LHCb

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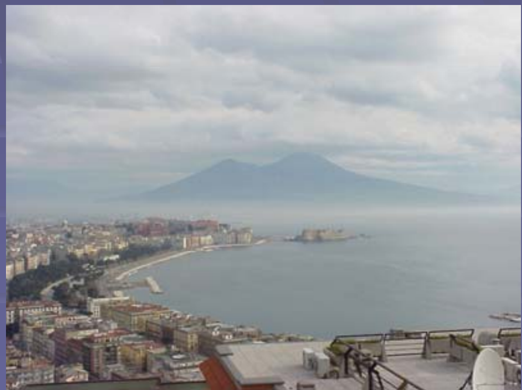


on behalf of the LHCb collaboration

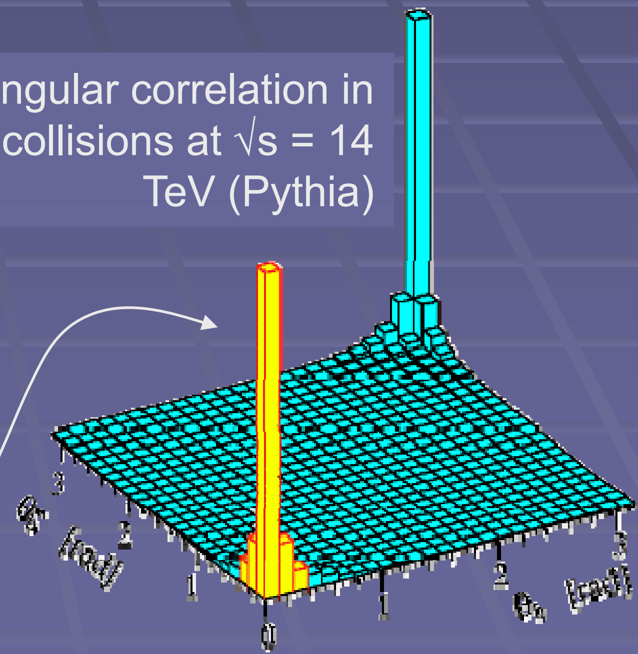
The whole idea

- Given the fact that
  - LHC will be the facility producing the largest number of b hadrons (of all types), by far, and for a long time
  - the Tevatron experiments have demonstrated the feasibility of B physics at hadron machines

→ **perform a dedicated B-physics experiment at the LHC**, but with a new challenge:

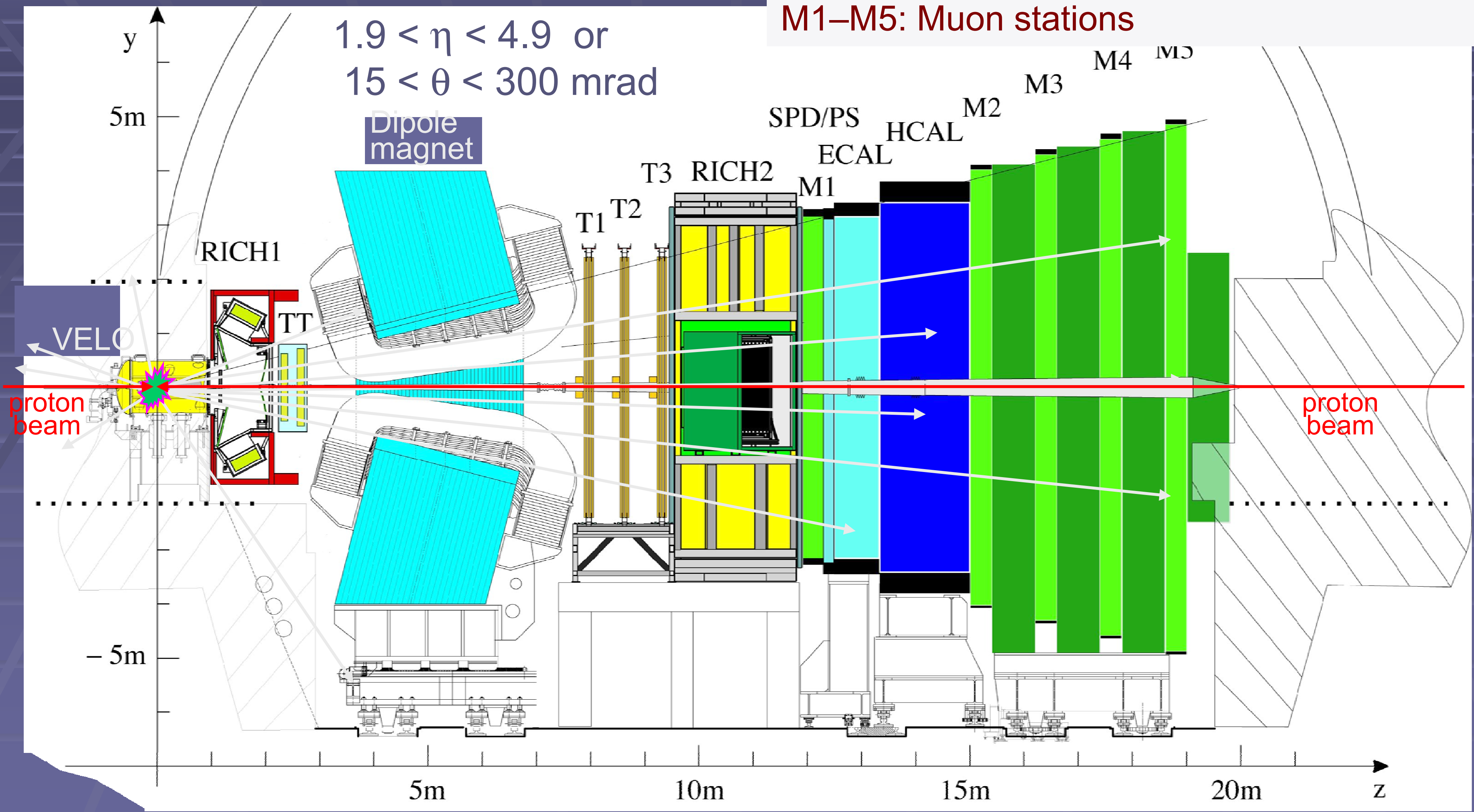
- exploit the huge bb production in the not-well-known forward region, despite the unfriendly hadronic environment (multiplicity, …) for B physics
  - ~ 230 μb of bb production in one of the forward peaks (400 mrad), corresponding to nearly 10^5 b hadrons per second at a low luminosity of 2×10^{32} cm^{-2}s^{-1}

$\bar{b}b$ angular correlation in pp collisions at $\sqrt{s}$ = 14 TeV (Pythia)

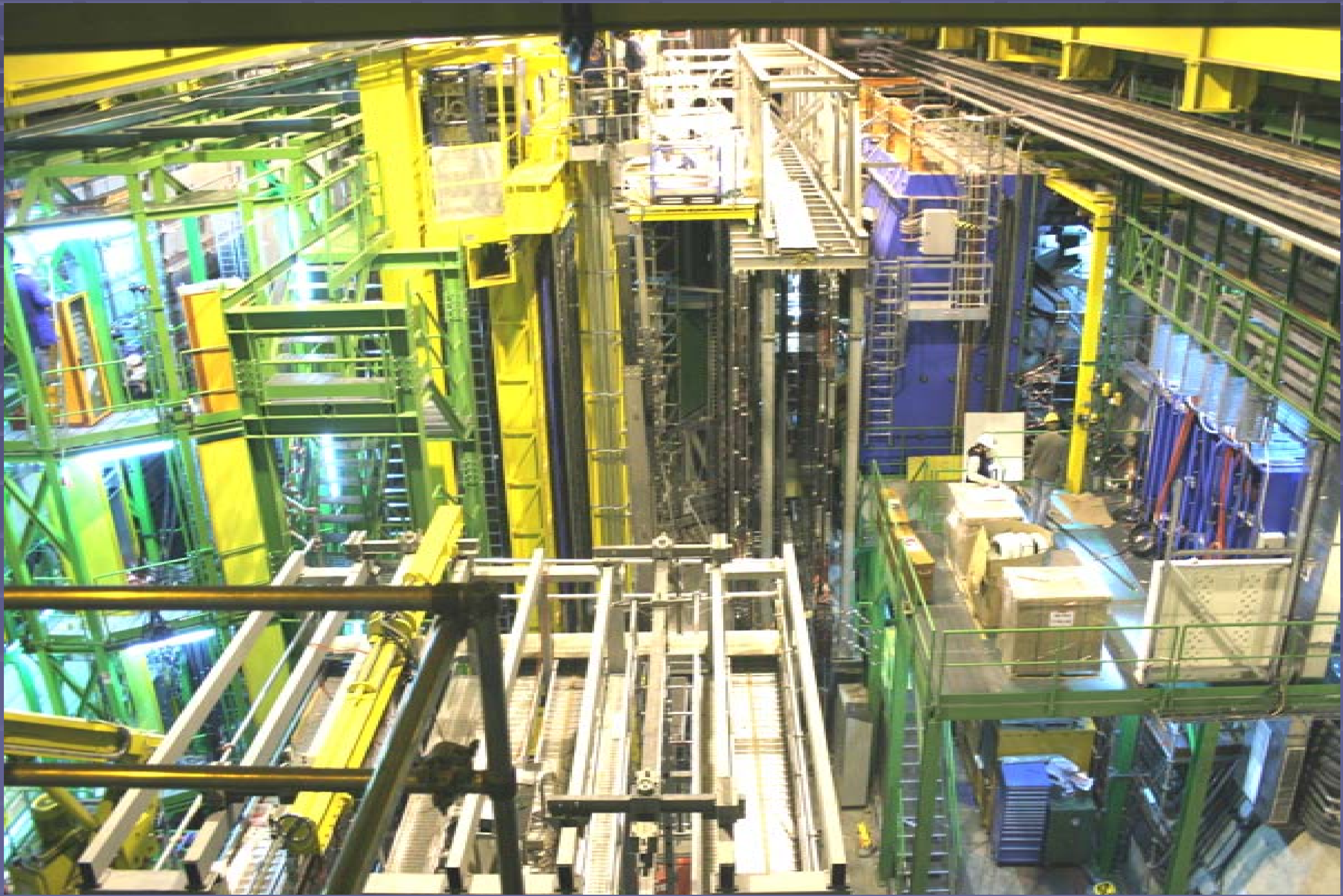


LHCb

VELO: Vertex Locator (around interaction poin
TT, T1, T2, T3: Tracking stations
RICH1-2: Ring Imaging Cherenkov detectors
ECAL, HCAL: Calorimeters
M1–M5: Muon stations

