First observation and polarization of $B_s^0 \to K^{*0}\overline{K}^{*0}$ at LHCb

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Outline

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3. Selection of control channel
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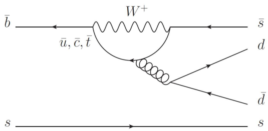
Outline

Introduction

- $B_s^0 \to K^{*0}\overline{K}^{*0}$ is a pure $b \to s$ penguin decay which has never been observed so far.

  Loops are particularly sensitive to New Physics. Penguin are dominated by the heaviest particles in SM: t, $\mathrm{W}^{\pm}$, Z^0... Are there more heavy particles interfering?



- $b \to d$ and $b \to s$ only allowed in SM by loops. $b \to d$ have been explored at B-factories but very little is known about $b \to s$ transitions ($B_s^0 \to \mu^+\mu^-$ is an example). This is the arena of LHCb.
- U-spin rotations, $d \leftrightarrow s$, are genuine flavour symmetries. Standard EW and QCD physics predict small breaking ($\lesssim 10\%$)
- Very interesting for precision CP-violation studies, where $B^0 \to K^{*0}\overline{K}^{*0}$ channel is used to control the theoretical error.

Introduction

- $B_s^0 \to K^{*0}\overline{K}^{*0}$ is a decay into two light vector mesons

$$H_0 >> H_{+1} >> H_{-1} \ , \quad \mathcal{O}\left(\frac{\Lambda_{QCD}}{m_b}\right)^{0,1,2}$$

- Predictions in the framework of QCD factorization are $(9.1^{+11.3}_{-6.8}) \times 10^{-6}$ for the branching fraction and $f_L = 0.63^{+0.42}_{-0.29}$ for the longitudinal fraction (improved to $(7.9^{+4.3}_{-3.9}) \times 10^{-6}$ and $f_L = 0.72^{+0.16}_{-0.21}$ when experimental input is used)[1].
- Recently updated SM prediction for the ratio of the longitudinal BR of $B_s^0 \to K^{*0}\overline{K}^{*0}$ and its U-spin rotated channel $B^0 \to K^{*0}\overline{K}^{*0}$. (See *New Physics mixing angles from penguin decays* by Javier Virto, Red de Física del sabor)

[1] Beneke et al. arXiv:hep-ph/0612290v2 [hep-ph] Dec 21, 2006

Introduction

- Searched for at SLD $\rightarrow \mathcal{B}(B_s^0 \rightarrow K^{*0}\overline{K}^{*0}) < 1.68 \times 10^{-3}$ (90% CL).
- $B^0 \rightarrow K^{*0}\overline{K}^{*0}$ was observed by BaBar

$$\mathcal{B}(B^0 \rightarrow K^{*0}\overline{K}^{*0}) = (1.28^{+0.35}_{-0.30} \pm 0.11) \times 10^{-6}$$
$$f_L(B^0 \rightarrow K^{*0}\overline{K}^{*0}) = 0.80^{+0.10}_{-0.12} \pm 0.06$$

- LHCb paper ready for publication in Physics Letters B

LHCb-ANA-2011-035
October 20, 2011
Version 1.1

First observation of the decay $B_s^0 \rightarrow K^{*0}\ \overline{K}^{*0}$

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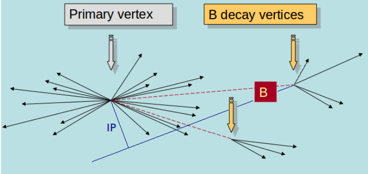
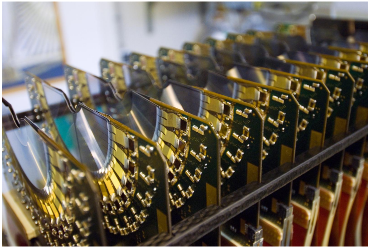
Outline

LHCb key features

- VELO:
  Provides precise information of PV and SV.
  Good IP resolution ($16\ \mu\mathrm{m} + 30\ \mu\mathrm{m}/p_T\,(\mathrm{GeV}/c)$).
- Tracking System & Magnet:
  Momentum resolution 0.3%-0.5%
  (3-100 GeV/c).
- RICH detectors:
  Allows $K - \pi$ separation.





