B Physics prospects at LHCb

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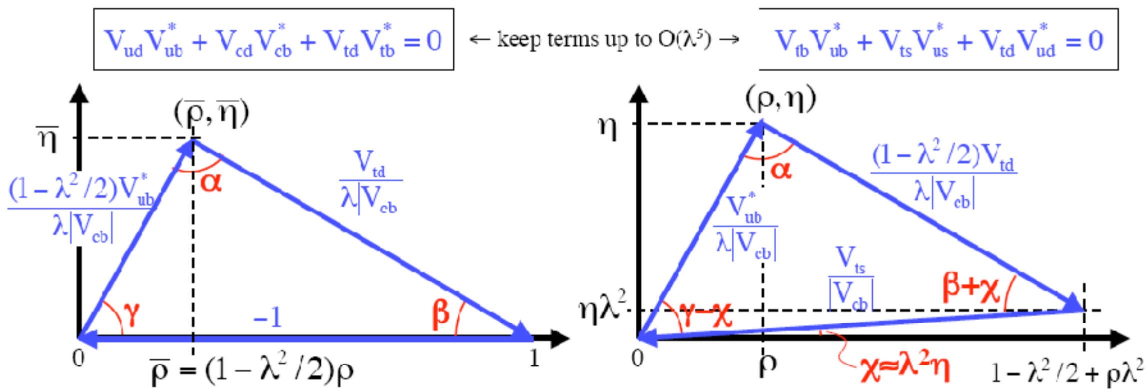
- Physics motivations
- Detector requirements
- Physics program

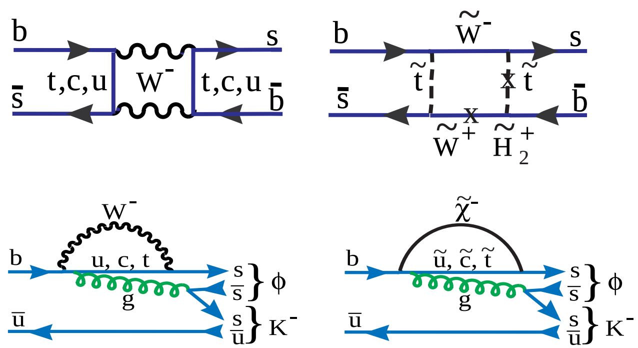
Physics motivation

- LHCb is a dedicated B physics precision experiment at LHC to study CP violation and rare decays
- Standard Model describes CP violation by a single complex phase in the unitary CKM matrix
- We will over constrain the unitarity triangles and search for new physics



LHCb precision enough to distinguish unitarity triangles (equal up to the λ^3 order)

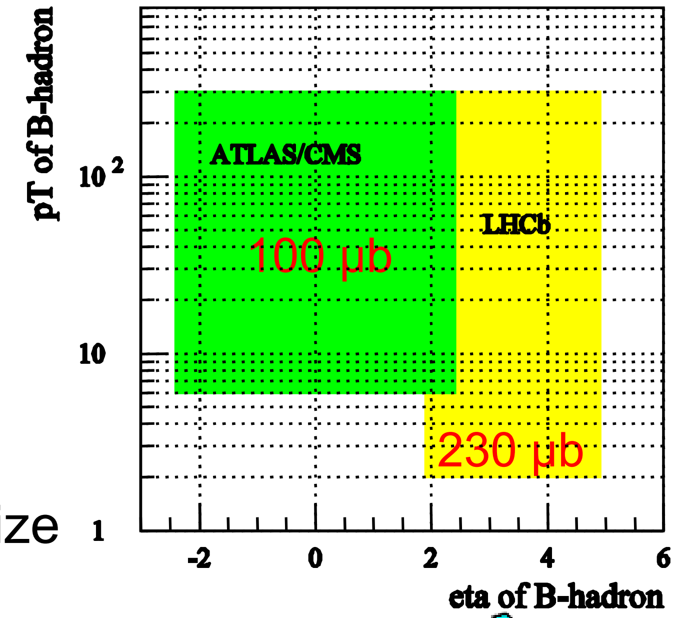
- New Physics can manifest through the exchange of a new intermediate particle in box and penguin diagram
  - compare measurements where NP effects are expected with tree level ones (no loop or penguins)



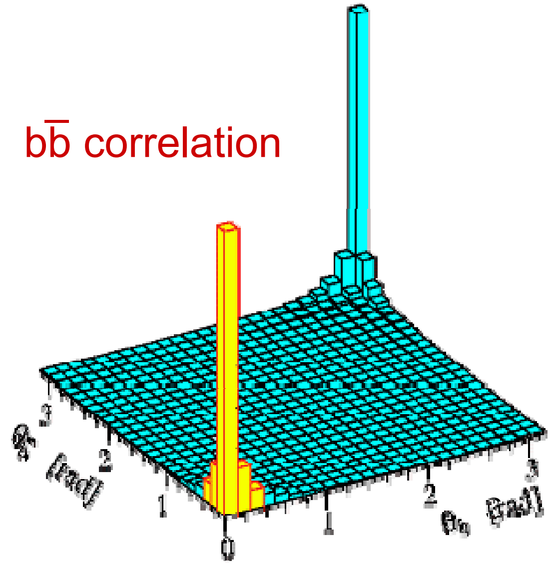
Detector design: B acceptance

- Designed to maximize B acceptance (within cost and space constraints)
- Forward spectrometer, $1.9 < \eta < 4.9$
  - more b hadrons produced at low angles
  - single arm OK since b-$\bar{b}$ pairs produced correlated in space
- Luminosity tuned (2×10^{32} $cm^{-2}s^{-1}$) to maximize the probability of single interaction per x-ing
- p_T trigger can be lowered up to 2 GeV/c, efficient also for purely hadronic B
- <u>1 year of running = ~2 fb^{-1} and 10^{12} b-$\bar{b}$ events</u> @nominal luminosity

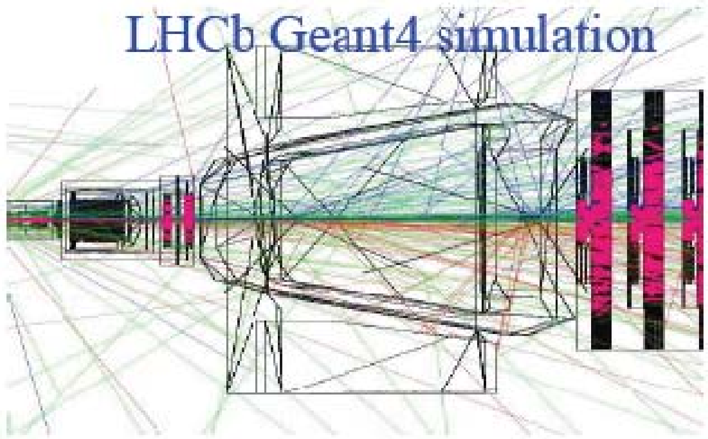
Pythia production cross section



b$\bar{b}$ correlation

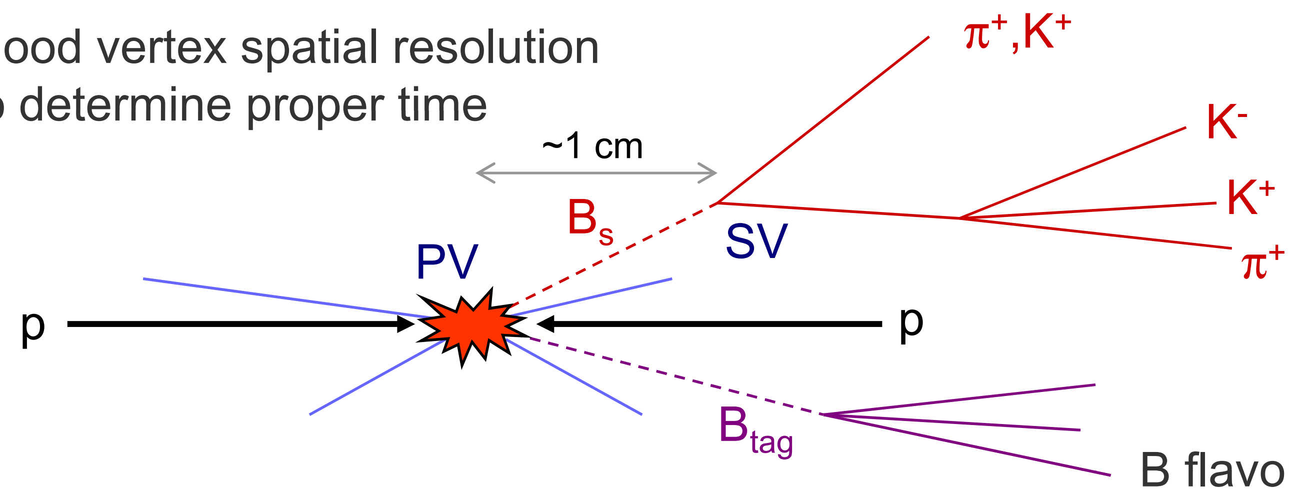


Detector requirements



- Time dependent measurements
- Reconstruction in the harsh LHC environment
- B events ~ few % of the total cross section
  - Need of a selective trigger
  - Mass and pointing constraint to reduce background