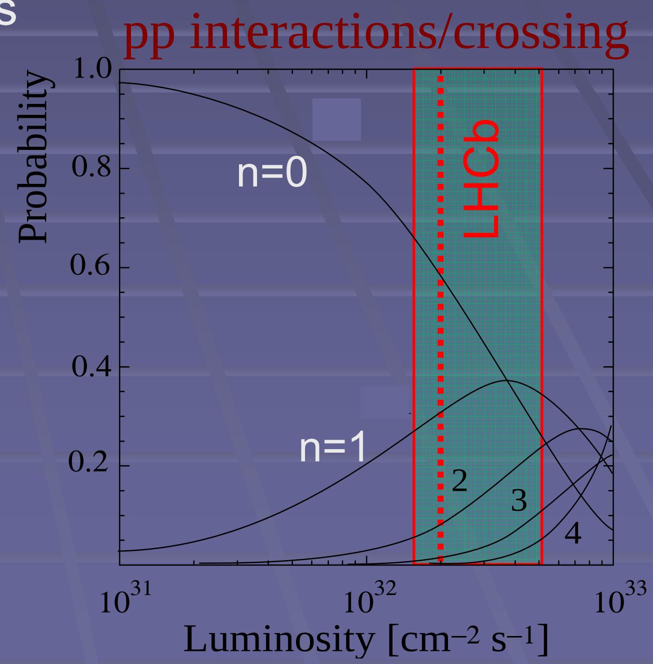


LHCb pit



Pileup and luminosity

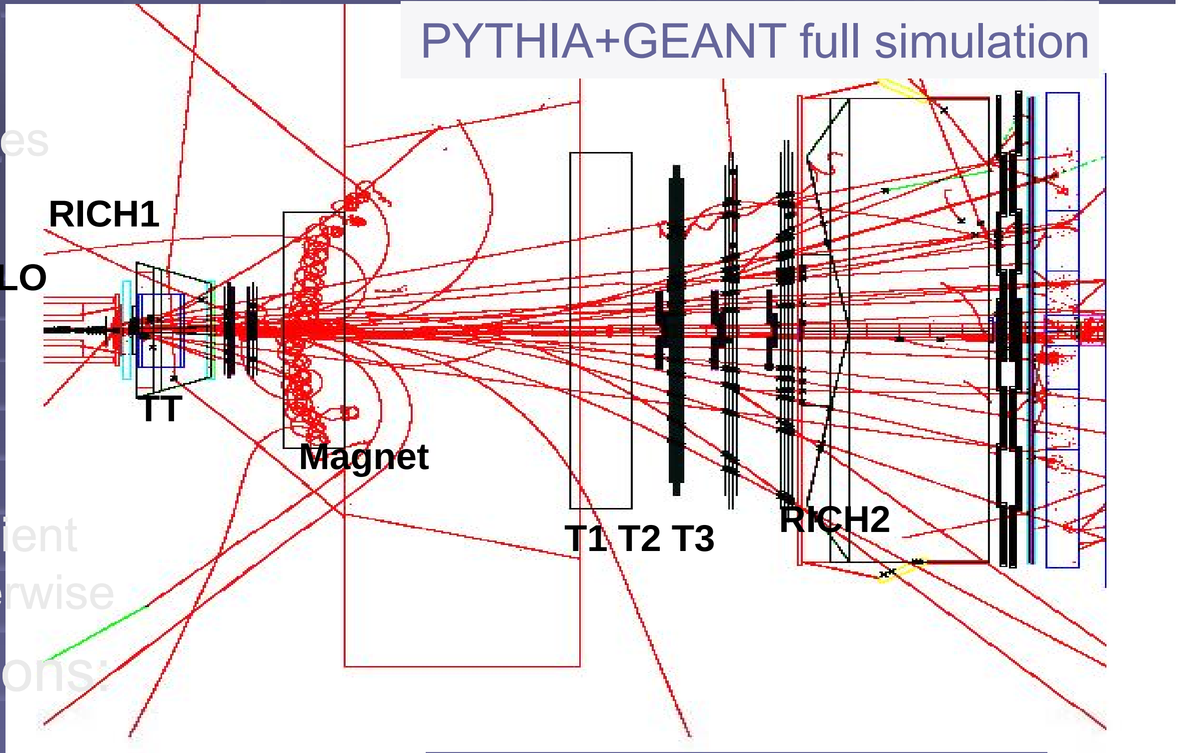
- LHC machine, pp collisions at $\sqrt{s}$ = 14 TeV:
  - design luminosity L= 10^{34} $cm^{-2}s^{-1}$, bunch crossing rate = 40 MHz
  - average non-empty bunch crossing rate f = 30 MHz (in LHCb)
  - Pileup:
    - n = number of inelastic pp interactions occurring in the same bunch crossing
    - Poisson distribution with mean <n> = $L\sigma_{inel}/f$, with σ_{inel} = 80 mb
    - <n> = 25 at 10^{34} $cm^{-2}s^{-1}$ $\rightarrow$ not good for B physics



- At LHCb:
  - L tuneable by adjusting final beam focusing
  - Choose to run at <L> ~ **2×10^{32} $cm^{-2}s^{-1}$** (max. 5×10^{32} $cm^{-2}s^{-1}$)
    - Clean environment: <n> = 0.5
    - Less radiation damage
    - Expected to be available from first physics run
  - 2 fb^{-1} of data in 10^7 s (= nominal year)

Tracking performance

- High multiplicity environment:
  - In a bb event, ~30 charged particles traverse the whole spectrometer
- Track finding:
  - efficiency > 95% for long tracks from B decays (~ 4% ghosts for $p_T > 0.5$ GeV/c)
  - $K_S \to \pi^+\pi^-$ reconstruction 75% efficient for decay in the VELO, lower otherwise
- Average B-decay track resolutions:
  - Impact parameter: ~30 μm
  - Momentum: ~0.4%
- Typical B resolutions:
  - Proper time: ~40 fs (essential for B_s physics)
  - Mass: 8–18 MeV/c^2



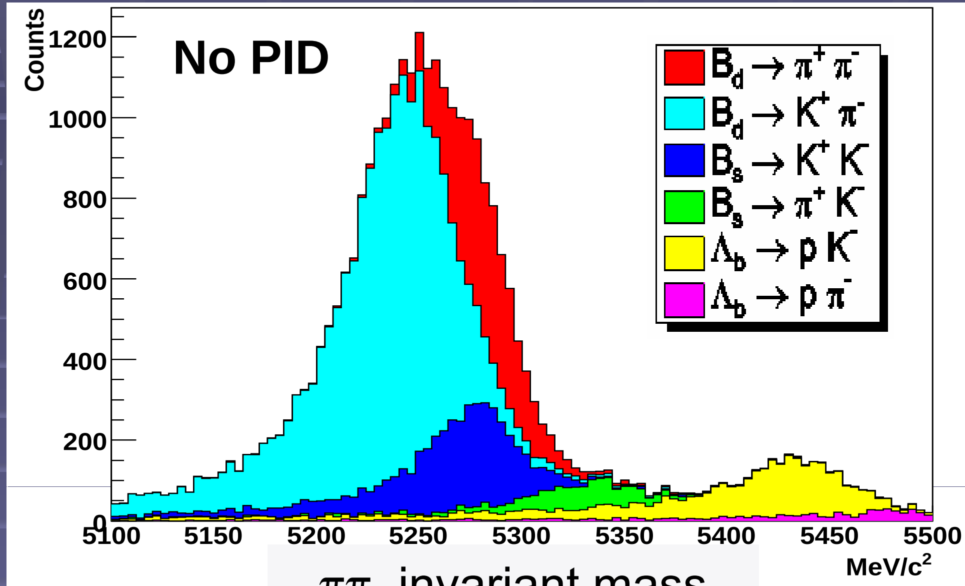
	Mass resolution
$B_s \to \mu\mu$	18 MeV/c^2
$B_s \to D_s \pi$	14 MeV/c^2
$B_s \to J/\psi\, \phi$	16 MeV/c^2
$B_s \to J/\psi\, \phi$	8 MeV/c^2

with J/ψ mass constraint

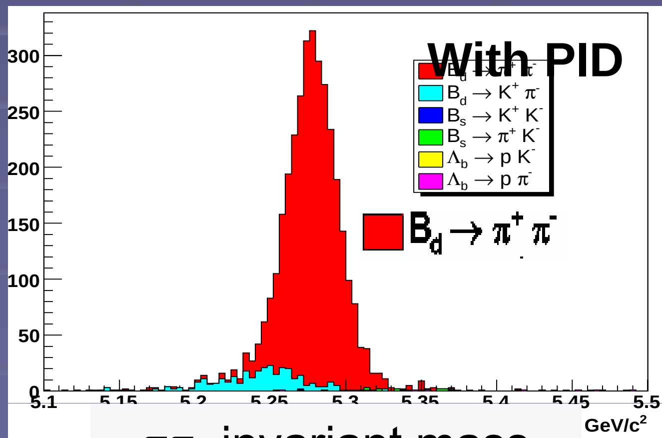
Particle ID performance

- Average efficiency:
  - K id = 88%
  - π mis-id = 3%

- Good K/π separation in 2–100 GeV/c range
  - Low momentum
    - kaon tagging
  - High momentum
    - clean separation of the different $B_{d,s}\rightarrow hh$ modes
    - will be the best performance ever achieved at a hadron collider



$\pi\pi$ invariant mass



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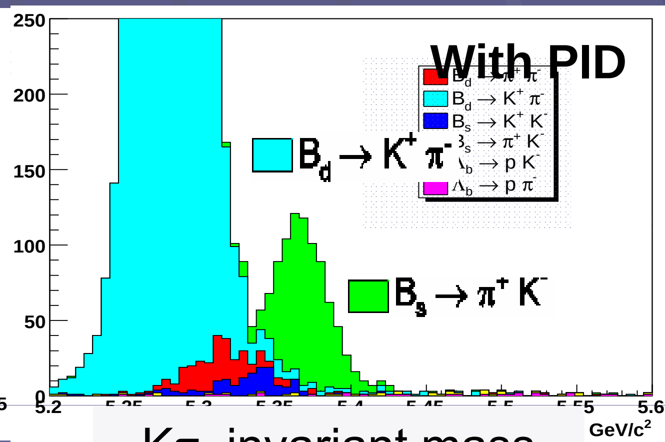
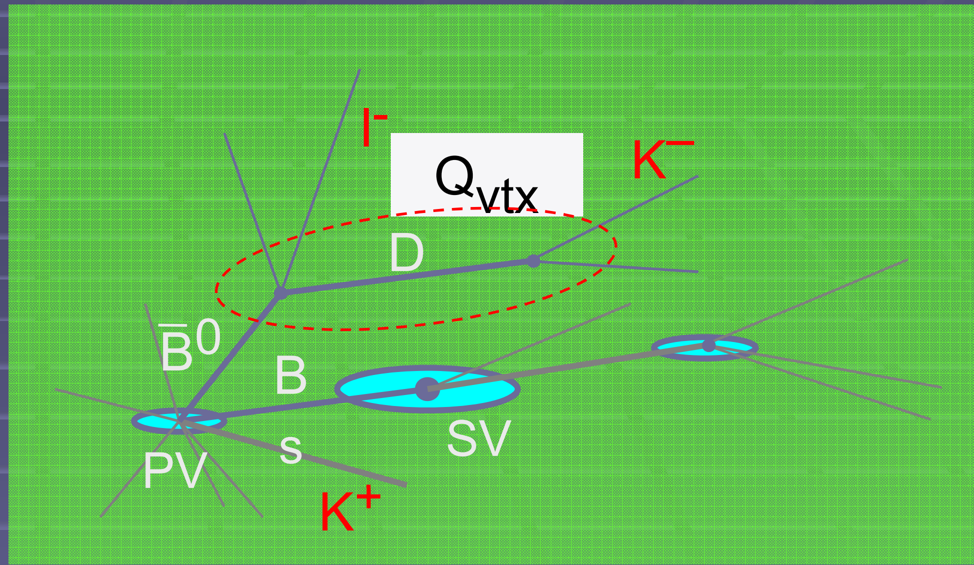