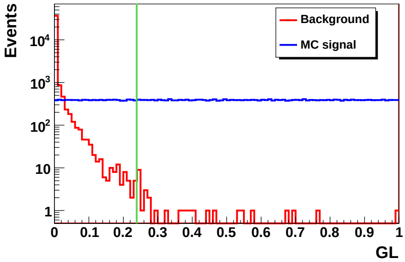
Data sample and Event Selection

- 35 pb^{-1} collected in the 2010 run by LHCb (7 TeV).
- $B_s^0 \to K^{*0}(K^+\pi^-)\overline{K}^{*0}(K^-\pi^+)$

- Loose cuts

	Selection cuts
All tracks p_T	> 500 MeV
All tracks IPχ^2	> 9
All tracks χ^2	< 5
$K^\pm$ PID$_{K-\pi}$	> 0
$\pi^\pm$ PID$_{K-\pi}$	< 0
K^{*0} mass window	± 150 MeV
K^{*0} p_T	> 900 MeV
K^{*0} vertex χ^2	< 9
$\cos(K^{*0})$	> 0
B$_s$ mass window	± 500 MeV
B$_s$ DOCA	$< 0.3mm$
B$_s$ vertex χ^2/ndof	< 5
B$_s$ IPχ^2	< 25
GL	> 0.24

- Geometrical Likelihood (GL)
  - Minimum IPχ^2 of the four tracks
  - B_s^0 IPχ^2
  - B_s^0 proper time
  - B_s^0 $p_{\rm T}$



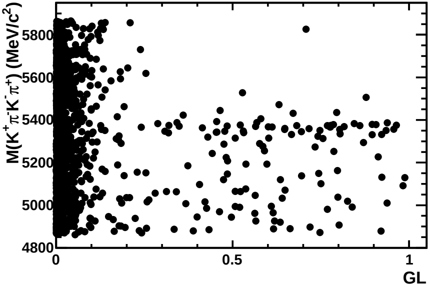
$M(K^+\pi^-K^-\pi^+)$ distribution

Signal:

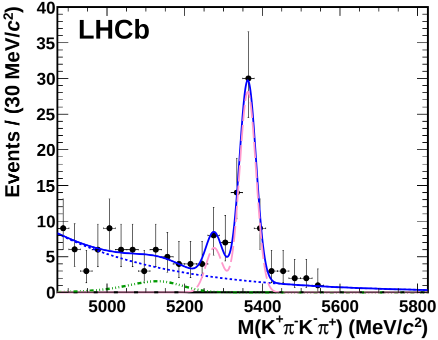
$$N_{B_s^0 \to K^{*0}\bar{K}^{*0}} = 50.1 \pm 7.5$$
$$N_{B^0 \to K^{*0}\bar{K}^{*0}} = 11.2 \pm 4.3$$

Impressive background conditions:

- Combinatorial
- Partially reconstructed B decays



2010 Data (35 pb^{-1})



10.9σ significance

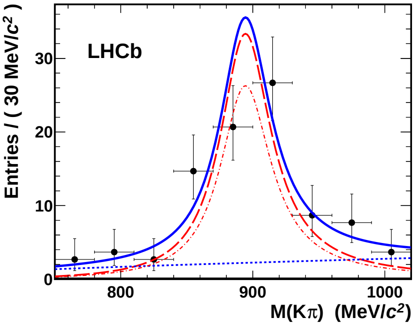
$K^+\pi^-$ and $K^-\pi^+$ mass distribution

- 2D maximum likelyhood fit $M(K^+\pi^-) \times M(K^-\pi^+)$ to data with $|M(K^+\pi^-K^-\pi^+) - m_{B_s^0}| < 50\ \mathrm{MeV}/c^2$:

$$(62 \pm 18)\% \text{ of } \mathrm{K}^{*0}\overline{\mathrm{K}}^{*0}$$

- Background subtracted using shape from the sidebands of the B_s^0 mass spectrum.
- Nonresonant component (linear x phase space)