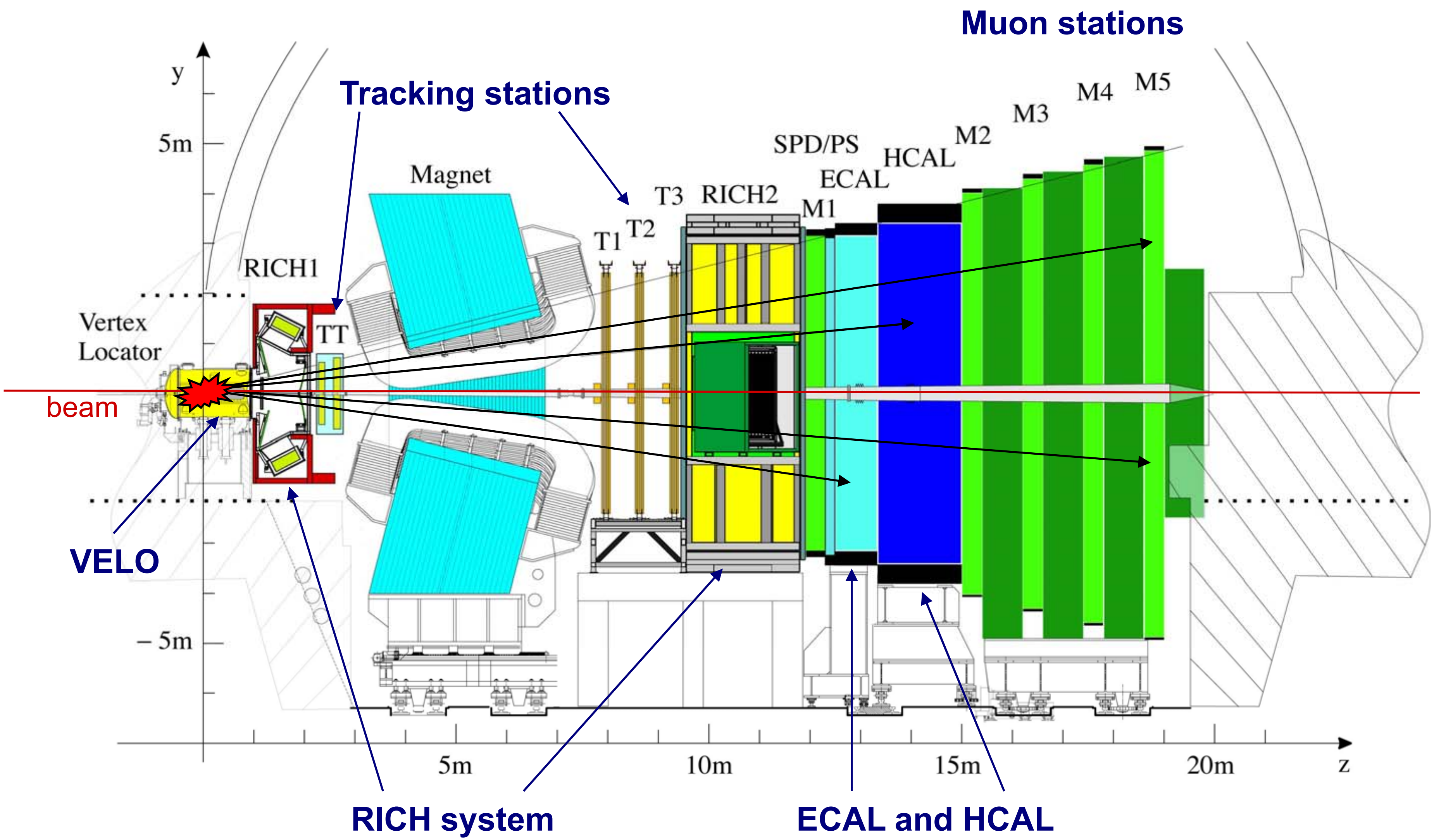
Good vertex spatial resolution
to determine proper time



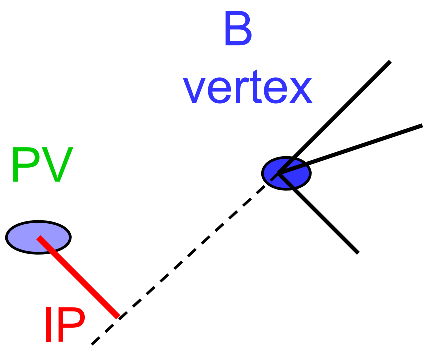
Good K/π separation

B flavor tagging

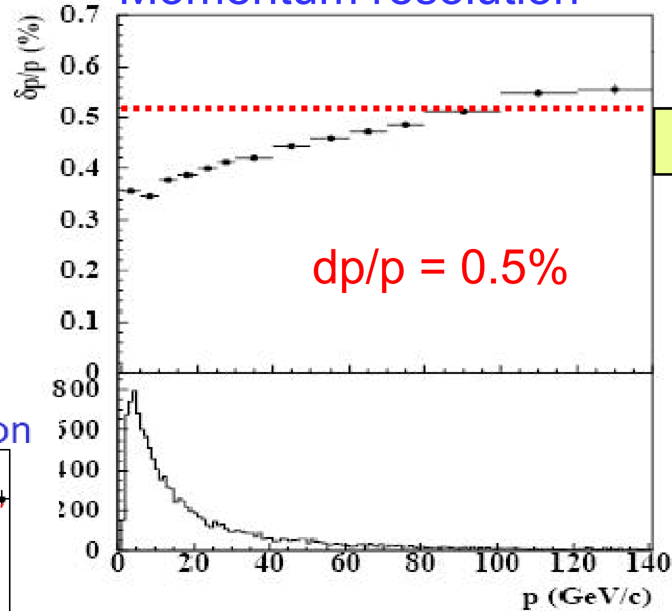
LHCb detector



Detector performances

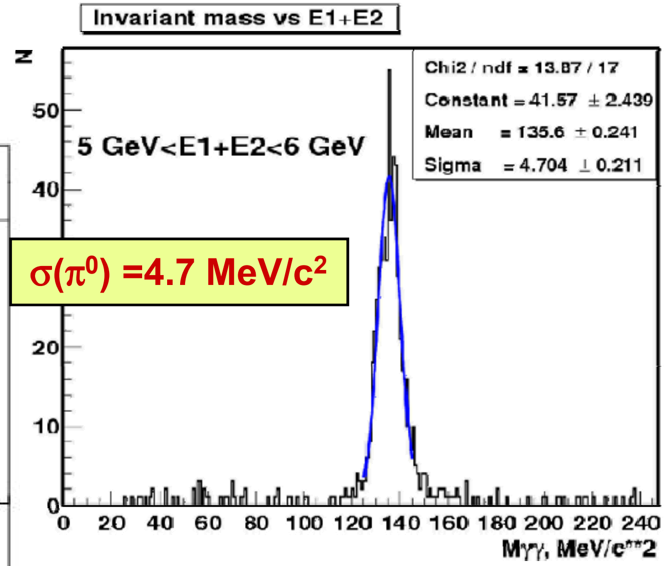


Momentum resolution

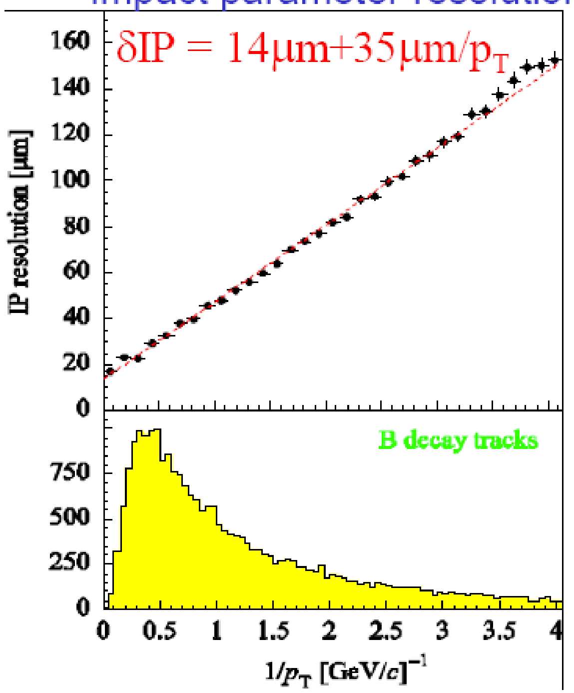


π^0 invariant mass spectrum

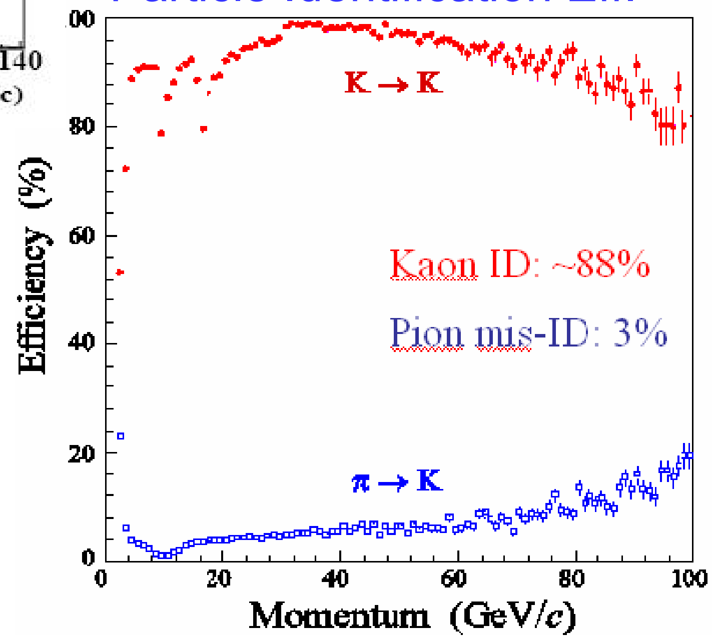
$\pi^- + {}^{12}C \rightarrow \pi^0 + X \rightarrow 2\gamma + X$



Impact parameter resolution



Particle Identification Eff.