Kπ invariant mass

Flavour tagging

Tag	$\varepsilon D^2 = \varepsilon(1-2w)^2$
Opposite μ	0.7%–1.8%
Opposite e	0.4%–0.6%
Opposite K	1.6%–2.4%
Opposite Q_{vtx}	0.9%–1.3%
Same side π (B^0)	0.8%–1.0%
Same side K (B_s)	2.7%–3.3%
Combined (B^0)	4%–5%
Combined (B_s)	7%–9%



- Performance assessed on full MC, after trigger and reconstruction
- Kaon tags are the most powerful, e.g. opposite K (from $b \to c \to s$)
- All tags combined with neural network
- Tagging performance depends on how the event is triggered !
  - will be measured in data using control channels

Trigger performance & rates

- Algorithms and performance:
  - Level-0 trigger algorithms mature, 1 MHz output rate
  - High-Level Trigger (HLT) under development
    - Prototype available within time budget for a limited set of channels
  - L0*HLT efficiencies:
    - Determined using detailed MC simulation
    - Typically **30%–80%** for offline-selected signal events, depending on channel

- HLT output rates:
  - Indicative rates (split between streams still to be determined)
  - Large inclusive streams to be used to control calibration & systematics (trigger, tracking, PID, tagging)

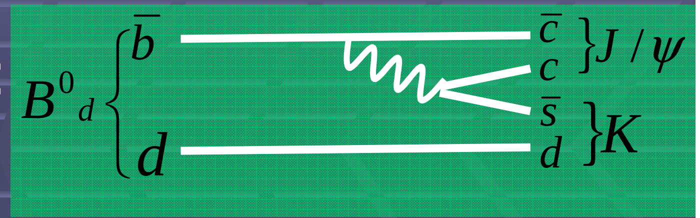
Output rate	Event type	Physics
200 Hz	Exclusive B candidates	B (core program)
600 Hz	High mass di-muons	J/ψ, $b \to J/\psi X$ (unbiased)
300 Hz	D* candidates	Charm
900 Hz	Inclusive b (e.g. $b \to \mu$)	B (data mining)

Integrated luminosity scenario

(before LHC problems of last weeks…)

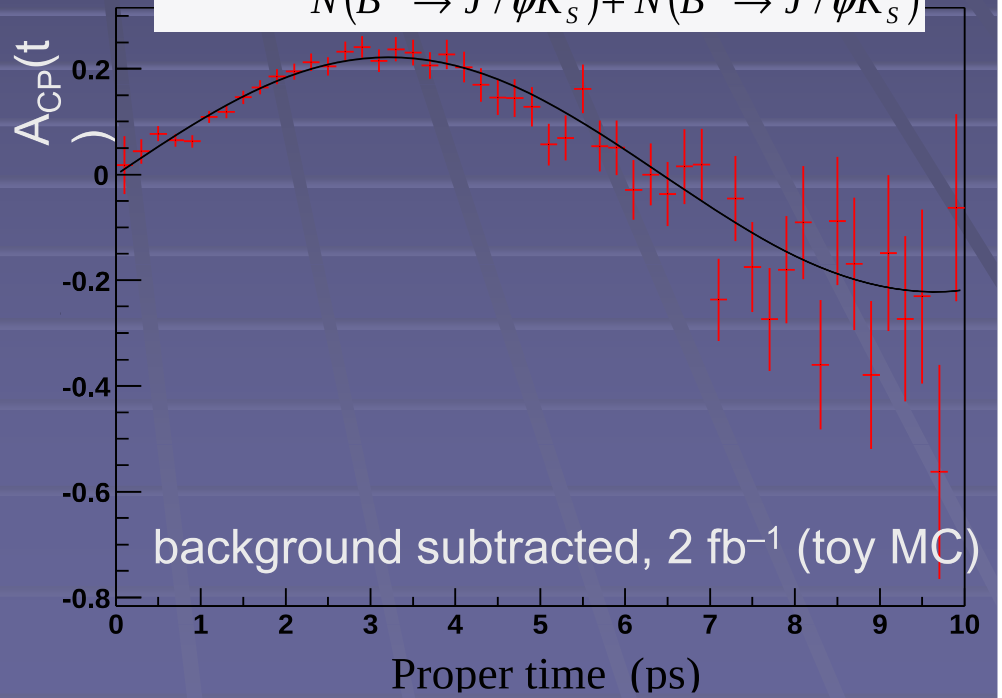
- 2007 (end):
  - Short pilot run at 450 GeV per beam with full detector installed
  - Establish running procedures, time and space alignment of the detectors
  - Integrated luminosity for physics **~ 0 fb^{-1}**
- 2008:
  - LHC reaches design energy
  - Complete commissioning of detector and trigger at $\sqrt{s}$=14 TeV
  - Calibration of momentum, energy and particle ID
  - Start of first physics data taking, assume **~ 0.5 fb^{-1}**
- 2009–:
  - Stable running, assume **~ 2 fb^{-1}/year**
- Availability of physics results:
  - with 0.5 fb^{-1} in ~2009
  - with 2 fb^{-1} in ~2010
  - with 10 fb^{-1} in ~2014

sin(2β) with $B^0 \to J/\psi K_S$

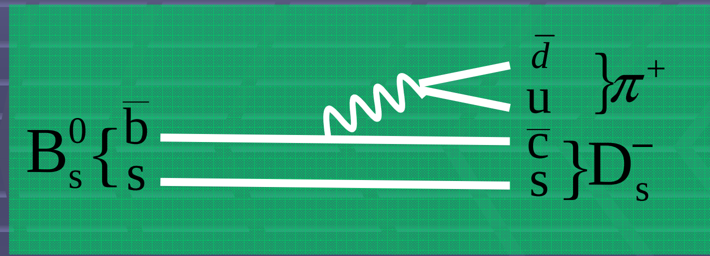


- Expected to be one of the first CP measurements:
  - Demonstrate (already with 0.5 fb^{-1}) that we can keep under control the main ingredients of a CP analysis
    - in particular tagging extraction from control channels
  - Sensitivity (from TDR, improved since):
    - ~ 216k signal events/2 fb^{-1}, B/S ~ 0.8
      $\Rightarrow \sigma_{stat}(\sin(2\beta)) = 0.02$
- With 10 fb^{-1}:
  - Should be able to reach σ(sin(2β)) ~ 0.010
    - to be compared with 0.017
      from final BaBar+Belle statistics
  - Can also push further the search for direct CP violating term $\propto \cos(\Delta m_d t)$

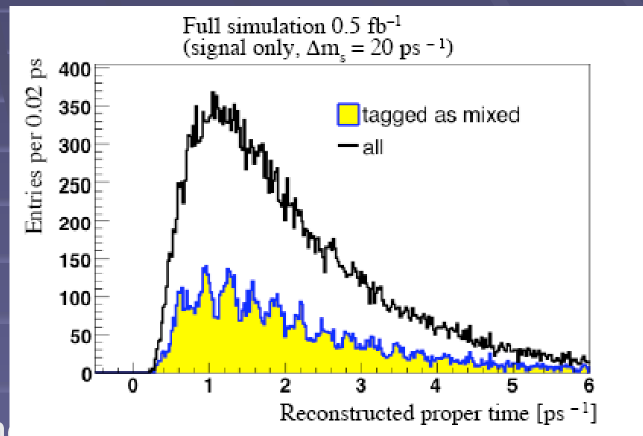
$$A_{CP}(t) = \frac{N(\bar{B}^0 \to J/\psi K_S) - N(B^0 \to J/\psi K_S)}{N(\bar{B}^0 \to J/\psi K_S) + N(B^0 \to J/\psi K_S)}$$



$B_s \to D_s^- \pi^+$ sample and B_s mixing



- Measurement of Δm_s:
  - CDF observed B_s oscillations in 2006:
    - Δm_s =17.77 0.10 0.07 ps^{-1} compatible with SM
  - LHCb expectation with 0.5 fb^{-1}:
    - ~35k $B_s \to D_s^- \pi^+$ signal events with average σ_t ~ 40 fs and B_{bb}/S < 0.05 at 90% CL $\Rightarrow \sigma_{stat}(\Delta m_s)$ = 0.012 ps^{-1}, i.e. 0.07%
    - will be completely dominated by systematics on proper time scale, but at most $\sigma(\tau(B^0))/\tau(B^0)$ = 0.5%

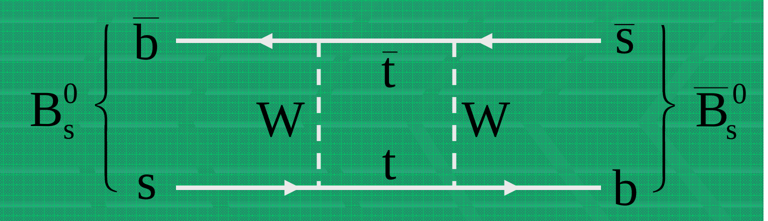


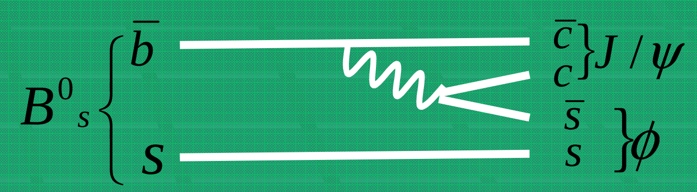
- Importance of $B_s \to D_s^- \pi^+$ sample:
  - Normalization channel for all B_s branching fraction measurements
    - First absolute measurement from Belle, BR($B_s \to D_s^- \pi^+$) = (0.68 0.22 0.16)%, expect soon ~10% measurement
  - Control channel for all time-dependent analyses with B_s decays
    - Measurement of dilution on cos($\Delta m_s t$) and sin($\Delta m_s t$) terms
  - Important step towards measurement of other B_s mixing parameters
    - e.g. mixing phase or CP violation in mixing

B_s mixing phase ϕ_s with $b \to c\bar{c}s$

- ϕ_s is the strange counterpart of $\phi_d = 2\beta$:
  - ϕ_s very small in SM
  - $\phi_s^{SM} = -\arg(V_{ts}^2) = -2\lambda\eta^2 =$ **–0.036   0.003** (CKMfitter)
  - Could be much larger if New Physics runs in the box
- Golden $b \to ccs$ mode is $B_s \to J/\psi\phi$:
  - Angular analysis needed to separate CP-even and CP-odd contributions
  - Expect ~130k $B_s \to J/\psi(\mu\mu)\phi$ signal events/2fb^{-1} (before tagging), $S/B_{bb} = 8$
- Add also pure CP modes such as $J/\psi\eta^{(')}$, $\eta_c\phi$, D_sD_s
  - No angular analysis needed, but smaller statistics
- Combined sensitivity after 10 fb^{-1}:
  - dominated by $B_s \to J/\psi\phi$
  - systematics (tagging, resolution) need to be tackled
  - hopefully >3σ evidence of non-zero ϕ_s, even if only SM