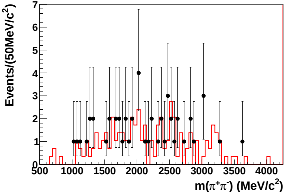
$$S(m) = (1 + bm)P(m)$$

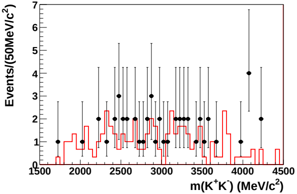


$$\mathcal{L} = \alpha BW(m_1)BW(m_2) + \beta(1-\beta)(BW(m_1)S(m_2) + BW(m_2)S(m_1)) + \beta^2 S(m_1)S(m_2)$$

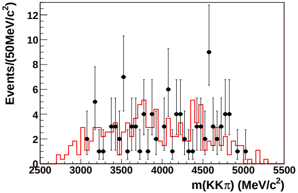
Further signal evidence

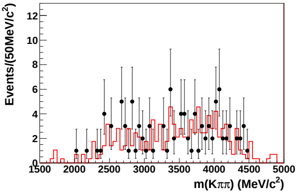
K^+K^- and $\pi^+\pi^-$ mass distributions: No resonant estructure (J/ψ or other) is observed, which might be indicative of a specific background or reflection channel.





$K^+K^-\pi^\pm$ spectrum starts above any known charm resonance. In particular, $\overline{B}^0_s \to D_s^+\pi^-$ is ruled out as a possible background for our signal.





Outline

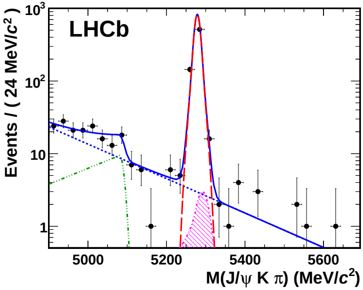
Determination of the BR

- Measure the $\mathcal{B}(B_s^0 \to K^{*0}\overline{K}^{*0})$ using $B^0 \to J/\psi\, K^{*0}$ as a control channel for normalization.

$$\mathcal{B}\left(B_s^0 \to K^{*0}\overline{K}^{*0}\right) = \lambda_{f_L} \times \frac{\epsilon^{sel}_{B^0 \to J/\psi\, K^{*0}}}{\epsilon^{sel}_{B_s^0 \to K^{*0}\overline{K}^{*0}}} \times \frac{\epsilon^{trig}_{B^0 \to J/\psi\, K^{*0}}}{\epsilon^{trig}_{B_s^0 \to K^{*0}\overline{K}^{*0}}} \times \frac{N_{B_s^0 \to K^{*0}\overline{K}^{*0}}}{N_{B^0 \to J/\psi\, K^{*0}}} \times \mathcal{B}_{vis}(B^0 \to J/\psi\, K^{*0}) \times \frac{f_d}{f_s} \times \frac{9}{4},$$

  - $\mathcal{B}_{vis}(B^0 \to J/\psi\, K^{*0}) = \mathcal{B}(B^0 \to J/\psi\, K^{*0}) \times \mathcal{B}(J/\psi \to \mu^+\mu^-) \times \mathcal{B}(K^{*0} \to K^+\pi^-)$
  - $\mathbf{\frac{f_s}{f_d} = 0.253 \pm 0.017 \pm 0.017 \pm 0.020}$
    (**LHCb recent measurement accepted in P.R.L.**)
  - Rely on MC to estimate the ratios of selection and trigger efficiencies.
  - No flat acceptance in the K^{*0} polarization angle $\Rightarrow$ Polarization dependent overall acceptance (λ_{f_L}).