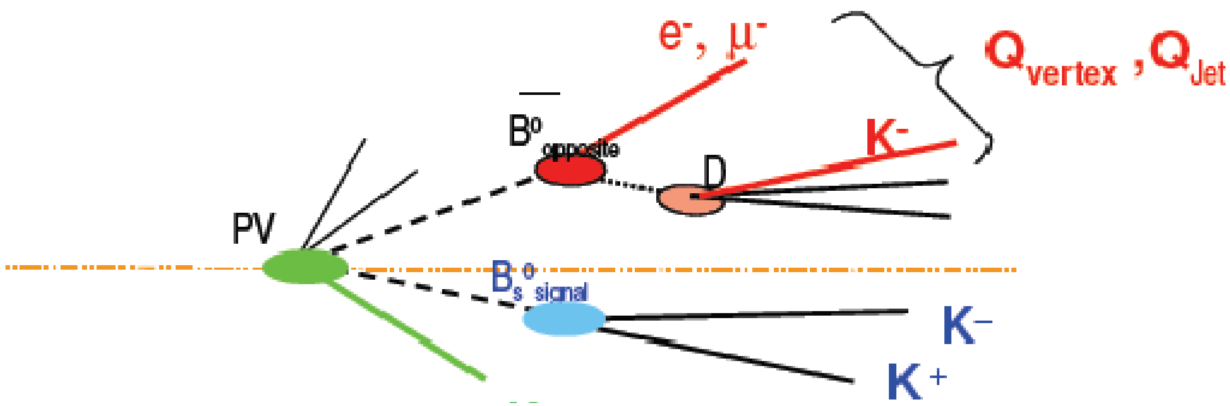
Flavor tagging

- Opposite side
  - Charge of the kaon in the b→ c→ s chain
  - Charge of the lepton in semi-leptonic decays
  - Charge of accompanying b jet

- Same side
  - Charge of the K accompanying B_s
  - Charge of the π from $B^{**} \rightarrow B^{*}\pi^{\pm}$

Tagging power in $\varepsilon(1-2\rceil)^2$

Tag (%)	B_d	B_s
Muon	1.1	1.5
Electron	0.4	0.7
Kaon opp. side	2.1	2.3
Vertex charge	1.0	1.0
Same side π/k	0.7 (π)	3.5 (K)
Combined (neu.net)	**~ 5.1**	**~ 9.5**



LHCb Physics program

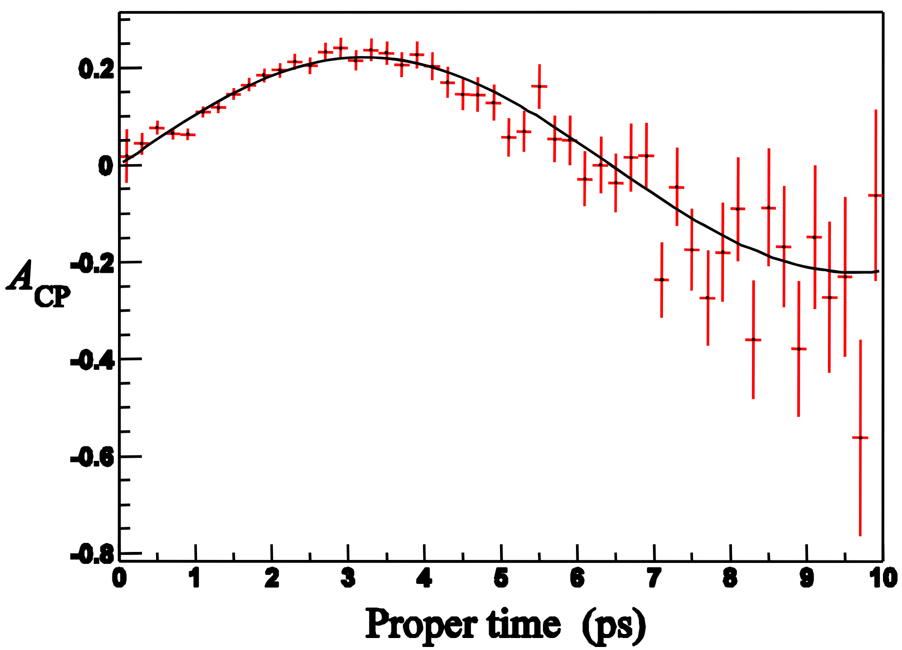
- B_s mixing parameters: $\Delta\Gamma_s$, Δm_s, ϕ_s
- α with $B_d \to \pi^0\pi^+\pi^-$
- β with $B_d \to J/\Psi\, K_s$
- γ with different methods
- Rare decays
  - $B_s \to \mu\mu$ to the level of the SM prediction
  - Radiative penguin $B_d \to K^*\gamma$, $B_s \to \phi\gamma$, $B_d \to \omega\gamma$
  - Electroweak penguin $B_d \to K^*\mu\mu$
- and much more, e.g. B_c, charm physics, D^0 mixing and CP violation)
- ....

<u>not exhaustive list !</u>

sin2β with $B^0 \to J/\psi K_S$

- One of the first CP measurements
  - golden mode, very well measured by b-factories
  - will be an important check of CP analyses and of tagging performance
  - can search for direct CP violating term $\propto \cos\Delta m_d t$
- Expect 240k reconstructed* $B^0 \to J/\psi\, K_S$ events/2fb^{-1}
- Precision $\sigma_{stat}(\sin 2\beta) \sim 0.02$ in 2fb^{-1} of collected data [currently $\sigma(\sin 2\beta) \sim 0.03$]

$A_{CP}(t)$ - background subtracted



*after trigger and reconstruction

Measure γ

- γ is the least well measured CKM angle and LHCb has several ways to measure it (independent)
- Most promising method is the ADS+GLW applied to $B \to DK$
  - $B^+ \to D(K\pi)K^+$, $D(K3\pi)K^+$, $D(\pi\pi,KK)K^+$
  - $B^+ \to D^*(K\pi)K^+$
  - $B^0 \to D(K\pi)K^{*0}$, $D(KK)K^{*0}$, $D(\pi\pi)K^{*0}$
- $B_S \to D_S K$
- Dalitz analysis for the neutral and charged $B \to DK$ decays
- $B^0 \to \pi^+\pi^-$ and $B_s \to K^+K^-$, sensitive to new physics

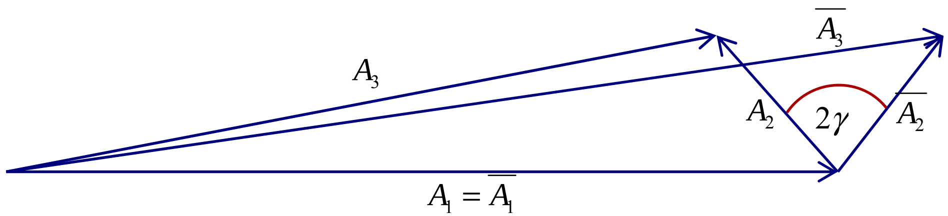
The $B^{\pm} \to DK^{\pm}$ decays (GLW and ADS method)

Consider the following decays (tree level)

$$B^+ \to \overline{D}^0 K^+ \quad B^+ \to D^0 K^+ \quad B^+ \to D^0_+ K^+$$

Color favored — Color suppressed

$$A_1 \equiv A\left(B^+ \to \overline{D}^0 K^+\right) = A\left(B^- \to D^0 K^-\right)$$
$$A_2 \equiv A\left(B^+ \to D^0 K^+\right) = A\left(B^- \to \overline{D}^0 K^-\right) \times e^{2i\gamma}$$
$$A_3 \equiv \sqrt{2} A\left(B^+ \to D^0_+ K^+\right) = A_1 + A_2$$



Measuring the three different decay rates (relative) and the c.c. will allow to extract the gamma angle in a clean way, but…

- because the color suppression, the two amplitudes, A_1 and A_2, very different $\to$ large error
- need the D^0 tag

Decays of D^0, D^0 to <u>same final state</u> allows the two tree diagrams (theoretically clean!) to interfere. Consider the decay $D^0 \to K^-\pi^+$

$$D^0 \to K^-\pi^+ \quad \overline{D}^0 \to K^-\pi^+$$

Cabibbo favored — Cabibbo suppressed

For these decays the reversed suppression of the D decays relative to the B decays results in much more equal amplitudes $\to$ **<u>big interference effects ~ *O(1)*</u>**

<u>Counting experiment: no need for flavor tagging or proper time determination</u>
$\to$ measure of BR ~ $O(10^{-7})$ or smaller