$\sigma_{stat}(\phi_s) = 0.010$



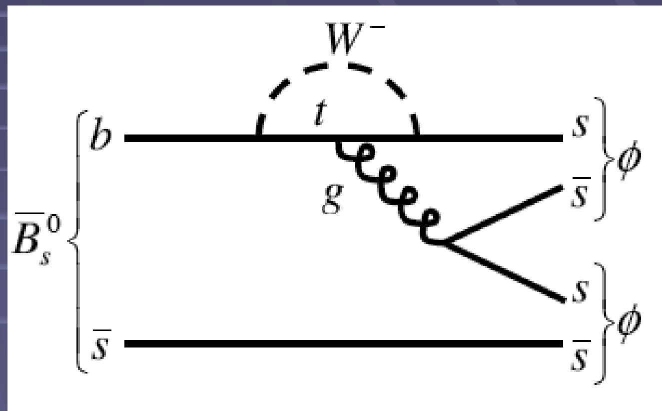


Statistical sensitivities on ϕ_s for 2 fb^{-1}

Channels	$\sigma(\phi_s)$ [rad]
$B_s \to J/\psi\ \eta(\pi^+\ \pi^-\ \pi^0)$	0.142
$B_s \to D_sD_s$	0.133
$B_s \to J/\psi\ \eta(\gamma\ \gamma)$	0.109
$B_s \to \eta_c\phi$	0.108
Combined (pure CP eigenstates)	**0.060**
$B_s \to J/\psi\phi$	0.023
Combined (all CP eigenstates)	**0.022**

$b \to s s \bar{s}$ hadronic penguin decays

- Time-dependent CP analysis of penguin decays to CP eigenstates



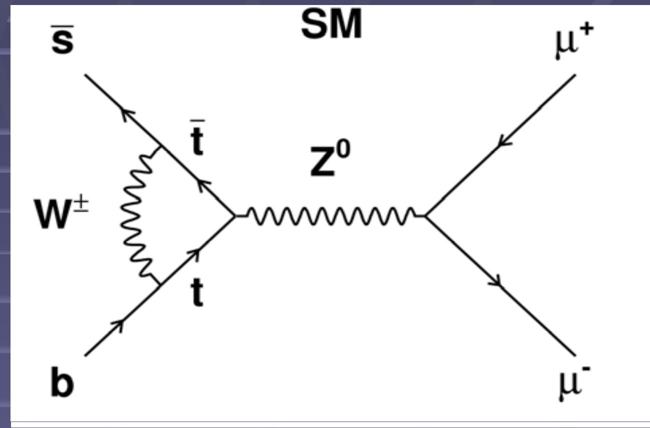
- $B^0 \to \phi K_S$:
  - 800 signal events per 2 fb^{-1}, B/S < 2.4 at 90% CL
  - After 10 fb^{-1}: **$\sigma_{stat}(\sin(2\beta_{eff})) = 0.14$**
  - Similar to a B factory experiment

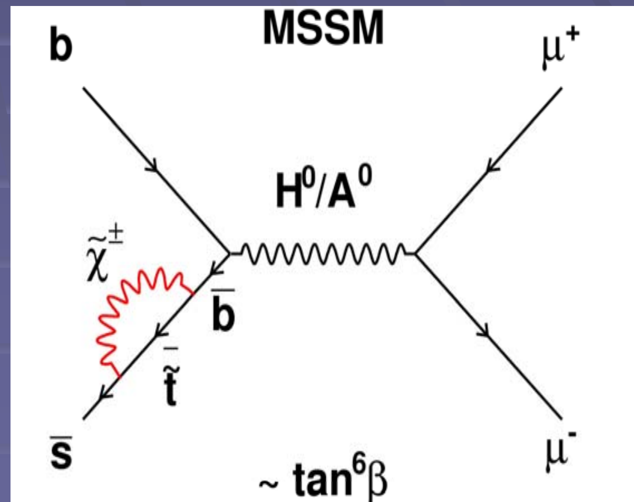
- $B_s \to \phi\phi$:
  - CP violation < 1% in SM
    (V_{ts} enters both in mixing and decay amplitudes)
    $\to$ significant CP-violating phase ϕ^{NP} would be due to New Physics
  - Angular analysis required
  - 4k signal events per 2 fb^{-1} (if BR=1.4×10^{-5}), 0.4 < B/S < 2.1 at 90%CL
  - After 10 fb^{-1}: **$\sigma_{stat}(\phi^{NP}) = 0.042$**

$$\lambda_{\phi\phi}^{SM} = \frac{q}{p}\frac{\bar{A}_{\phi\phi}}{A_{\phi\phi}} = \underbrace{\frac{V_{tb}V_{ts}^*}{V_{tb}^*V_{ts}}}_{\text{mixing}}\underbrace{\frac{V_{tb}^*V_{ts}}{V_{tb}V_{ts}^*}}_{\text{decay}} = 1$$

$B_s \to \mu^+\mu^-$

- Very rare loop decay, sensitive to new physics:
  - BR ~3.5×10^{-9} in SM, can be strongly enhanced in SUSY
  - Current 90% CL limit from CDF+D0 with 1 fb^{-1} is ~20 times SM
- Main issue is background rejection
  - with limited MC statistics, indication that main background is $b\to\mu$, $b\to\mu$
  - assume background is dominated by $b\to\mu$, $b\to\mu$

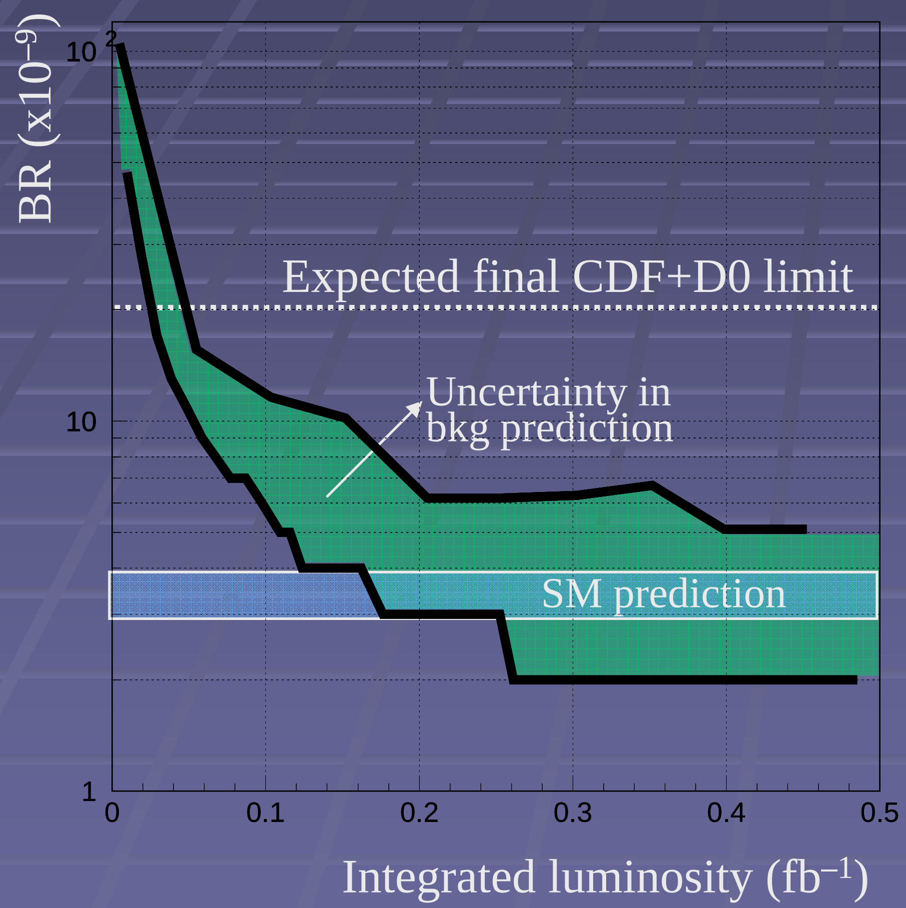




$B_s \to \mu^+\mu^-$

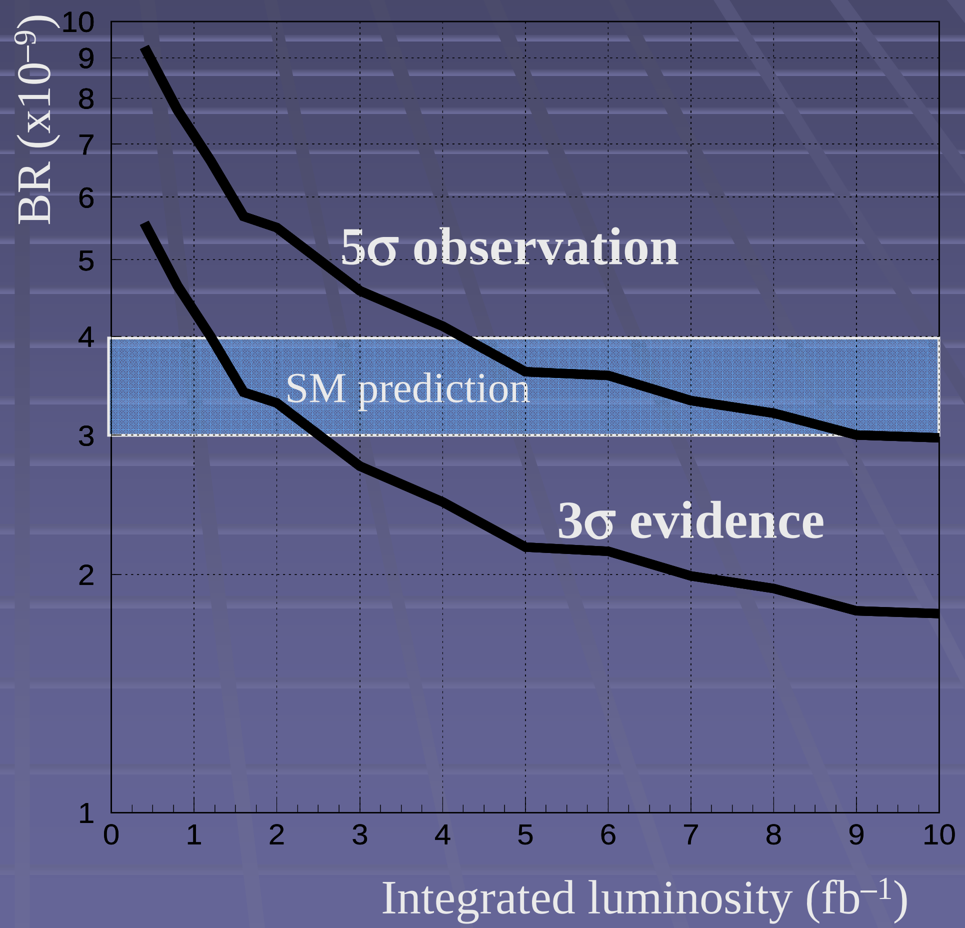
LHCb limit on BR at 90% CL

(only bkg is observed)