Selection of control channel



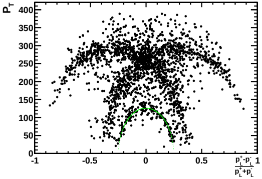
Variable	Cut
All tracks p_T	$>$500 MeV
K and π IPχ^2	$>$9
μ^- and μ^+ IPχ^2	$>$25
$K^{\pm}$ PID$_{K-\pi}$	$>$2
$\pi^{\pm}$ PID$_{K-\pi}$	$<$0
K^{*0} p_T	$>$900 MeV
K^{*0} vertex χ^2	$<$ 9
K^{*0} mass window	$\pm$150 MeV
J/ψ p_T	$>$900 MeV
J/ψ flight distance χ^2	$>$169
J/ψ DOCA	$<$0.3mm
J/ψ vertex χ^2	$<$9
J/ψ mass window	$\pm$60 MeV
B^0 IPχ^2	$<$25
B^0 vertex χ^2/ndof	$<$ 5
B^0 flight distance χ^2	$>$225
$B^0 \to J/\psi K^{*0}$ GL	$>$0.24

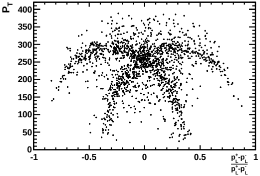
- Similar topology to the signal $\rightarrow$ Selection criteria harmonization easy. Same cuts when possible and use the same GL as for the signal.
- Higher trigger efficiency due to muon triggers $\rightarrow$ Consider only hadron triggers.

Ratio of selection efficiencies

	ϵ^{sel} (%)
$B^0 \to K^{*0}\overline{K}^{*0}$	0.370 ± 0.005
$B^0 \to J/\psi K^{*0}$	0.547 ± 0.007
ratio	0.678 ± 0.013

- Systematic effects:
  - Data/MC discrepancies in vertex and track quality (smeared MC): 2%
  - K PID cuts: Comparison data/MC using $B^0 \to J/\psi K^{*0}$ data (tighter K^{*0} mass cut) $\Rightarrow k_{PID} = 1.098 \pm 0.019$
    Systematic error: 1.7%





Ratio of trigger efficiencies

- $B^0 \to J/\psi K^{*0}$: Accept events only when the trigger decisions were not initiated by muon-tagged tracks from the signal.
- Data driven method to determine trigger effciencies[2] for $B^0 \to J/\psi K^{*0} \Rightarrow -9\%$ correction
- Systematic uncertainty: 11%

	ϵ^{trig} (%)
$B^0 \to K^{*0}\overline{K}^{*0}$	37.12 ± 0.39
$B^0 \to J/\psi K^{*0}$	31.16 ± 0.63
ratio	1.191 ± 0.027

- Detector occupancies are larger by a 10% in the real data $\Rightarrow +4.5\%$ correction

[2] E. Lopez Asamar et al., LHCb-PUB-2007-073

Correction for nonresonant signal

- $B^0 \to J/\psi\, K^{*0}$:
  - $\sim 8\%$ S-wave observed by BaBar.
  - LHCb measurement yields a $(9 \pm 4)\%$ contribution (extrapolating to our ± 150 MeV/c^2 window).

- $B_s^0 \to K^{*0} \overline{K}^{*0}$:
  - Contribution is doubled
  - Our direct measurement of $(17 \pm 8)\%$ is still lacking precision

- Assume a 9% S-wave for each K^{*0} or $\overline{K}^{*0}$ and compute the correction to the BR:

$$\frac{f_{K^* \overline{K}^{*0}}}{f_{J/\Psi K^*}} = \frac{(1-0.09)^2}{1-0.09} = 0.910$$

- Assing a 50% error to this hypothesis $\Rightarrow$ 5% systematic uncertainty in $\mathcal{B}$

Outline

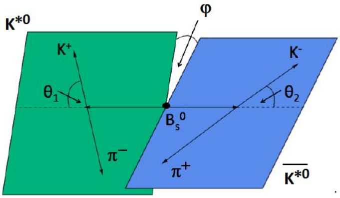
Angular distribution

$$I(\theta_1,\theta_2,\varphi) = \frac{\mathrm{d}^3\Gamma}{\mathrm{d}\cos\theta_1\,\mathrm{d}\cos\theta_2\,\mathrm{d}\varphi} = \Bigg(\frac{1}{\Gamma_L} \quad |A_0|^2 \quad \cos^2\theta_1\cos^2\theta_2 + \\ \frac{1}{\Gamma_L} \quad |A_\parallel|^2 \quad \frac{1}{2}\sin^2\theta_1\sin^2\theta_2\cos^2\varphi + \\ \frac{1}{\Gamma_H} \quad |A_\perp|^2 \quad \frac{1}{2}\sin^2\theta_1\sin^2\theta_2\sin^2\varphi + \\ \frac{1}{\Gamma_L} \quad |A_0| \quad |A_\parallel|\cos\delta_\parallel \frac{1}{2\sqrt{2}}\sin 2\theta_1 \sin 2\theta_2 \cos\varphi \Bigg)$$

