma)}$$

- Example : Dalitz analysis of $D / \bar{D} \to K_s \pi\pi$ to extract (r_B, δ_B, γ)









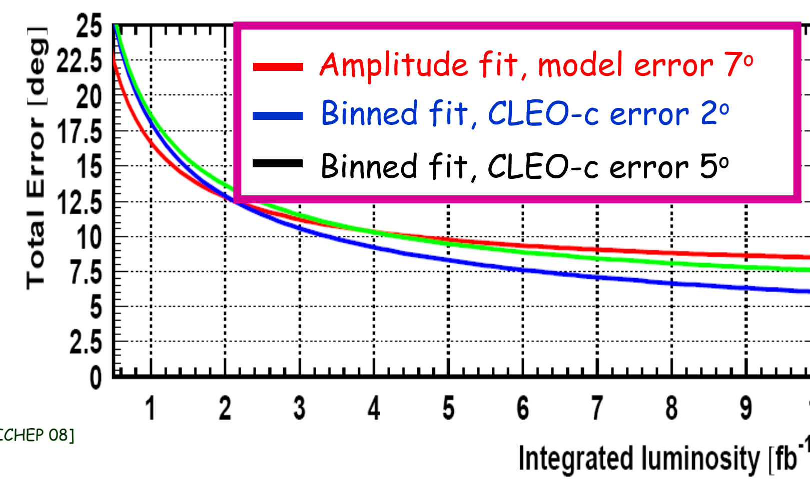
Expect 6.8×10^3 selected signal events / 2 fb^{-1}

B/S < 0.5 @ 90% CL

contamination from $B^- \to D\ \pi^-$ < 10%

- Unbinned Amplitude fit analysis assuming isobar model

$\sigma(\gamma) \sim 9\text{-}11^\circ$ stat with 2 fb^{-1} $\oplus$ 7° model [PRD 78 (2008) 034023]



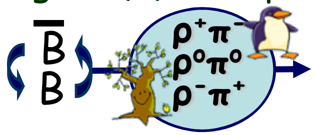
- Model independent binned fit using inputs from correlated ψ(3770) decay at Cleo-c. Residual systematuc error 1-2 [Asner, ICHEP 08]

- Dalitz method possibly extented using $D \to K_s KK$, $K_s K\pi$, $KK\pi\pi$, $K\pi\pi$,

Probing the decay dynamics

The UT angle α from the time-dependent Dalitz analysis of the tagged $B_d \to (\rho\pi)^\circ$ decay

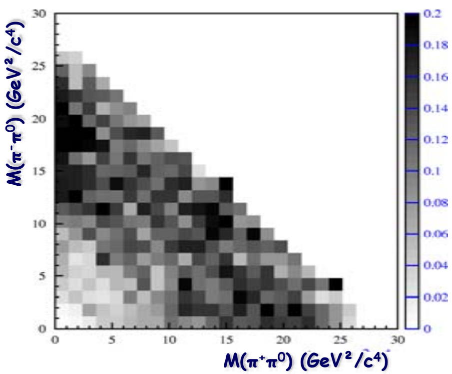
- Using SU(2) asumption the interferences in the

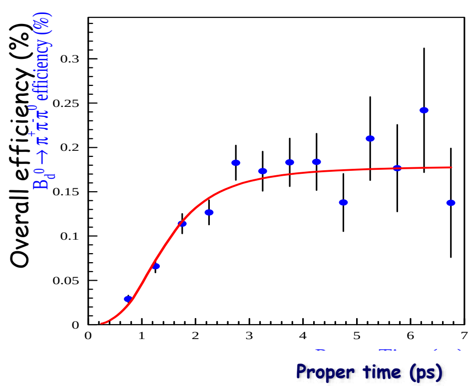


$\pi^-\pi^0\pi^+$ transition

provides a theoretically clean extraction of α

- Require an accurate control of the ρ-lineshapes and the experimental acceptance