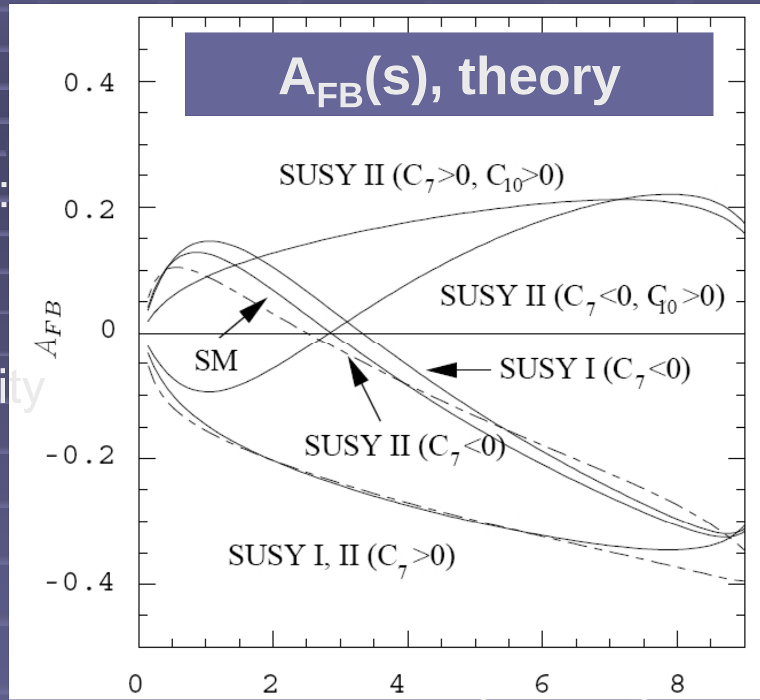
LHCb sensitivity

(signal+bkg is observed)

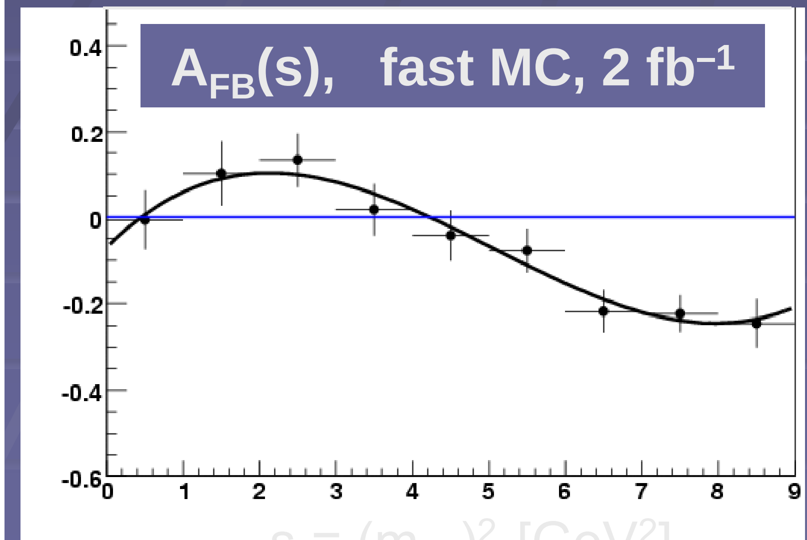


$B^0 \rightarrow K^{*0}\mu^+\mu^-$

- Suppressed loop decay, BR ~1.2×10^{-6}
  - Forward-backward asymmetry $A_{FB}(s)$ in the $\mu\mu$ rest-frame is sensitive probe of New Physics:
    - Predicted zero of $A_{FB}(s)$ depends on Wilson coefficients C_7^{eff}/C_9^{eff}
  - Other sensitive observables based on transversity angles are accessible



s = $(m_{\mu\mu})^2$ [GeV^2]



- Sensitivity
  (ignoring non-resonant $K\pi\mu\mu$ evts for the time being)
  - 7.7k signal events/2fb^{-1}, $B_{bb}/S = 0.4 \quad 0.1$
  - After 10 fb^{-1}:
    zero of $A_{FB}(s)$ located to 0.28 GeV^2
    → determine C_7^{eff}/C_9^{eff} with 7% stat error (SM)

Other rare decays

- $B^+ \to K^+l^+l^-$ decays
  - $\mu\mu$/ee ratio equal to 1 in SM:

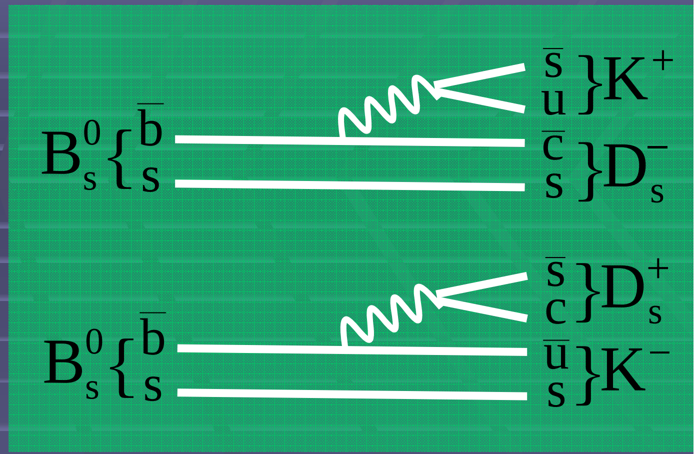
Hiller & Krüger, PhysRevD69;074020,2004

  - New Physics can have O(10%) effect
  - After 10 fb^{-1}: $\sigma_{stat}(R_K) = 0.043$
- Radiative decays:
  - $K^*\gamma$:
    - $A_{CP} < 1\%$ in SM, up to 40% in SUSY
    - Can measure at <% level
  - $\phi\gamma$:
    - No mixing-induced CP asymmetry in SM, up to 50% in SUSY
  - $\Lambda\gamma$:
    - Right-handed component of photon polarization O(10%) in SM
    - Can get 3σ evidence down to 15% (10 fb^{-1})
- LFV decays e.g. $B_{d,s} \to e\mu$

Decay	2 fb^{-1} yield	B_{bb}/S
$B^+ \to K^+\mu\mu$	3.8k	~1
$B^+ \to K^+ee$	1.9k	~5
$B_d \to K^*\gamma$	35k	< 0.7
$B_d \to \omega\gamma$	40	< 3.5
$B_s \to \phi\gamma$	9k	< 2.4
$\Lambda_b \to \Lambda(1115)\gamma$	0.75k	< 42
$\Lambda_b \to \Lambda(1520)\gamma$	4.2k	< 10
$\Lambda_b \to \Lambda(1670)\gamma$	2.5k	< 18
$\Lambda_b \to \Lambda(1690)\gamma$	2.2k	< 18

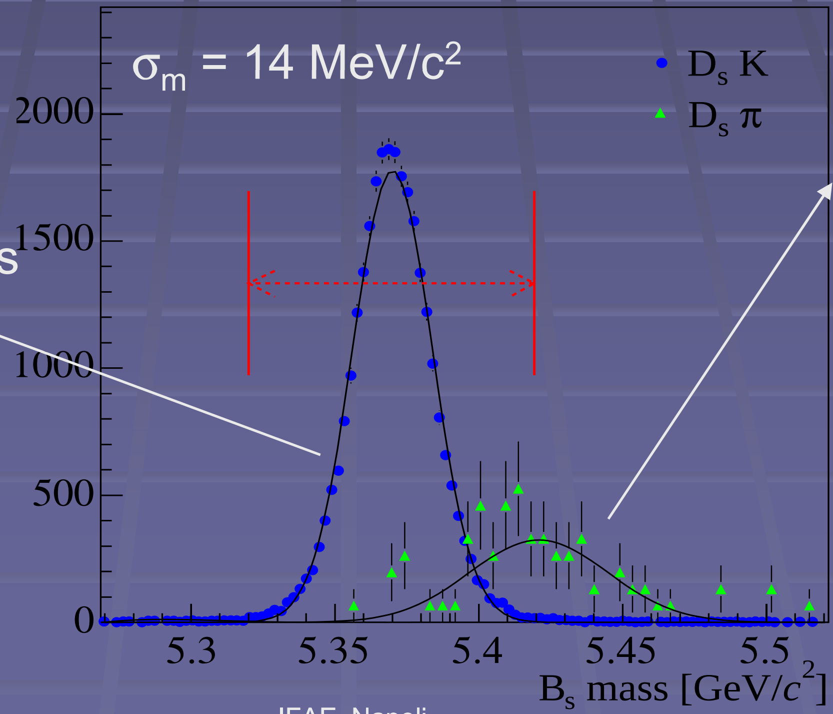
γ from $B_s \rightarrow D_sK$

- Two tree decays ($b\rightarrow c$ and $b\rightarrow u$), which interfere via B_s mixing:
  - can determine $\phi_s + \gamma$, hence γ in a very clean way
  - similar to $2\beta+\gamma$ extraction with $B^0 \rightarrow D^*\pi$, but with the advantage that the two decay amplitudes are similar ($\sim\lambda^3$) and that their ratio can be extracted from data