The $B^\pm \rightarrow D(K\pi)K^\pm$ decays

$4\ B^\pm \rightarrow (K\pi)_D K^\pm$ decays

$$\Gamma(B^+ \rightarrow (K^+\pi^-)_D K^+) \propto 1 + (r_B r_D^{K\pi})^2 + 2 r_B r_D^{K\pi} \cos(\delta_B - \delta_D^{K\pi} + \gamma)$$ **(1)** **56000***

$$\Gamma(B^+ \rightarrow (K^-\pi^+)_D K^+) \propto r_B^2 + (r_D^{K\pi})^2 + 2 r_B r_D^{K\pi} \cos(\delta_B + \delta_D^{K\pi} + \gamma)$$ **(2)** **700**

$$\Gamma(B^- \rightarrow (K^-\pi^+)_D K^-) \propto 1 + (r_B r_D^{K\pi})^2 + 2 r_B r_D^{K\pi} \cos(\delta_B - \delta_D^{K\pi} - \gamma)$$ **(3)** **56000**

$$\Gamma(B^- \rightarrow (K^+\pi^-)_D K^-) \propto r_B^2 + (r_D^{K\pi})^2 + 2 r_B r_D^{K\pi} \cos(\delta_B + \delta_D^{K\pi} - \gamma)$$ **(4)** **700**

*both charges

$$\frac{A(DCS)}{A(favoured)} = \frac{A(\overline{D^0} \rightarrow K^-\pi^+)}{A(D^0 \rightarrow K^-\pi^+)} = \frac{A(D^0 \rightarrow K^+\pi^-)}{A(\overline{D^0} \rightarrow K^+\pi^-)} \equiv r_D^{K\pi} e^{-i\delta_D^{K\pi}}$$

- Interference parameters
  - From the B decays:
    - γ – because have b→u , b→c interference
    - r_B – the ratio in magnitude of two diagrams (≤0.1 for $DK^\pm$)
    - δ_B – a CP conserving strong phase difference
  - The D decays introduce:
    - $r_D^{K\pi}$ – the ratio in magnitude of two diagrams (0.060)
    - $\delta_D^{K\pi}$ – a CP conserving strong phase difference

rates (1) and (3) are favored + CP eigenstate = GLW method

rates (2) and (4) are suppressed + another D decay = ADS method

but these suppressed rates have order 1 interference term, as $r_B \sim r_D$

$B^{\pm} \rightarrow DK^{\pm}$ strategy: ADS+GLW

- **$D^0 \rightarrow K\pi$**
  3 observables from the relative rates of the 4 processes, depend on 4 unknowns γ, r_B, δ_B, $\delta_D^{K\pi}$
  - $r_D^{K\pi}$ is already well measured
  - may benefit from $\cos(\delta_D)$ measurements in CLEO-c and/or BES III
  - Need another D^0 decay channel to solve for all unknowns

- **$D^0 \rightarrow K\pi\pi\pi$** (BR ~ 8%):
  provides 3 observables which depends on 4 unknowns γ, r_B, δ_B, $\delta_D^{K3\pi}$
  only $\delta_D^{K3\pi}$ new, $r_D^{K3\pi}$ is already well measured

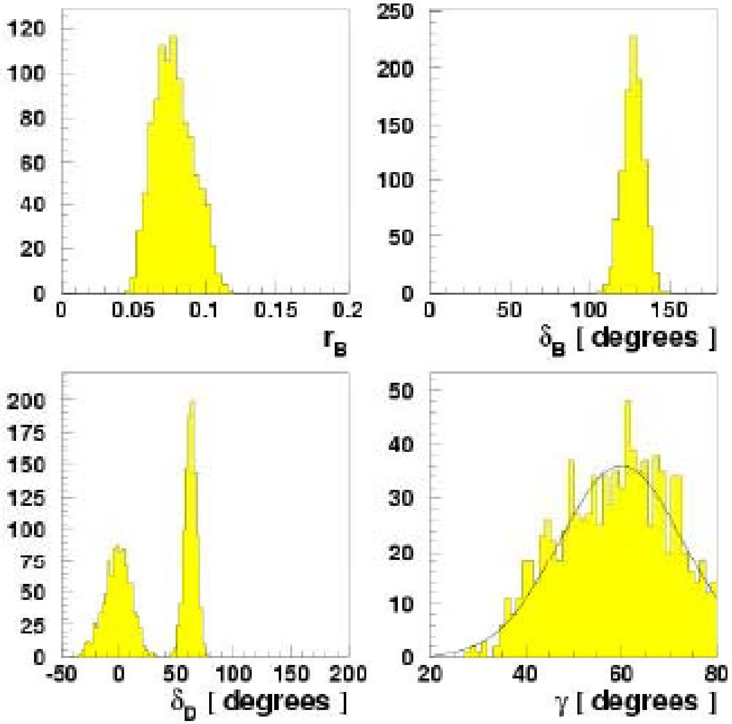
- **$D^0 \rightarrow KK/\pi\pi$**
  each CP mode provides one more observables with no new unknowns

$$\Gamma(B^- \rightarrow (h^+h^-)_D K^-) \propto 1 + r_B^2 + 2r_B \cos(\delta_B - \gamma)$$

$$\Gamma(B^+ \rightarrow (h^+h^-)_D K^+) \propto 1 + r_B^2 + 2r_B \cos(\delta_B + \gamma)$$

LHCb sensitivity

- Toy MC to simulate 2 fb^{-1} signal data: → fit results return input values
- Combine $K\pi$ with:
  - $K3\pi$ similar yields and identical background level
  - $KK\ \pi\pi$ 4300 B^+ and 3300 B^- with B/S ~ 2



w/o bkgrd

$\delta_D^{K\pi}$, $\delta_D^{K3\pi}$	-25	-16.6	-8.3	0	8.3	16.6	25
-180	3.8	3.1	3.0	3.9	3.2	2.8	2.7
-120	2.8	2.5	2.5	2.5	2.2	2.2	1.9
-60	3.9	3.6	3.4	4.3	4.2	3.7	3.6
0	4.5	4.2	4.4	5.6	8.0	6.1	4.9
60	3.3	3.1	3.3	4.6	6.6	9.4	11.0
120	3.4	3.6	3.8	4.1	3.9	3.6	3.3
180	3.5	3.0	2.9	3.8	3.2	2.8	2.6

estimated bkgrd

$\delta_D^{K\pi}$, $\delta_D^{K3\pi}$	-25	-16.6	-8.3	0	8.3	16.6	25
-180	8.6	7.5	6.5	6.8	7.2	7.3	6.0
-120	6.0	6.3	6.3	6.4	6.2	6.2	4.7
-60	8.0	7.9	8.1	7.8	7.4	6.7	6.2
0	10.3	11.1	12.4	11.5	12.1	13.1	13.0
60	9.1	10.6	11.2	12.9	13.4	15.0	15.2
120	11.6	11.3	11.8	11.0	10.9	11.1	10.8
180	8.5	7.4	6.5	6.8	7.1	7.3	6.5

(Highlighted are RMS quoted from non-Gaussian distribution of fit results due to close ambiguous solutions, will disappear as statistics increase. Global analysis using all modes will also help.)

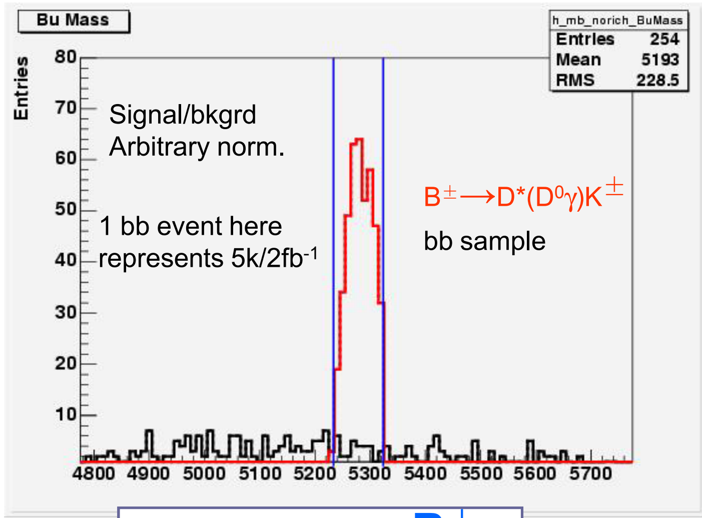
$\sigma(\gamma)$ ~ 5º-15º in 2 fb^{-1}

depending on r_B, $\delta_D^{K\pi}$ and $\delta_D^{K3\pi}$

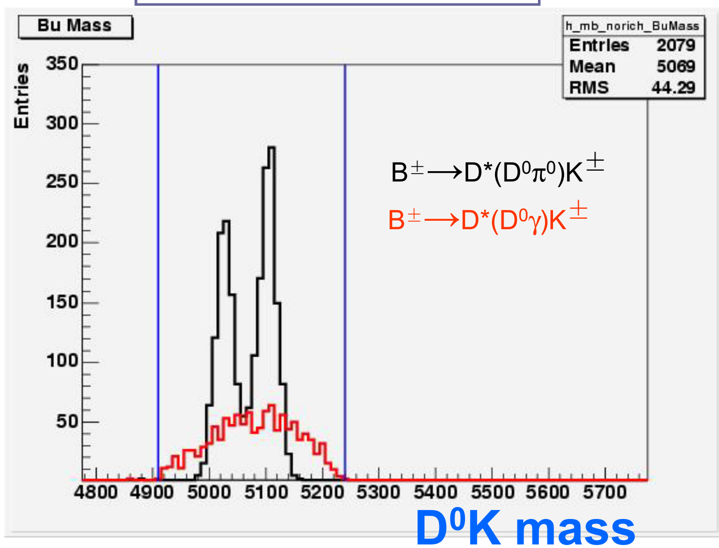
ADS with B± →D*K± decays

- Attractive feature
  - $D^* \to D^0\pi^0$ (BR~2/3) – has strong (CP con.) phase δ_B
  - $D^* \to D^0\gamma$ (BR~1/3) – strong phase $\delta_B + \pi$
  - → if can distinguish the two decays, powerful additional constraint !
  - Preliminary studies (without background) show that, including D*K improves precision of previous analyses to **$\sigma(\gamma)$ = 2º - 5º** (favored mode: 17k/2 fb^{-1})