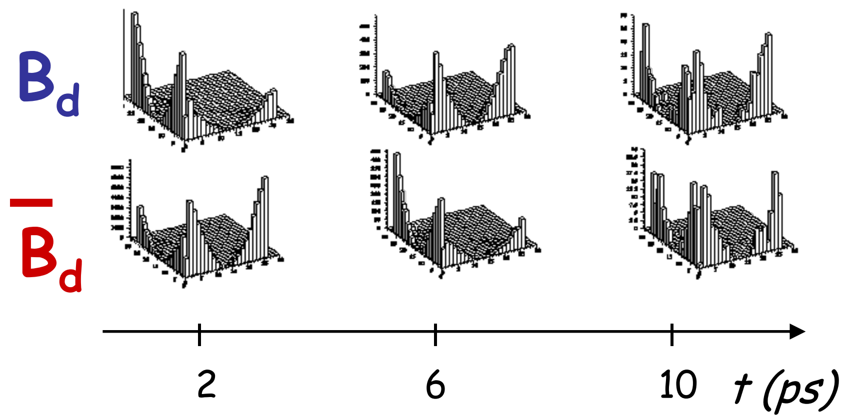
- Unbinned likelihood fit analysis

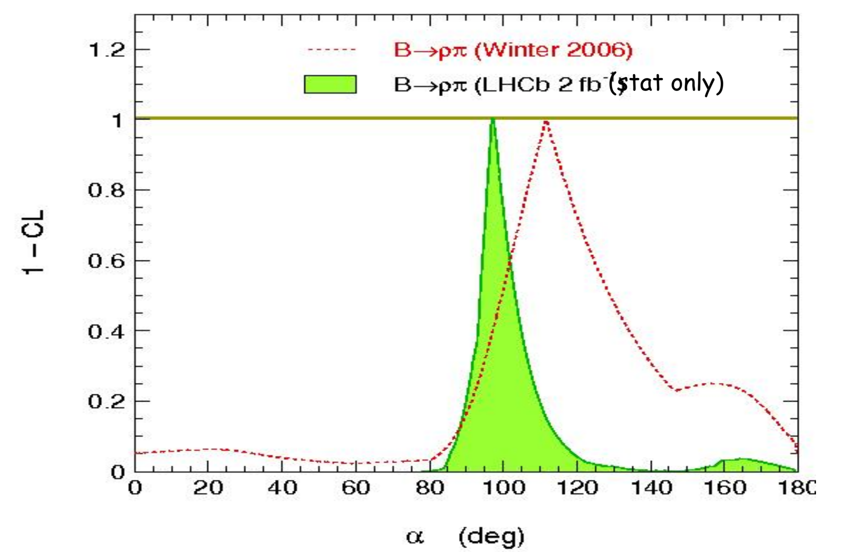
Expect 10×10^3 selected signal events / 2 fb^{-1}

B/S < 0.8 @ 90% CL

$\sigma^{stat}(\alpha) \sim 8$ with 2 fb^{-1}

$$M^{\pm}(s^+,s^-,t) = e^{-\frac{\Gamma t}{2}}\left\{\cos\left(\frac{\Delta m}{2}t\right)A^{\pm}(s^+,s^-) + i\left(\frac{q}{p}\right)^{\pm 1}\sin\left(\frac{\Delta m}{2}t\right)A^{\mp}(s^+,s^-)\right\}$$

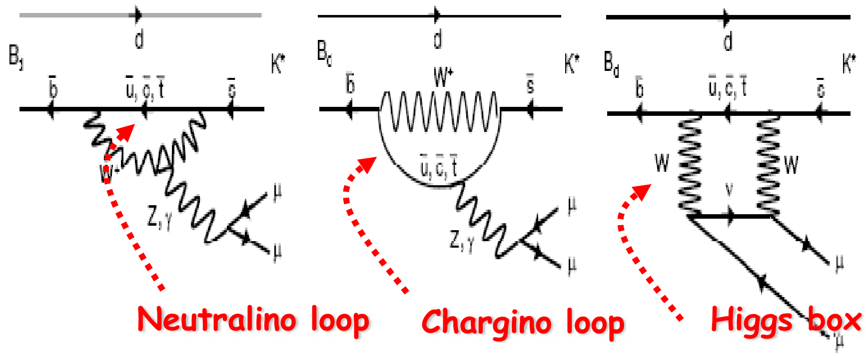




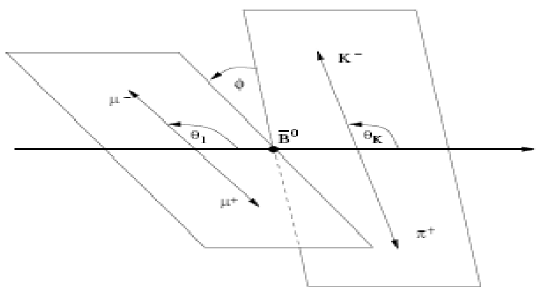
Probing the decay dynamics

Forward-Backward asymmetry from the **angular analysis** of the rare $B_d \to K^* \mu\mu$ decay