Expect 6200 signal events in 2 fb^{-1}

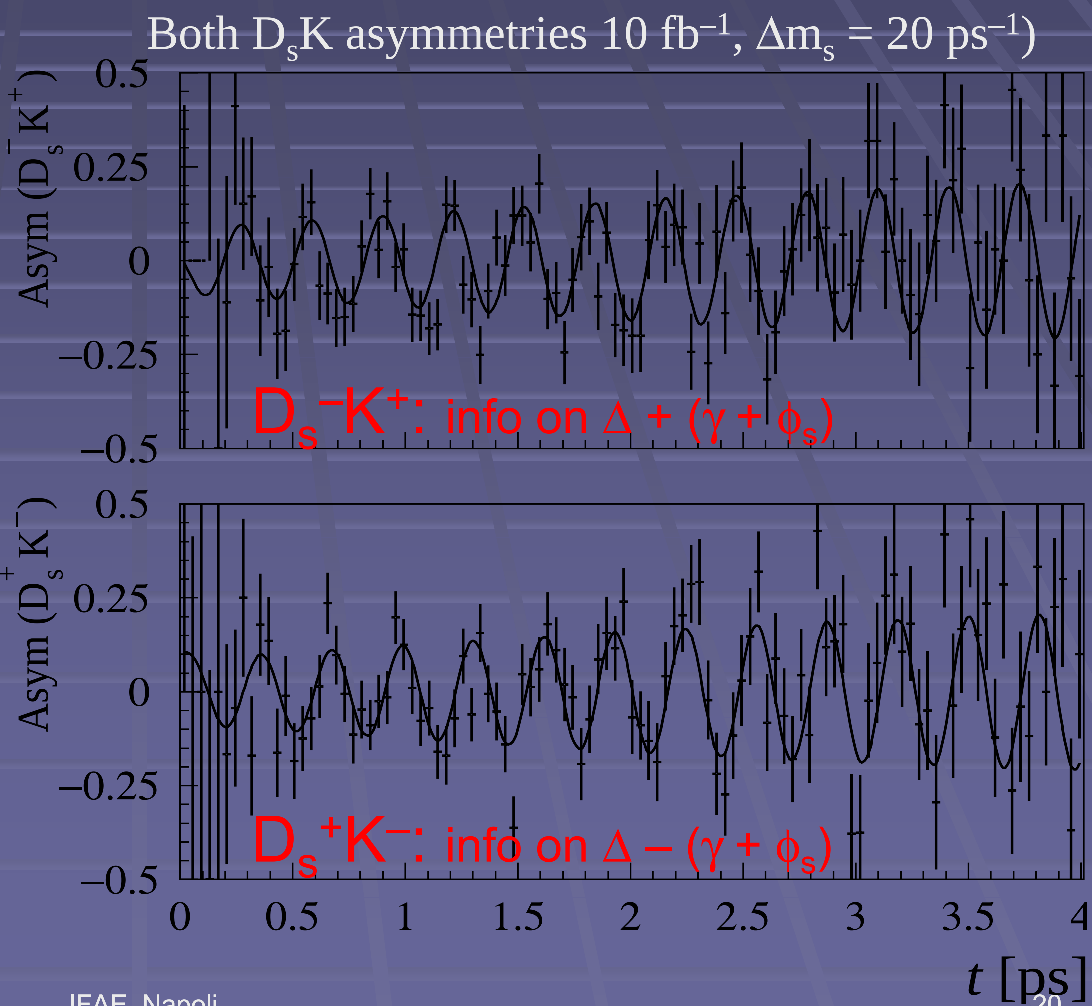
$B_{bb}/S < 0.5$



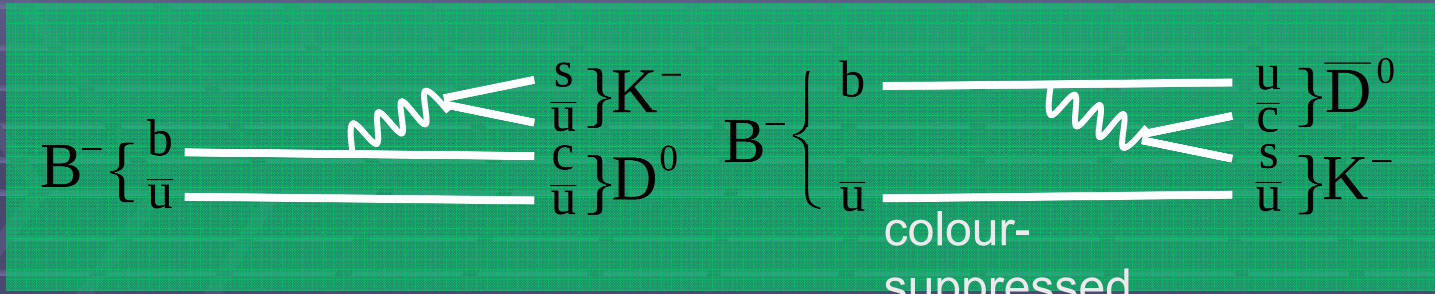
$B_s \rightarrow D_s^-\pi^+$ background (with ~ 15 $\times$ larger BR) suppressed using PID: $\rightarrow$ residual contamination only ~ 10%

γ from $B_s \to D_sK$

- Fit the 4 tagged time-dependent rates:
  - Extract $\phi_s + \gamma$, strong phase difference Δ, amplitude ratio
  - $B_s \to D_s\pi$ also used in the fit to constrain other parameters (mistag rate, Δm_s, $\Delta\Gamma_s$ …)
- $\sigma(\gamma)$ ~ 13° with 2 fb^{-1}
  - expected to be statistically limited



γ from $B^{\pm} \to D^0K^{\pm}$



colour-suppressed

Weak phase difference = γ

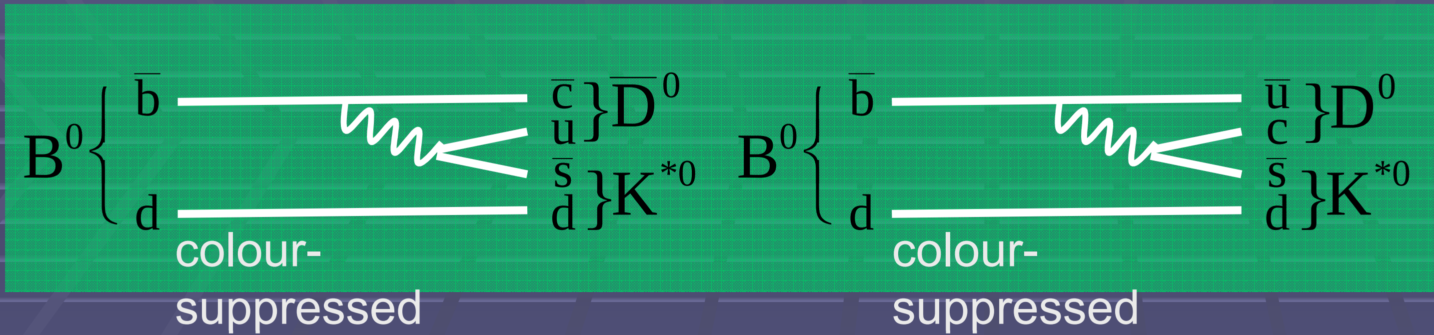
Magnitude ratio = r_B ~ 0.08

- "ADS+GLW" strategy:
  - Measure the relative rates of $B^- \to DK^-$ and $B^+ \to DK^+$ decays with neutral D's observed in final states such as: $K^-\pi^+$ and $K^+\pi^-$, $K^-\pi^+\pi^-\pi^+$ and $K^+\pi^-\pi^+\pi^-$, K^+K^-
  - These depend on:
    - Relative magnitude, weak phase and strong phase between $B^- \to D^0K^-$ and $B^- \to \bar{D}^0K^-$
    - Relative magnitudes (known) and strong phases between $D^0 \to K^-\pi^+$ and $D^0 \to K^-\pi^+$, and between $D^0 \to K^-\pi^+\pi^-\pi^+$ and $D^0 \to K^-\pi^+\pi^-\pi^+$
  - Can solve for all unknowns, including the weak phase γ:

    $\sigma(\gamma)$ = 5–15° with 2 fb^{-1}
  - Use of B → D*K under study

Decay	2 fb^{-1} yield	B_{bb}/S
$B^- \to (K^-\pi^+)_D K^-$	28k	~0.6
$B^+ \to (K^+\pi^-)_D K^+$	28k	~0.6
$B^- \to (K^+\pi^-)_D K^-$	180	4.3
$B^+ \to (K^-\pi^+)_D K^+$	530	1.5

γ from $B^0 \rightarrow D^0K^{*0}$



Weak phase difference = γ
Magnitude ratio = $r_B \sim 0.4$

- Treat with same ADS+GLW method
  - So far used only D decays to $K^-\pi^+$, $K^+\pi^-$, K^+K^- and $\pi^+\pi^-$ final states

$\sigma(\gamma)$ = 7–10° with 2 fb^{-1}

Decay mode (+cc)	2 fb^{-1} yield	B_{bb}/S
$B^0 \rightarrow (K^+\pi^-)_D K^{*0}$	3400	<0.3
$B^0 \rightarrow (K^-\pi^+)_D K^{*0}$	500	<1.7
$B^0 \rightarrow (K^+K^-, \pi^+\pi^-)_D K^{*0}$	600	<1.4

γ from $B \rightarrow DK$ Dalitz analyses

- $B \rightarrow D(K_S\pi^+\pi^-)K$:
  - D^0 and anti-D^0 contributions interfere in Dalitz plot
  - If good online K_S reconstruction: 5k signal events in 2 fb^{-1}, B/S < 1
  - Assuming signal only and flat acceptance across Dalitz plot:
    $\sigma(\gamma) = 8°$ with 2 fb^{-1}

- $B^0 \rightarrow D(K_S\pi^+\pi^-)K^{*0}$:
  - Under study

- $B \rightarrow D(KK\pi\pi)K$:
  - Four-body "Dalitz" analysis
  - 1.7 k signal events in 2 fb^{-1}
  - Assuming signal only and flat acceptance across Dalitz plot:
    $\sigma(\gamma) = 15°$ with 2 fb^{-1}

Sensitivities to γ from $B \to DK$ decays

B mode	D mode	Method	$\sigma(\gamma)$, 2 fb^{-1}
$B^+ \to DK^+$	$K\pi$ + $KK/\pi\pi$ + $K3\pi$	ADS+GLW	5º–15º
$B^+ \to D^*K^+$	$K\pi$	ADS+GLW	Under study
$B^+ \to DK^+$	$K_S\pi\pi$	Dalitz	8º
$B^+ \to DK^+$	$KK\pi\pi$	4-body "Dalitz"	15º
$B^+ \to DK^+$	$K\pi\pi\pi$	4-body "Dalitz"	Under study
$B^0 \to DK^{*0}$	$K\pi$ + KK + $\pi\pi$	ADS+GLW	7º–10º
$B^0 \to DK^{*0}$	$K_S\pi\pi$	Dalitz	Under study
$B_s \to D_sK$	$KK\pi$	tagged, A(t)	13º

} Signal only, no accept. effect (applies to the $K_S\pi\pi$ Dalitz and $KK\pi\pi$ 4-body "Dalitz" rows)

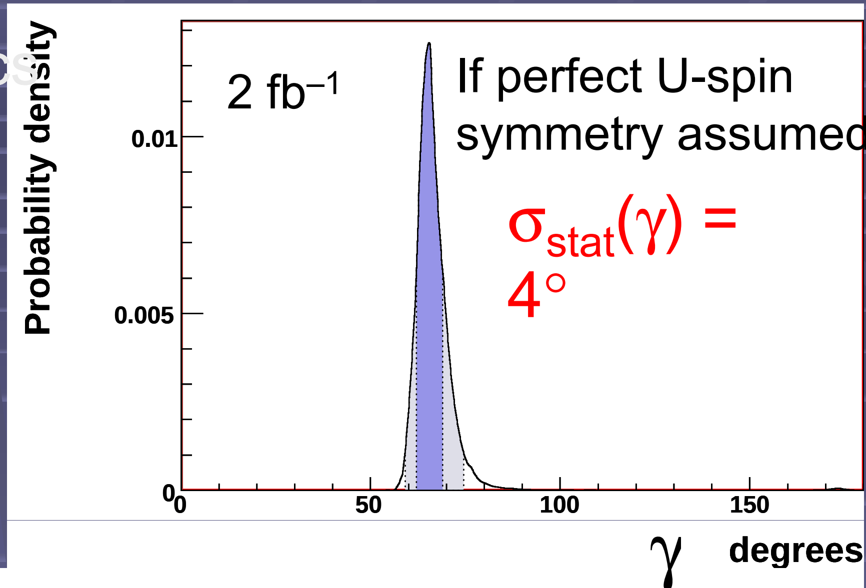
- All channels combined (educated guess):
  - $\sigma(\gamma)$ = 4.2º with 2 fb^{-1}
  - $\sigma(\gamma)$ = 2.4º with 10 fb^{-1}