- However…
  - Reconstruction efficiency is small for soft γ while background is enormous
  - Non trivial to separate $D^0\pi^0$ and $D^0\gamma$
  - Fit DK mass shape to get π^0 and γ components ignoring neutrals



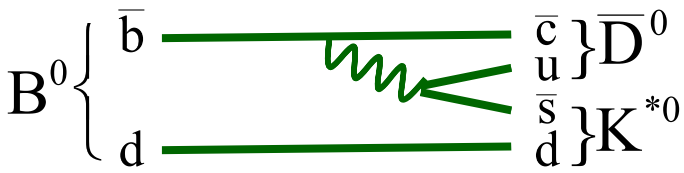
Charged reconstruction B± mass

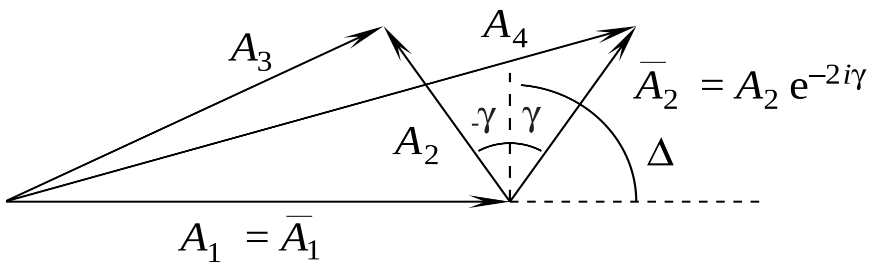


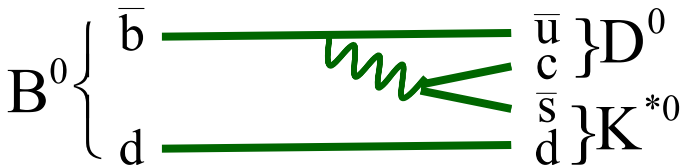
D^0K mass

GLW method - γ from $B^0 \rightarrow D^0K^{*0}$

- Dunietz variant of Gronau-Wyler method makes use of interference between two color-suppressed diagrams interfering via D^0 common final states ($\pi\pi$, πK, KK)







$A_1 = A(B^0 \rightarrow \bar{D}^0K^{*0})$: $b\rightarrow c$ transition, phase 0

$A_2 = A(B^0 \rightarrow D^0K^{*0})$: $b\rightarrow u$ transition, phase $\Delta+\gamma$

$A_3 = \sqrt{2}\, A(B^0 \rightarrow D_{CP}K^{*0}) = A_1+A_2$, because $D_{CP}=(D^0+\bar{D}^0)/\sqrt{2}$

- Measuring the 6 decay rates, $B^0 \rightarrow D^0(K\pi,\pi\pi,KK)K^{*0}$ + CP conjugates, allows γ to be extracted <u>without flavor tagging or proper time determination</u>

Mode (+ cc)	Yield*	B_{bb}/S (90%CL)
$B^0 \rightarrow (K^+\pi^-)_D\, K^{*0}$	3400	< 0.3
$B^0 \rightarrow (K^-\pi^+)_D\, K^{*0}$	500	< 1.7
$B^0 \rightarrow (K^+K^-)_D\, K^{*0}$	600	< 1.4

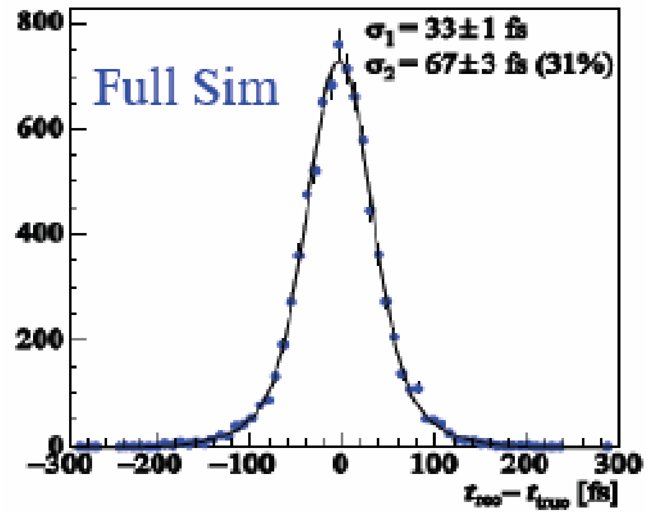
*in 2 fb^{-1}, both charges

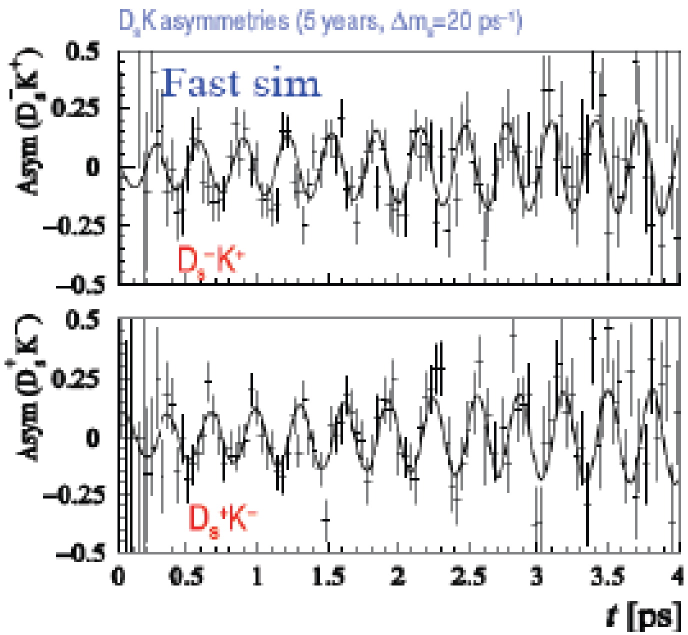
$\sigma(\gamma) \sim 7^o - 10^o$ (2 fb^{-1})
depending on , $\delta_D^{K\pi}$ and $\delta_D^{K3\pi}$

$B_s \rightarrow D_s K$

- Interference between tree level decays via B_S mixing (s-version of $B_d \rightarrow D^* \pi$): time dependent analysis (clean, no penguins)
- Measures $\gamma + \phi_S$ (ϕ_S from $B_S \rightarrow J/\Psi\ \Phi$)
- Expect 5400 events/2fb^{-1}
- Excellent proper-time resolution ($\sigma_t \sim 40$ fs) allows to resolve B_S oscillations
- $\sigma(\gamma) \sim 13°$ from 2fb^{-1} data [Δm_s=17.3 ps^{-1}]
- Main background from $D_S\pi$ (BR×10)
  - Suppressed using kaon ID from RICH detector
  - B/S <1 @ 90% CL
- Parallel analysis possible with $B_d \rightarrow D\pi^\pm$

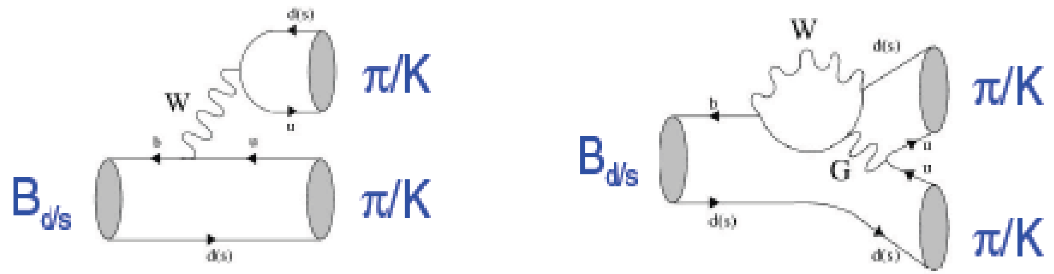
  (~790k events/2fb^{-1} with B/S ~ 0.3, γ extraction requires $r_{D\pi}$ or combined $B_s \rightarrow D_s K$ U-spin analysis)





γ from $B^0 \rightarrow hh$

- $B^0 \rightarrow \pi\pi$ originally proposed to measure α but the influence of penguin diagrams makes the task difficult