- Suppressed FCNC in $b \to s$ EW-penguin transition
  - BR ~ $(1.2 \pm 0.4)\ 10^{-6}$

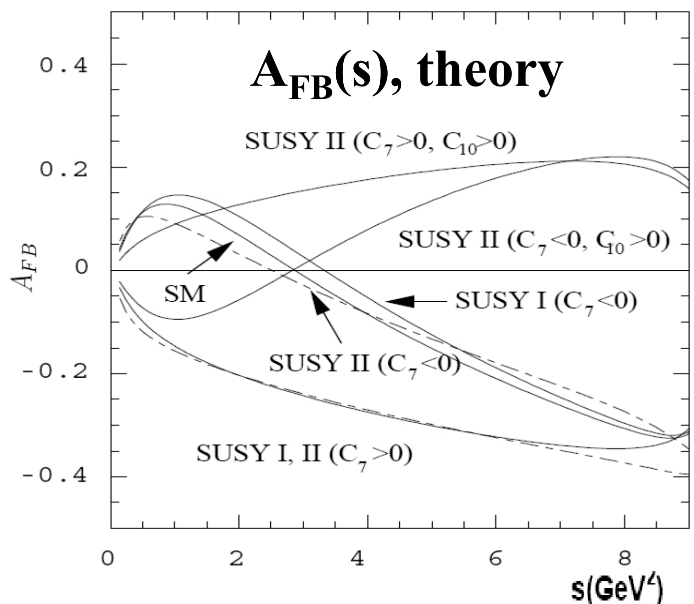


- Lepton angular distribution affected by NP



- Several observable to test the dynamics
  - $s = m^2_{\mu^+\mu^-}$ distribution
  - $A_{FB}(s)$: forward-backward asymmetry in Θ_μ
- Zero-crossing point $A_{FB}(s_0) = 0$ prediction depends on C_7^{eff} & C_9^{eff}

$s_0^{SM}(C_7, C_9) = 4.39^{+0.38}_{-0.35}$ GeV^2



Expect 7×10^3 selected signal events / 2 fb^{-1}

B/S ~ 0.2

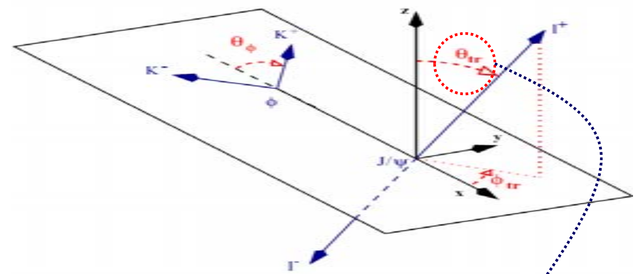
$\sigma(s_0) \sim 0.5$ GeV^2 with 2 fb^{-1}

- Full angular analysis will give better discrimination between NP models

Probing the decay dynamics

The mixing phase Φ_s from the **time-dependent angular analysis** of the **tagged** $B_s \to J/\psi\varphi$ decay

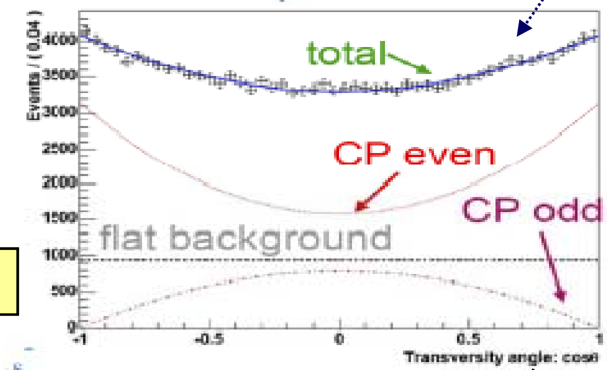
- B_s mixing phase from (almost) pure $b \to ccs$ tree transition
  - sensitive to NP in $\Delta F=2$ transition
  - SM value well determined from CKM metrology : $\Phi_s = -2\beta_s = 0.0362 \pm 0.0018$
  - Tevatron direct measurement 2σ away : $\Phi_{J/\psi\varphi} = 0.76 \pm 0.36$