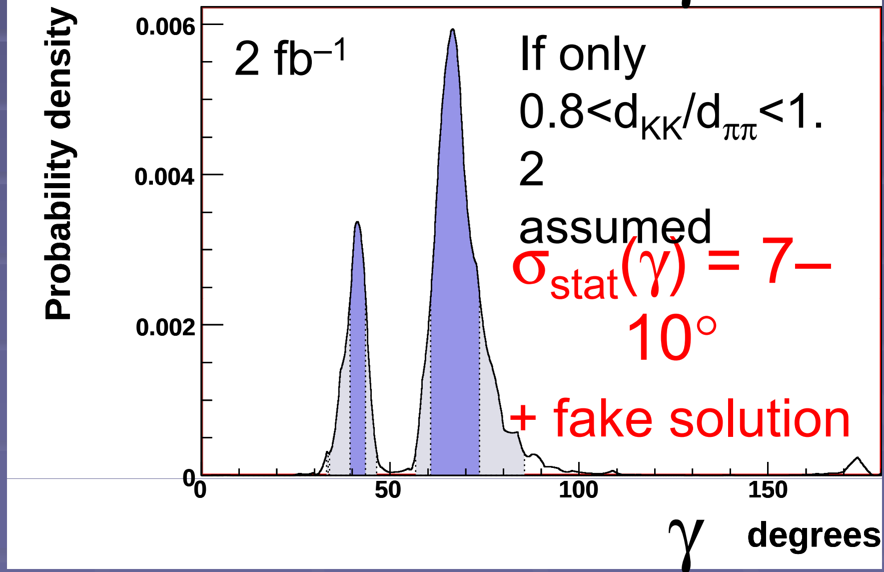
γ from $B_d \to \pi^+\pi^-$ and $B_s \to K^+K^-$

- Penguin decays, sensitive to New Physics
- Measure CP asymmetry in each mode:

$$A_{CP}(t) = A_{dir}\cos(\Delta m t) + A_{mix}\sin(\Delta m t)$$

  - A_{dir} and A_{mix} depend on mixing phase, angle γ, and ratio of penguin to tree amplitudes = d $e^{i\theta}$
- Exploit U-spin symmetry (Fleischer):
  - Assume $d_{\pi\pi}=d_{KK}$ and $\theta_{\pi\pi}=\theta_{KK}$
  - 4 measurements and 3 unknowns (taking mixing phases from other modes) → can solve for γ
- With 2 fb^{-1}:
  - 36k $B^0 \to \pi^+\pi^-$, B/S ~ 0.54
    36k $B_s \to K^+K^-$, B/S < 0.14
  - Sensitivity to A_{dir} and A_{mix} ~ twice better than current world average





Charm physics

- Foresee dedicated D* trigger:
  - Huge sample of $D^0 \to h^+h^-$ decays
  - Tag D^0 or anti-D^0 flavor with sign of pion from $D^* \to D^0\pi$
- Performance studies not as detailed as for B physics
  - just started

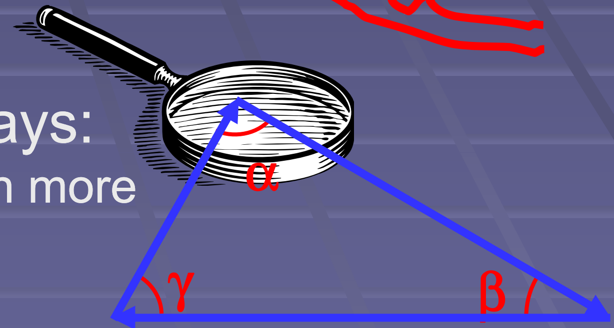
Potentially usable statistics in 10 fb^{-1}	
$D^* \to D^0(hh)\pi$	500M
D^*-tagged $D^0 \to K^+K^-$ from b-hadrons	25M
D^*-tagged WS $D^0 \to K^+\pi^-$ from b-hadrons	1M

- Interesting (sensitive to NP) & promising searches/measurements:
  - Time-dependent D^0 mixing with wrong-sign $D^0 \to K^+\pi^-$ decays
  - Direct CP violation in $D^0 \to K^+K^-$
    - ACP $\leq 10^{-3}$ in SM, up to 1% (~current limit) with New Physics
    - Expect $\sigma_{stat}(A_{CP}) \sim O(10^{-3})$ with 2 fb^{-1}
  - $D^0 \to \mu^+\mu^-$
    - BR $\leq 10^{-12}$ in SM, up to 10^{-6} (~current limit) with New Physics
    - Expect to reach down to $\sim 5 \times 10^{-8}$ with 2 fb^{-1}

Summary

- LHCb can chase New Physics in loop decays:
  - couple superb highly-sensitive b→s observables
    - $B_s \to \mu\mu$, B_s mixing phase
      - expect interesting results with 0.5 fb^{-1} and 2 fb^{-1} already
      - can measure down to SM with 10 fb^{-1} (in case of no New Physics)
  - several other exciting windows of opportunity:
    - Exclusive b → sss Penguin decays (limited, even with 10 fb^{-1})
    - Exclusive b→sll and $b \to s\gamma$
    - B→ hh Penguins
    - High statistics charm physics

- LHCb can improve significantly on γ from tree decays:
  - use together with other UT observables to test CKM even more



But …

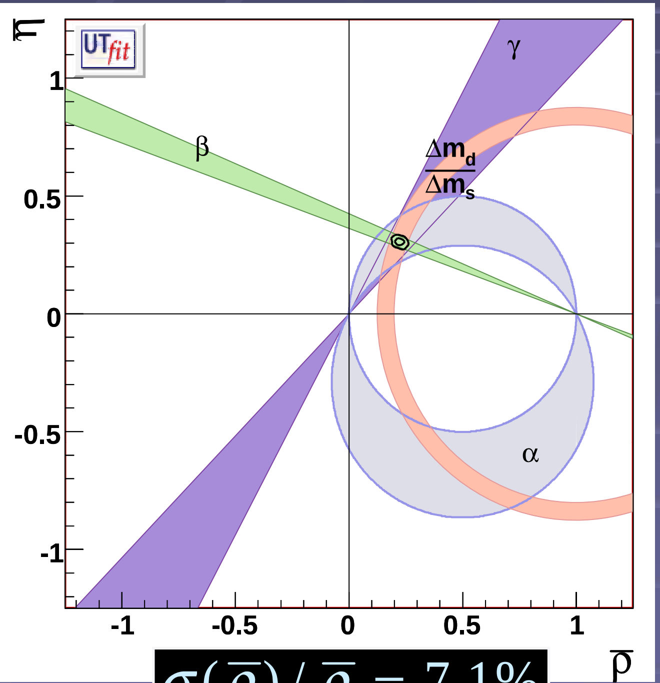
- this is only MC, performance not demonstrated in real life yet
  → another 2 years to go !

spares

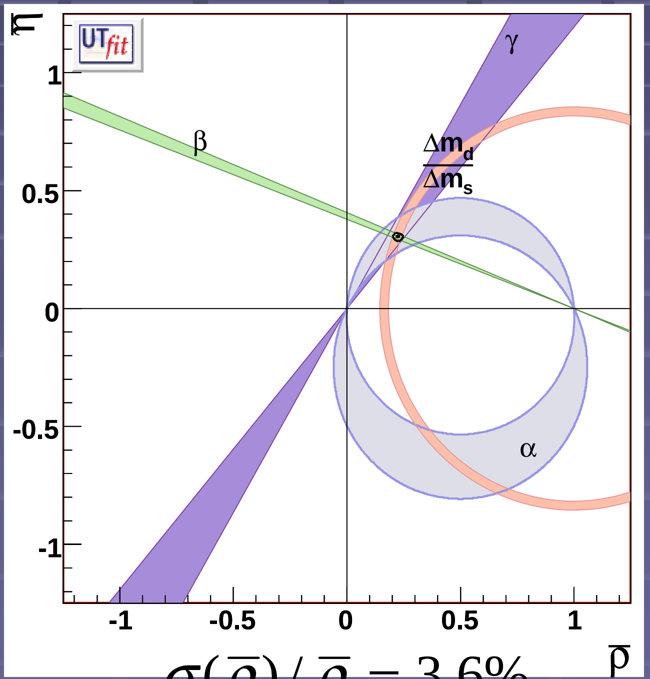
Impact of LHCb on UT

LHCb + LQCD only

2 fb^{-1} (2010) **10 fb^{-1} (2014)**



$$\sigma(\bar{\rho})/\bar{\rho} = 7.1\%$$
$$\sigma(\bar{\eta})/\bar{\eta} = 3.9\%$$



$$\sigma(\bar{\rho})/\bar{\rho} = 3.6\%$$
$$\sigma(\bar{\eta})/\bar{\eta} = 1.8\%$$

- LHCb (2 fb^{-1}, 10 fb^{-1}):
  - LHCb:
  - $\sigma(\sin(2\beta))$ = 0.02, 0.01
  - $\sigma(\gamma)$ = 4.2º, 2.4º
  - $\sigma(\alpha)$ = 10º, 4.5º
- Lattice QCD (2010, 2014):
  - 40, 1000 Tflop year
  - $\sigma(\xi)/\xi$ = 2.5%, 1.5%
- Central values:
  - SM assumed (just for illustration)

From V. Vagnoni, CKM workshop, Dec 2006

MC studies

- Technical proposal (1998):
  - Rough detector description
  - No trigger simulation
  - No pattern recognition in tracking
  - Parametrized PID performance
- Re-opt. Technical Design Report (2003)
  - Final detector design
  - Simulation of L0 and L1 trigger only
  - First version of full pattern recognition
- "DC04" MC datasets (2004–2005):
  - Detailed material description
  - First simulation of High-Level Trigger
- "DC06" MC datasets (2006–2007):
  - "Final" geometry and material description
  - Redesigned High-Level Trigger
  - "Final" reconstruction algorithms

REMINDER of important requirements for B physics
- Flexible and efficient trigger
  - final states with leptons
  - fully hadronic final states
- Excellent tracking:
  - Track finding efficiency
  - Momentum and mass resolution
  - Vertexing, proper time resolution
- Particle identification ($p/K/\pi/\mu/e$)