From the time dependent CP asymmetry

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

Extract four asymmetries

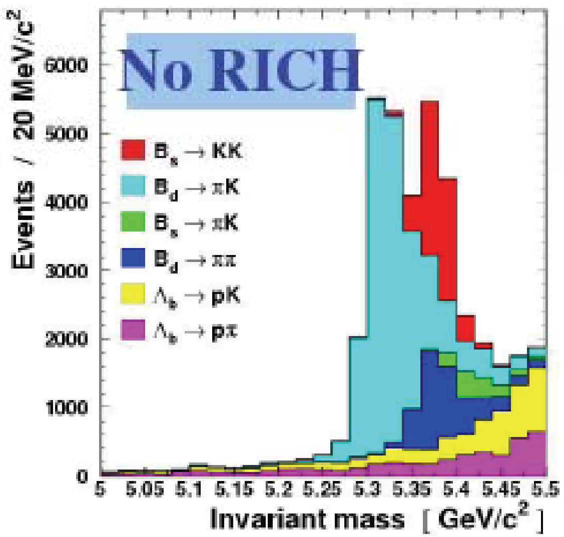
$$A_{dir}(B^0 \rightarrow \pi^+\pi^-) = f_1(d,\theta,\gamma)$$
$$A_{mix}(B^0 \rightarrow \pi^+\pi^-) = f_2(d,\theta,\gamma,\beta)$$
$$A_{dir}(B_s \rightarrow K^+K^-) = f_3(d',\theta',\gamma)$$
$$A_{mix}(B_s \rightarrow K^+K^-) = f_4(d',\theta',\gamma,\chi)$$

$de^{i\theta}$ = ratio of penguin and tree amplitude in $B \rightarrow \pi\pi$
$d'e^{i\theta'}$ = ratio of penguin and tree amplitude in $B \rightarrow KK$

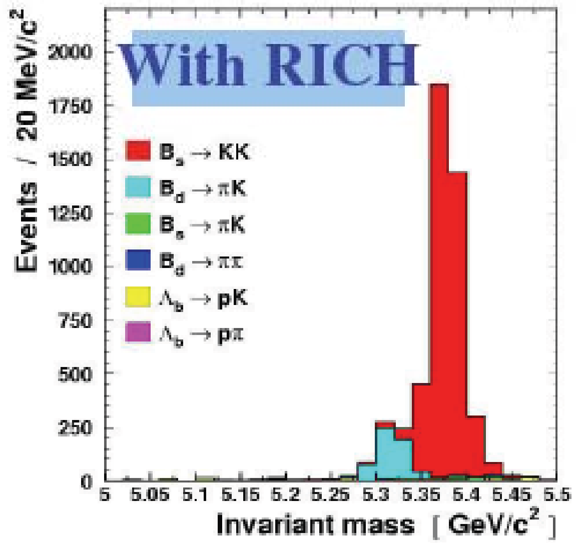
Assuming U-spin flavor symmetry ($u \leftrightarrow s$) *$d=d'$ and $\theta=\theta'$* and taking β from $B_d \rightarrow J/\psi\, K_s$ and χ from $B_s \rightarrow J/\psi\, \phi$ we can solve for γ

γ from $B^0 \rightarrow hh$

- 26k $B_d \rightarrow \pi\pi$ events with $2fb^{-1}$, B/S < 0.7
- 37k $B_s \rightarrow KK$ events, B/S = 0.3
- $\sigma(\gamma) \sim 5^o$ + uncertainty from U-spin symmetry breaking
- Sensitive to new physics



Use PID from RICH



Summary of performances on γ

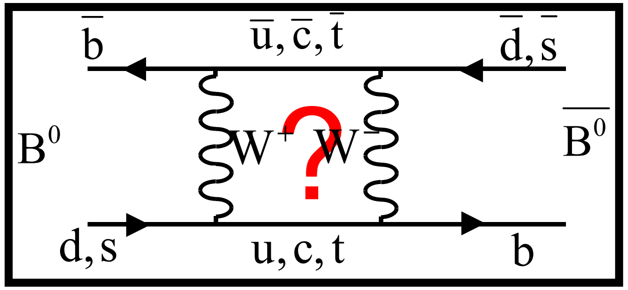
B mode	D mode	Method	$\sigma(\gamma)$
$B^+ \to DK^+$	$K\pi + KK/\pi\pi + K\pi\pi\pi$	ADS+GLW	5°-15°
$B^+ \to D^*K^+$	$K\pi$	ADS+GLW	under study
$B^+ \to DK^+$	$K_S\pi\pi$	Dalitz	15°
$B^+ \to DK^+$	$KK\pi\pi$	4-body "Dalitz"	15°
$B^+ \to DK^+$	$K\pi\pi\pi$	4-body "Dalitz"	under study
$B^0 \to DK^{*0}$	$K\pi + KK + \pi\pi$	ADS+GLW	7°-10°
$B^0 \to DK^{*0}$	$K_S\pi\pi$	Dalitz	under study
$B_S \to D_SK$	$KK\pi$	tagged, A(t)	13°
$B \to \pi\pi, KK$			4°-10°

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

Combining all modes, with a nominal year of data (2 fb^{-1}), LHCb will be able to extract γ with ~ 4° resolution, and compare the $B \to DK$ direct measurement with the indirect determination ($B^0 \to \pi^+\pi^-$, $B_s \to K^+K^-$) to make a stringent test of the SM

B_s mixing phase, ϕ_s, from $B_s \to J/\psi(\mu^+\mu^-)\,\phi$

In the SM $\phi_s^{SM} = -2\chi = -2\lambda^2\eta$ (small) and from UT fits we get $\phi_s = -0.037 \pm 0.002$
Direct measurements not very precise: recent D0: $-0.79^{+0.47}_{-0.39}$
CP violating decay can proceed directly or through mixing.



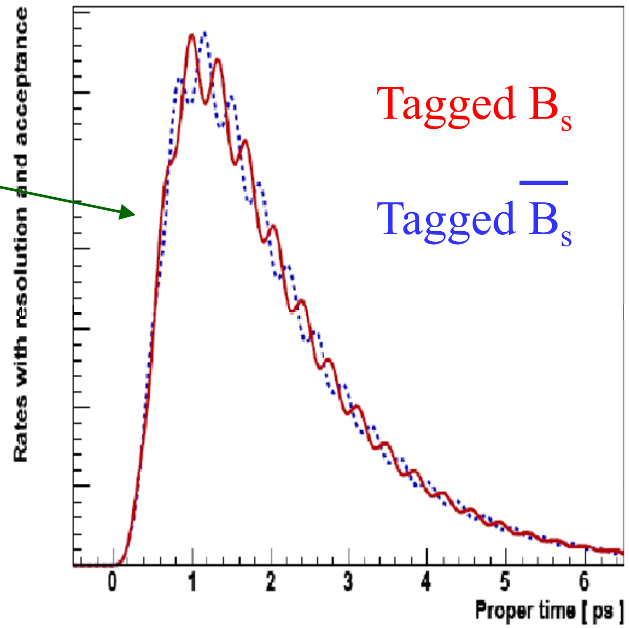
The "mixing box" can have contributions from NP particles, resulting in $\phi_s = \phi_s^{SM} + \phi_s^{NP} \neq -2\lambda^2\eta$

Measure proper time dependence
Measure time-dependent CP asymmetry

$$A_{CP}(t) = \frac{\Gamma[\overline{B}_s(t) \to f] - \Gamma[B_s(t) \to f]}{\Gamma[\overline{B}_s(t) \to f] + \Gamma[B_s(t) \to f]}$$

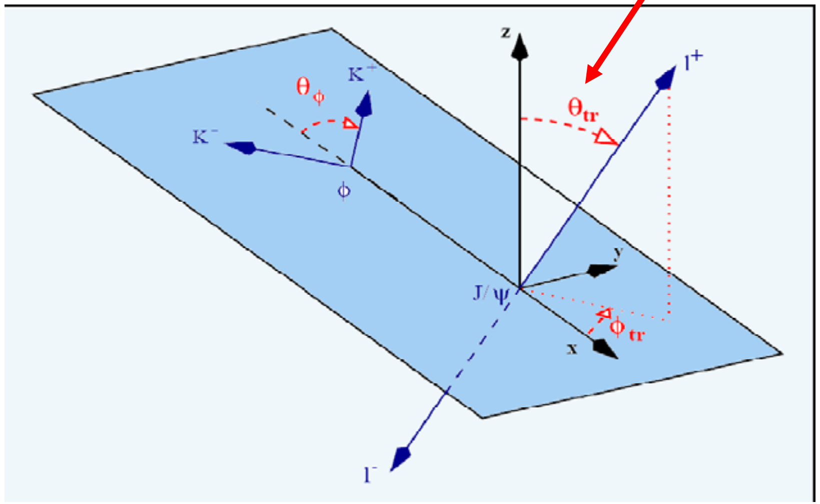
$\eta_\phi = \pm 1$ CP

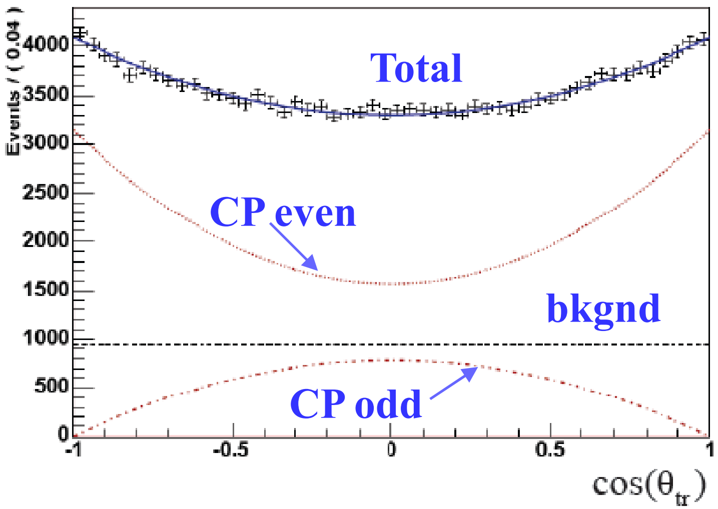
$$A_{CP}(t) = \frac{\eta_f \sin\phi_s \sin(\Delta m_s)t}{\cosh(\Delta\Gamma_s t/2) - \eta_f \cos\phi_s \sinh(\Delta\Gamma_s t/2)}$$



B_s mixing phase, ϕ_s, from $B_s \rightarrow J/\psi(\mu^+\mu^-)\ \phi$

- Because the final state contains two vector particles, it is a mixture of CP odd and CP even
- Use θ_{tr} angle between μ^+ and normal to ϕ decay plane to do an angular analysis to identify the states.