- $J/\psi\varphi$ is not pure CP eigenstate
  - → angular analysis to separate the CP odd/even components

Expect 115×10^3 selected signal events / 2 fb^{-1}

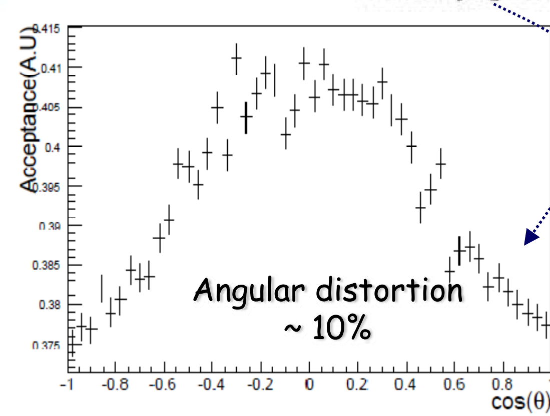
B/S ~ 1.8 (prompt bkg) + 0.5 (long- lived bkg)



- Unbinned likelihood fit analysis :
  - 7 parameters (φ_s, Γ_s, $\Delta\Gamma_s$, $R_\perp$, $R_{//}$, $\delta_\perp$, $\delta_{//}$)

$\sigma^{stat}(\Phi_{J/\psi\varphi}) \approx 0.03$ with 2 fb^{-1}

- Control of the acceptance, flavour-tagging and bkg level is crucial
  - Use control channels and side-bands
  - $B \to J/\psi K^*$ (Acceptance), $B^+ \to J/\psi K^+$, $B_s \to D_s^+\pi^-$ (Tagging)



- Similar analysis for the pure $b \to sss$ penguin decay $B_s \to \varphi\varphi$
  - 4×10^3 events / 2 fb^{-1} - B/S < 2.1 @ 90% CL
  - $\sigma^{stat}(\Phi_{\varphi\varphi}) \approx 0.1$ with 2 fb^{-1}

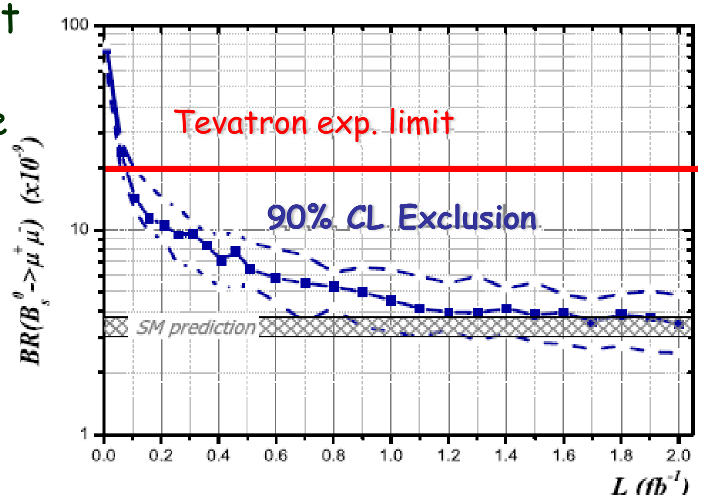
[More details in the poster session : « $2\beta_s$ measurement at LHCb » (Geraldine Conti)]

Conclusion & summary

- LHCb : heavy flavour dedicated experiment

- Aims at performing a lot of precision measurements using sophisticated reconstruction and analysis techniques within a challenging hadronic environment