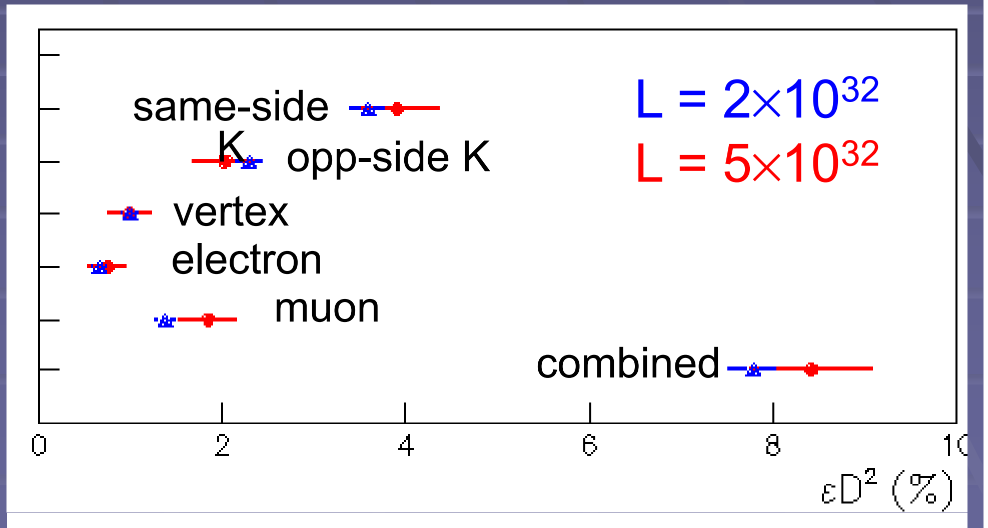
Background estimates:
– based on a sample of inclusive bb events equivalent to a few minutes of data taking !
– sometimes can only set limits

oday's numbers: mostly from DC04 MC, at <L> = 2×10^{32} cm^{-2}s

Physics performance vs L

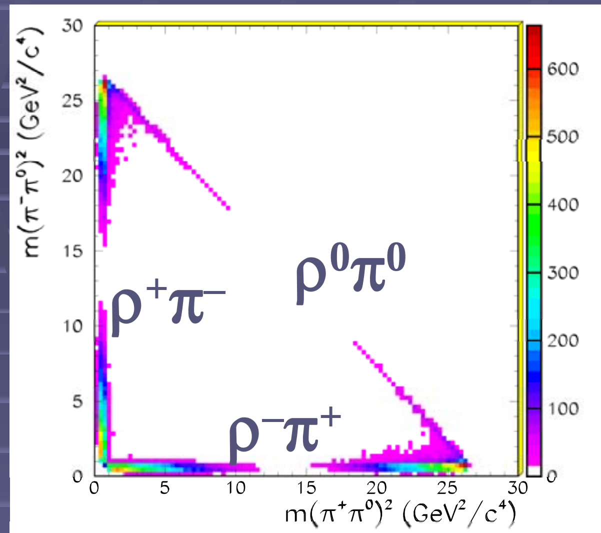
- Rough and quick study:
  - small MC samples generated at <L> = 5×10^{32} cm^{-2}s^{-1} for a few representative signal channels
  - backgrounds not investigated yet (but will be possible with DC06 samples)

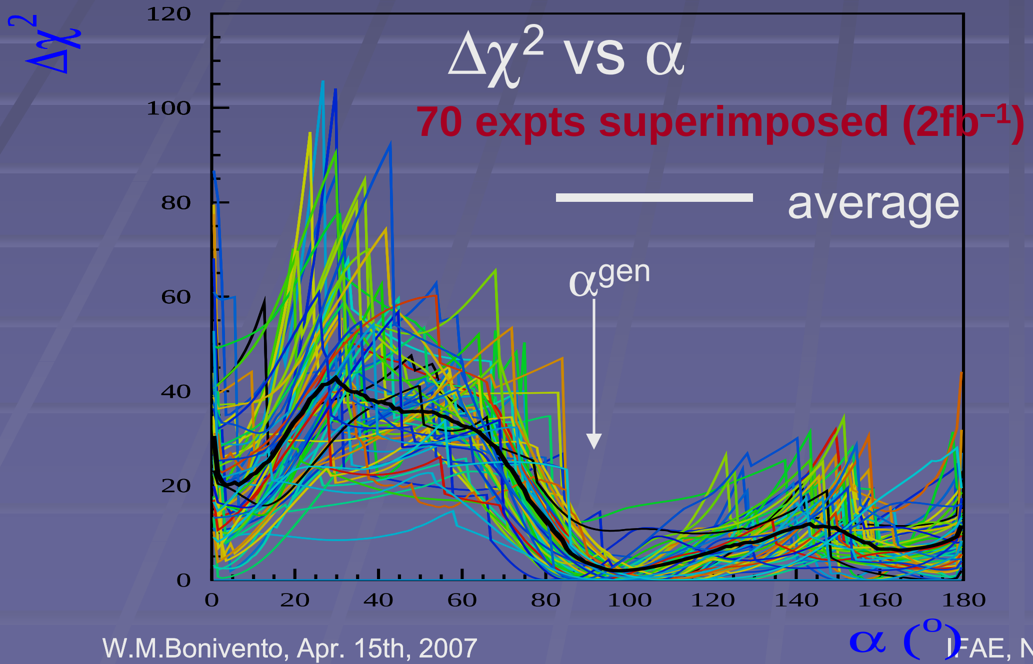
- Preliminary overall conclusion (for L = 2–5×10^{32} cm^{-2}s^{-1}):
  - Significant gain for dimuon channels
    - yield $\propto$ L
  - "Status quo" for hadronic channels
    - yield ~ constant
  - Tagging performance seems ~constant (at least for $B_s \to D_sK$)

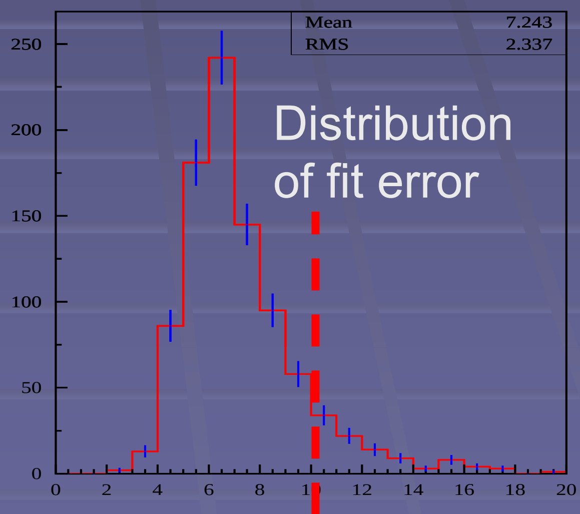


Sensitivity to α

- SU(2) analysis of $B^0 \to \rho^+\rho^-$, $\rho\ \rho^0$, $\rho^0\rho^0$:
  - Main LHCb contribution could be $B^0 \to \rho^0\rho^0$
- Time-dependent Dalitz plot analysis of $B^0 \to \rho\pi \to \pi^+\pi^-\pi^0$ (Snyder & Quinn)
  - 14k signal events/2fb^{-1}, B/S ~1





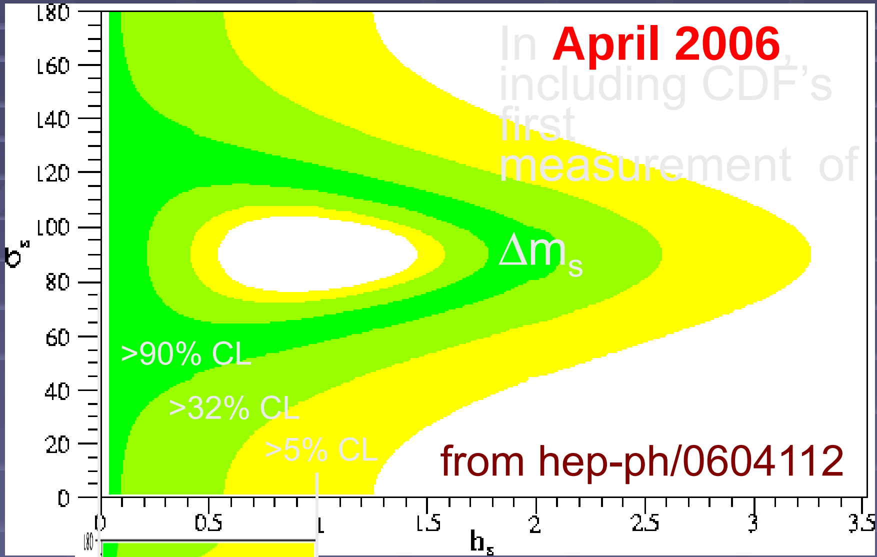


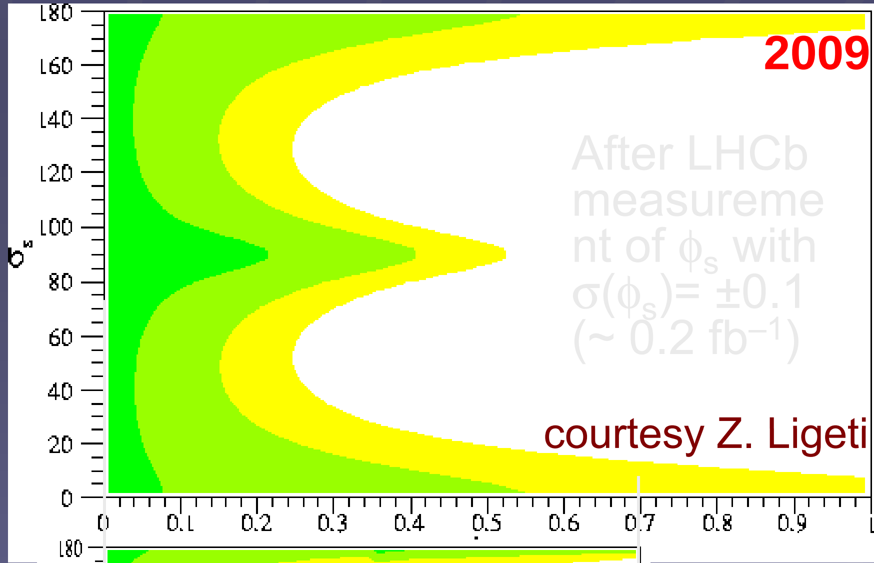
15% (< 1%) fake solutions with 2 (10) fb^{-1}

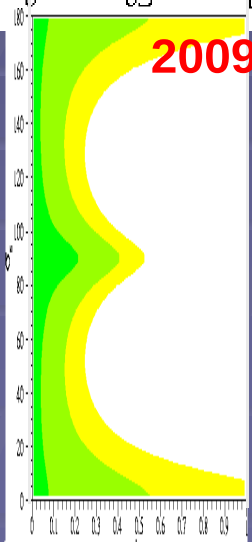
$\sigma_{stat}(\alpha) < 10^o$ in 90% of the cases (2 fb^{-1})

Constraints on New Physics in B_s mixing from ϕ_s measurement

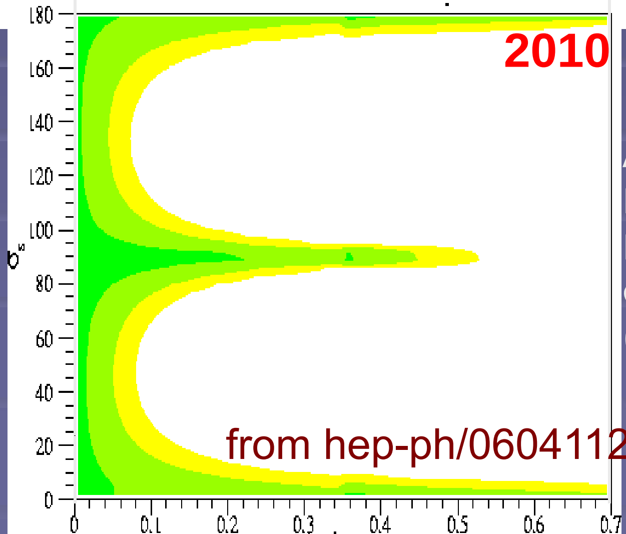
New physics in B_s mixing parametrized with h_s and σ_s : $M_{12} = (1 + h_s \exp(2i\sigma_s))\, M_{12}^{SM}$







After LHCb
measureme
nt of ϕ_s with
$\sigma(\phi_s)$= ±0.1
(~ 0.2 fb^{-1})



After LHCb
measureme
nt of ϕ_s with
$\sigma(\phi_s)$= ±0.03
(~ 2 fb^{-1})