Simultaneous fit to **time** and **angular** distributions

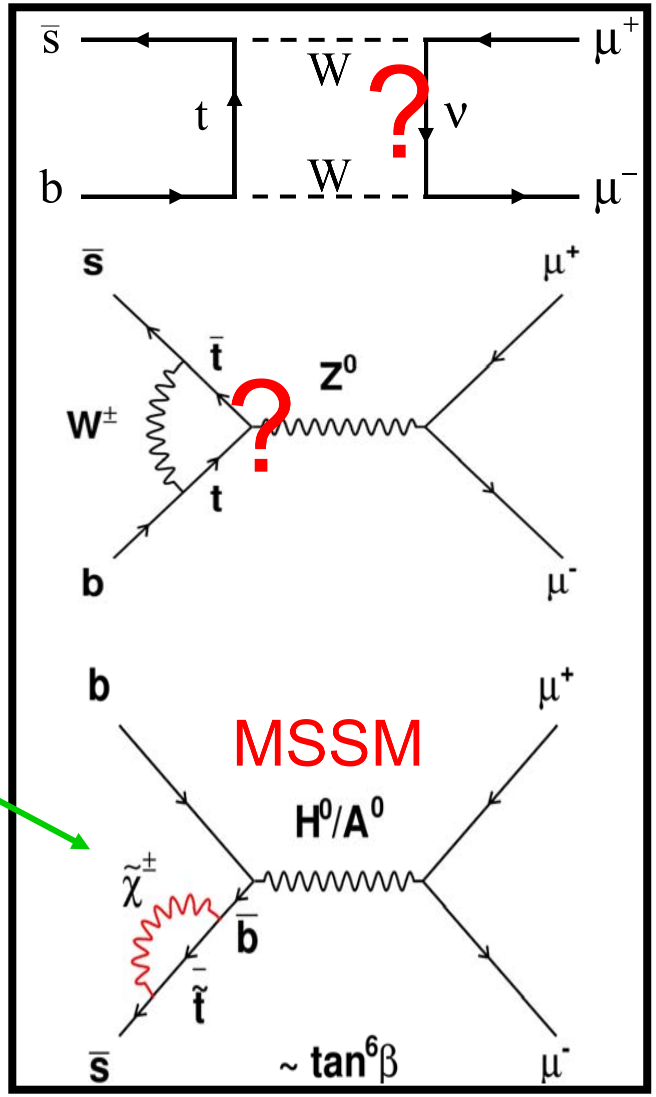
With: 2 fb^{-1} of data
Precision on ϕ_s $\sigma(\phi_s) = 0.023$

From pure CP states $B_s \rightarrow J/\psi\eta$,
$\sigma(\phi_s)$= 0.059

Combining **$\sigma(\phi_s)$= 0.021**
(UT fit value: -0.037)

$B_s \rightarrow \mu^+\mu^-$

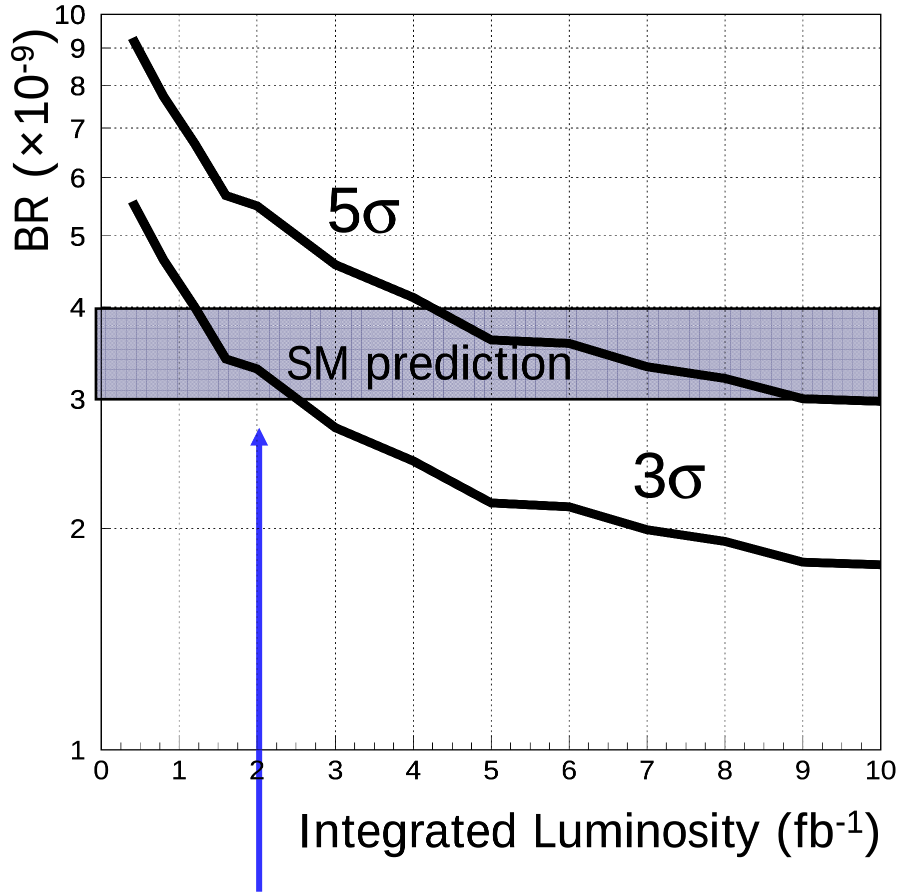
- Very small branching ratio in SM: **$(3.4 \pm 0.5) \times 10^{-9}$**
- Present limit from Tevatron at 95% CL($1\ fb^{-1}$): **$< 7 \times 10^{-8}$**
  (expected final limit at 95% CL ($8\ fb^{-1}$): **$< 2 \times 10^{-8}$**)
- Sensitive to New Physics through loops
- Could be strongly enhanced by SUSY.



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

- LHCb should have good prospect for significant measurement:
  17 SM events/2fb^{-1}
- Difficult to get reliable estimate of expected background
  - No background events selected in sample of 33M events but estimation limited by statistic
  - Combinatorial: B to μ^+X, B to μ^-X known as the main source of background, addressed by very good mass resolution 18 MeV/c^2
  - B_d, B_s to $\pi\pi$, πK, KK and mis-id. addressed by particle identification and mass resolution.

LHCb Sensitivity *(signal+bkg is observed)*



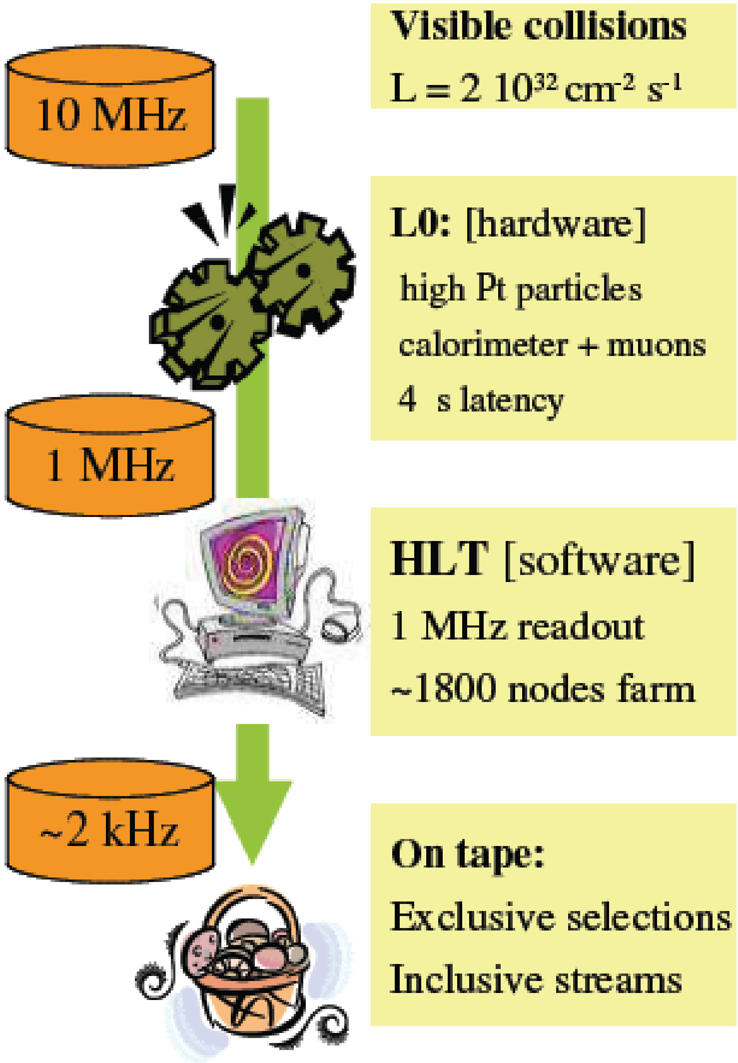
with L=2fb^{-1}
3σ observation if at SM value