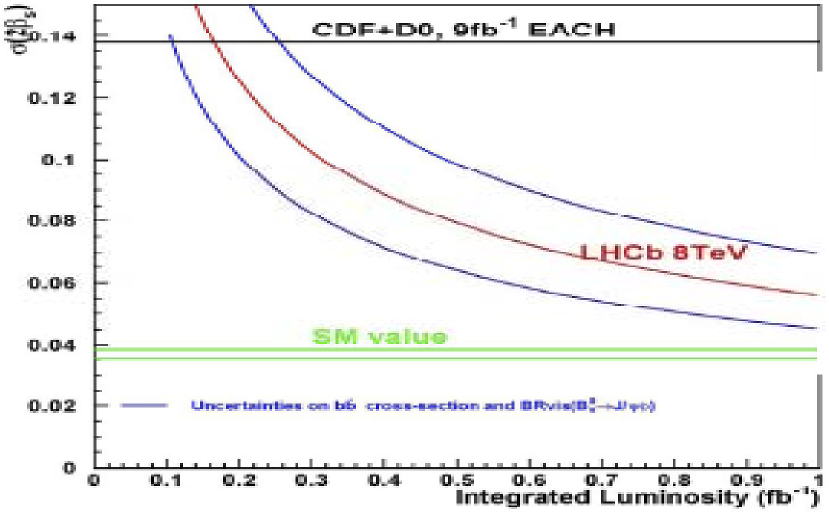
- Expect much more interesting results than presented here



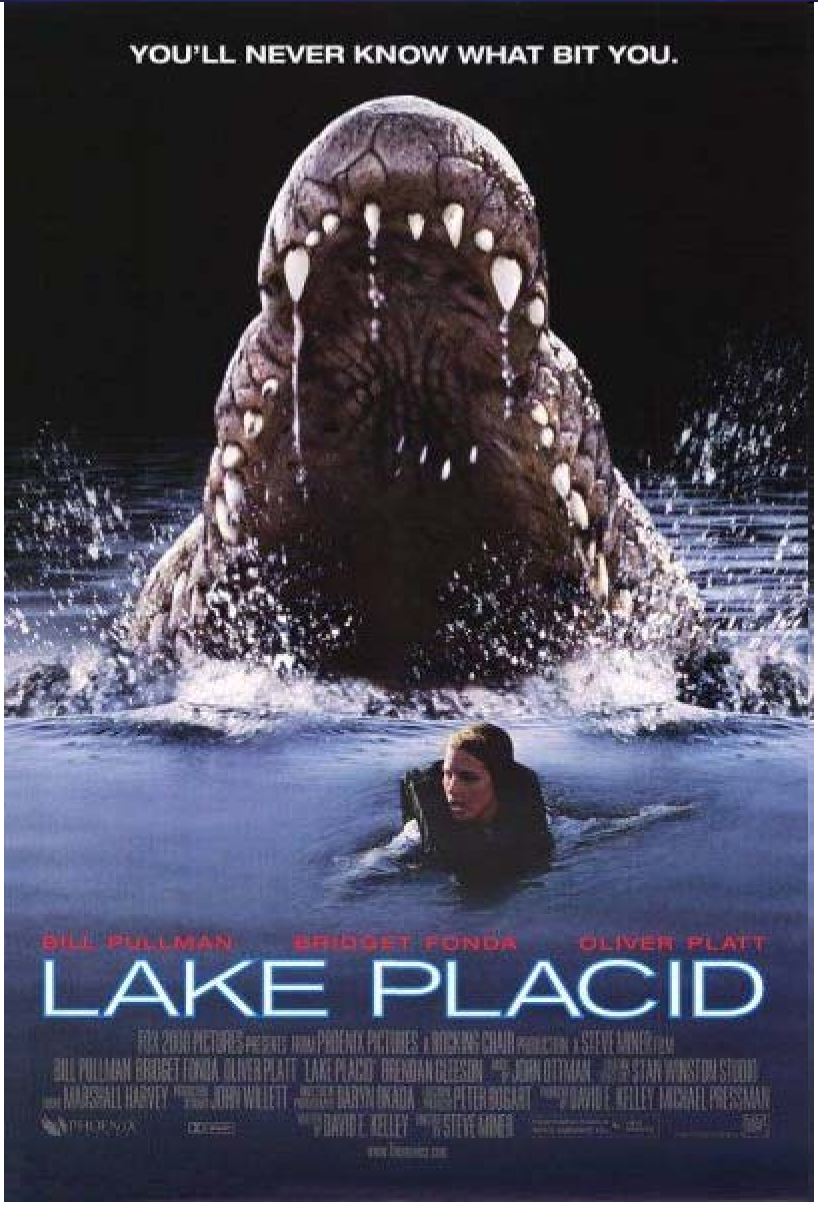
Eagerly waiting for data

- Important results can come early

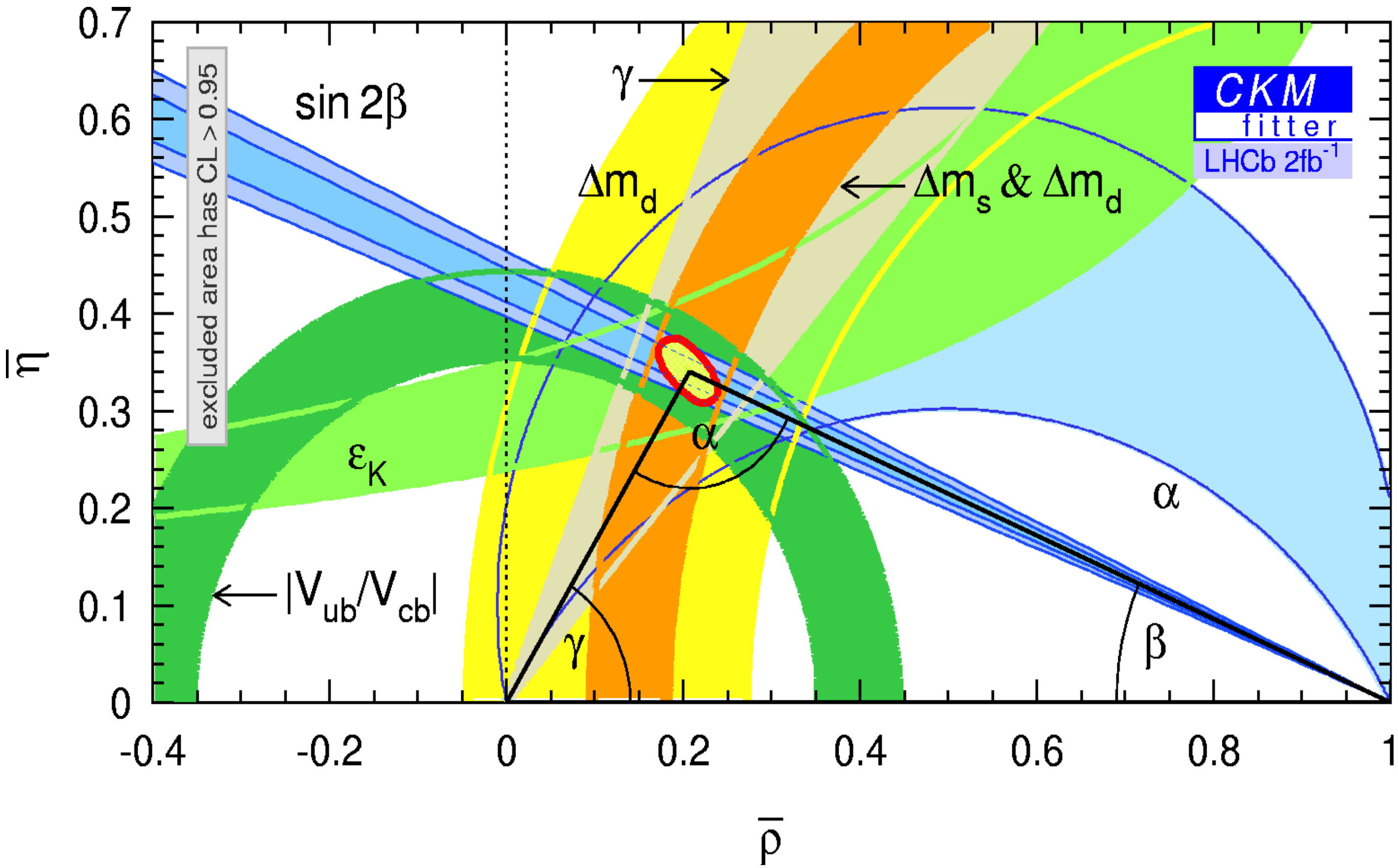
  - $B_s \to \mu\mu$ BR limit close to SM expectation
  - Hints in the B_s sector (including φ_s)



Spare slides



LHCb 2012 ?