Conclusions

- LHCb will be ready to collect data with its full detector as LHC turns on. Physics at 14 TeV starting in 2008
- It will make precision measurements that will severely constrain the unitarity triangle fits and probe rare decays
- These measurements could either limit New Physics contributions to B decays or, more optimistically, uncover them

Spare slides

LHCb trigger



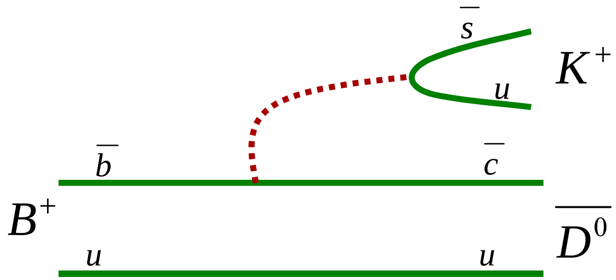
- Selection of the b-b events in the sample: μ, e, h, γ (1-4 GeV) and pile-up veto
  - High P_t particles
  - Displaced tracks
  - Increased b-cont from 1% to ~ 50%
- Different output streams from HLT
  - 200 Hz are dedicated to the exclusive selections of specific channels
  - Main stream for the core LHCb physics program
  - Inclusive streams for calibration and data mining:
    - di-muon stream
    - D* stream
    - single muon

B physics: LHC vs B-factories

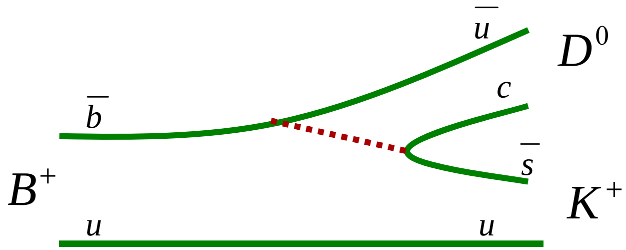
	$e^+e^- \rightarrow \Upsilon(4S) \rightarrow$ **BB** PEPII, KEKB	**pp→bbX** ($\sqrt{s}$ = 14 TeV, Δt_{bunch}=25 ns) LHCb @$2x10^{32}cm^{-2}s^{-1}$	
Production σ_{bb}	1 nb	~500 μb	☺
Typical bb rate	10 Hz	100 kHz	
bb purity	~1/4	$\sigma_{bb}/\sigma_{inel}$ = 0.6% Trigger is a major issue !	☹
Pileup	0	0.5	
b-hadron types	B^+B^- (50%) B^0B^0 (50%)	B^+B^- (40%), B^0 (40%), B_s (10%) B_c (< 0.1%), b-baryons (10%)	☺
b-hadron boost	Small	Large (decay vertexes well separated)	
Production vertex	Not reconstructed	Reconstructed (many tracks)	
Neutral B mixing	Coherent B^0B^0 pair mixing	Incoherent B^0 and B_s mixing (extra flavour-tagging dilution)	☹
Event structure	BB pair alone	Many particles not associated with the two b hadrons	

The $B^{\pm} \rightarrow DK^{\pm}$ decays (GLW method)

Consider the following diagrams and the c.c.



colour favoured

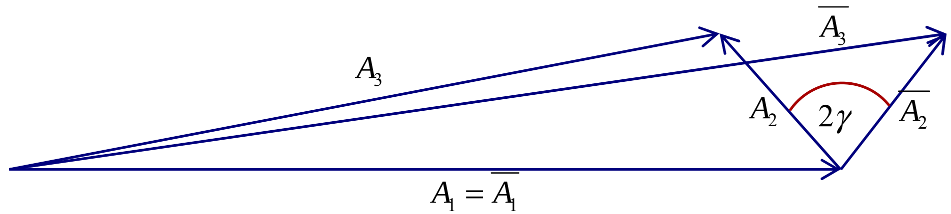


colour suppressed

$$A_1 \equiv A\left(B^+ \rightarrow \overline{D}^0 K^+\right) = A\left(B^- \rightarrow D^0 K^-\right)$$

$$A_2 \equiv A\left(B^+ \rightarrow D^0 K^+\right) = A\left(B^- \rightarrow \overline{D}^0 K^-\right) \times e^{2i\gamma}$$

$$A_3 \equiv \sqrt{2} A\left(B^+ \rightarrow D_+^0 K^+\right) = A_1 + A_2$$



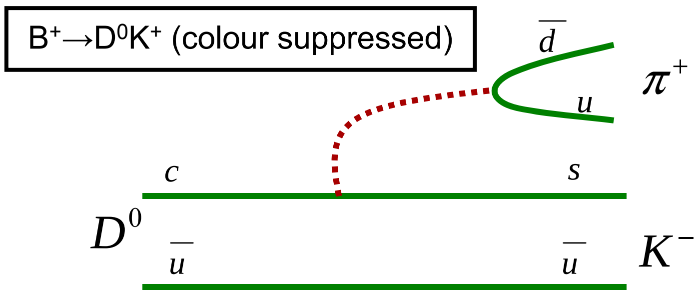
Measuring the three different decay rates (relative) and the c.c. will allow to extract the gamma angle in a clean way, but…

- two amplitudes (A_1 and A_2) very different → large error
- need the D^0 tag

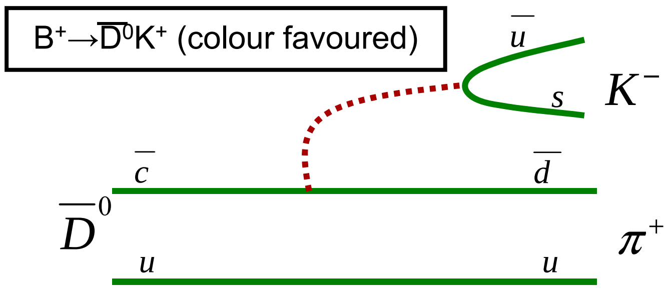
The ADS method

$$B^+ \to \overline{D}^0[\to f_i]K^+$$
$$B^+ \to D^0[\to f_i]K^+$$

Decays of D^0, $\overline{D}^0$ to same final state allows the two tree diagrams (theoretically clean!) to interfere. Consider the decay $D \to K^-\pi^+$



Cabibbo favoured



Cabibbo suppressed

For these decays the reversed suppression of the D decays relative to the B decays results in much more equal amplitudes → **big interference effects ~ *O(1)***

Counting experiment: no need for flavor tagging or proper time determination

→ measure of BR ~ $O(10^{-7})$ or smaller

Background studies $B^{\pm} \to D(K\pi)K^{\pm}$

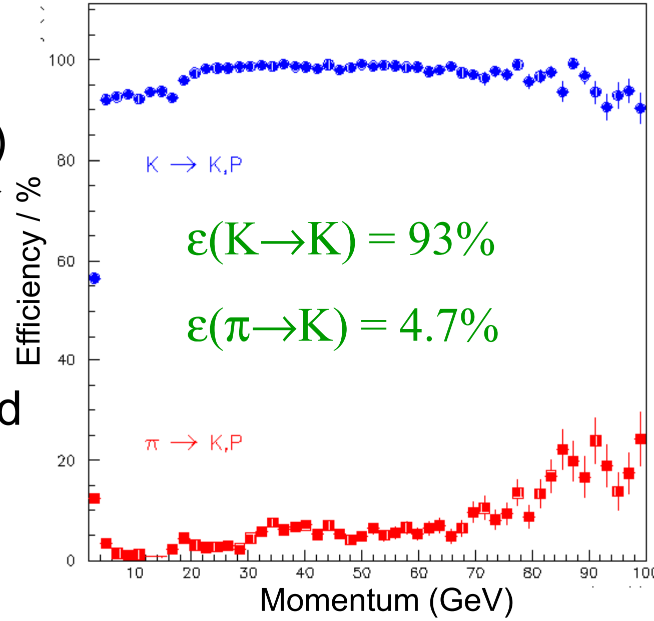
- **Favoured modes**
  - Background from $D^0\pi$ decays dominates (BR $\times$13)
    - Use RICH information to separate D^0K and $D^0\pi$ ⇒
    - Use dedicated sample of $D^0\pi$ decays

    → Expect ~17k bkgrd events/2fb^{-1} from $D^0\pi$
  - Use bb sample to assess combinatorial background

    → Expect ~0.7k bkgrd events/2fb^{-1}

~28k/year $B^+ \to (K^+\pi^-)_D K^+$ B/S ~ 0.6

~28k/year $B^- \to (K^-\pi^+)_D K^-$ B/S ~ 0.6



- **Suppressed modes**
  - bb sample indicates that the combinatorial contribution dominates :

    → Expect ~0.7k background events/2fb^{-1}

~530/year $B^+ \to (K^-\pi^+)_D K^+$ B/S ~ 1.5

~180/year $B^- \to (K^+\pi^-)_D K^-$ B/S ~ 4.3