Assumptions:

$\sigma(\Delta m_s)$=0.01

$\sigma(\sin 2\beta)$=0.02

$\sigma(\alpha)$ = 10°

$\sigma(\gamma)$ = 5°

LHCb global sensitivity to γ_{UT}

- **γ from tree**

$B^- \to D^0K^-$

- $D^0 \to$ Kq, KK, qq — ADS/GLW
- $D^0 \to$ Kqqq
- $D^0 \to K_S$qq — GGSZ

$B^0 \to D^0K^{*0}$

- $D^0 \to$ Kq, KK, qq

Time dependent measurements:

- $B^0 \to$ Dq — $\gamma+2\beta$
- $B_s \to D_sK$ — $\gamma+2\beta_s$

- **γ from loop**

$B_{(s)} \to h^+h^-$

Time dependent CP asymmetry
Assume U-spin symmetry

Summary of event yields in 2 fb^{-1}

Channel	Signal	Background
$B^\pm \to D(K^\pm\pi^\mp)K^\pm$	56k	35k
$B^+ \to D(K^-\pi^+)K^+$	680	780
$B^- \to D(K^+\pi^-)K^-$	400	780
$B^+ \to D(K^+K^- + \pi^+\pi^-)K^+$	3.3k	7.2k
$B^- \to D(K^+K^- + \pi^+\pi^-)K^-$	4.4k	7.2k
$B^\pm \to D(K^\pm\pi^\mp\pi^+\pi^-)K^\pm$	61k	40k
$B^+ \to D(K^-\pi^+\pi^+\pi^-)K^+$	470	1.2k
$B^- \to D(K^+\pi^-\pi^+\pi^-)K^-$	350	1.2k
$B^0 \to D(K^+\pi^-)K^{*0}$, $\bar{B}^0 \to D(K^-\pi^+)\bar{K}^{*0}$	3.4k	1.7k
$B^0 \to D(K^-\pi^+)K^{*0}$	350	850
$\bar{B}^0 \to D(K^+\pi^-)\bar{K}^{*0}$	230	850
$B^0 \to D(K^+K^- + \pi^+\pi^-)K^{*0}$	150	500
$\bar{B}^0 \to D(K^+K^- + \pi^+\pi^-)\bar{K}^{*0}$	550	500
$B^\pm \to D(K_S^0\pi^+\pi^-)K^\pm$	5k	4.7k
$B_s, \bar{B}_s \to D_s^\mp K^\pm$	6.2k	4.3k
$B^0, \bar{B}^0 \to D^\mp\pi^\pm$	1,300k	290k

$\sigma(\gamma) = 5^\circ$ with 2 fb^{-1} of data

Channel	Yield (2 fb^{-1})	B/S
$B \to \pi\pi$	36k	0.5
$B_s \to KK$	36k	0.15

$\sigma(\gamma) \sim 10^\circ$ with 2 fb^{-1}

LHCb global sensitivity to β_s

2009: 0.5 fb^{-1}: sensitivity ~0.042 using $B_S \rightarrow J/\psi\ \phi$ (cf SM value 2 β_s~ - 0.04)

Decay Mode	Yield (2 fb^{-1})	σ (2β_s)
$J/\psi\ \eta(\gamma\gamma)$	8.5 k	0.109
$J/\psi\eta(\pi\pi\pi)$	3 k	0.142
$J/\psi\ \eta'(\pi\pi\pi)$	2.2 k	0.154
$J/\psi\ \eta'(\rho\gamma)$	4.2 k	0.08
$\eta_c\ \phi$	3 k	0.108
$D_s^+\ D_s^-$	4k	0.133
All CP eigenstates	-	0.046
$J/\psi\ \phi$	130 k	0.023
All	-	0.021

Sensitivity with 2 fb^{-1} and Δm_s = 17 ps $^{-1}$, 2β_s= -0.04, $\Delta\Gamma/\Gamma$= 0.15