$$A_0 = H_0$$

$$A_\parallel = \frac{1}{\sqrt{2}}(H_{+1} + H_{-1})$$

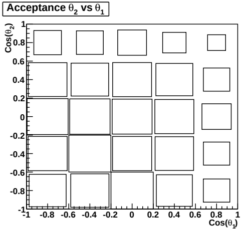
$$A_\perp = \frac{1}{\sqrt{2}}(H_{+1} - H_{-1})$$

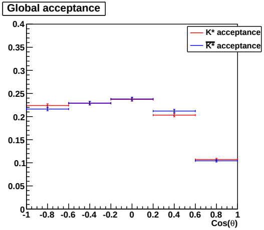


Normalization $\Rightarrow |A_0|^2 + |A_\parallel|^2 + |A_\perp|^2 = 1$

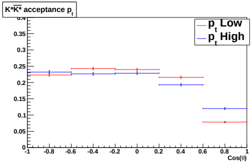
Angular Acceptance

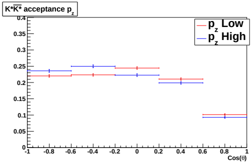
- Flat acceptance in φ.
- Acceptance in $\theta_{1,2}$ drops to zero as $cos\theta \to 1$.

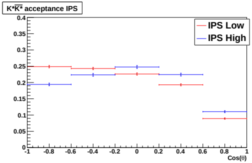




- $\epsilon(\theta)$ depends significantly on K^{*0} momentum (p_T, p_z) and on the IP of the daughters.



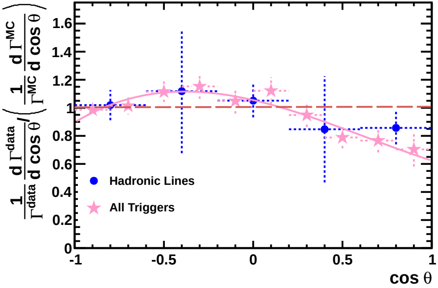




Angular Acceptance correction

- Acceptance ratio $B^0 \to J/\psi\, K^{*0}$ data/MC

With high statistics sample (adding muon triggers) a 10% discrepancy is detected.



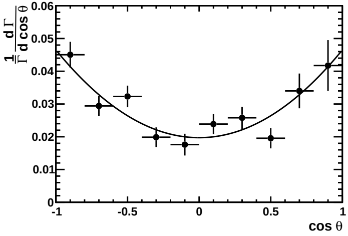
Validation with $B^0 \to J/\psi\, K^{*0}$

- We reproduce BaBar and CDF measurements on $B^0 \to J/\psi\, K^{*0}$ data

$$PDF(cos\theta) = A\left(2f_L \cos^2\theta + (1-f_L)\sin^2\theta\right)$$

- Angular acceptance from MC cross-checked with $B^0 \to J/\psi\, K^{*0}$ data.
- Measured longitudinal polarization fraction

$$f_L = 0.541 \pm 0.033$$



BaBar: $0.569 \pm 0.009 \pm 0.009$

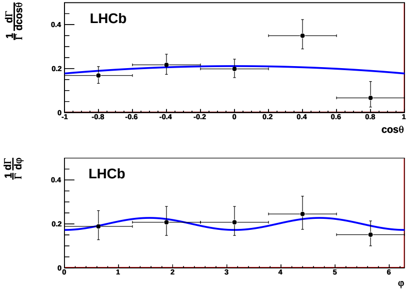
CDF: $0.531 \pm 0.02 \pm 0.007$

Fit results

- Fit to $B_s^0 \to K^{*0}\overline{K}^{*0}$ data in the signal region ($m_{B_s} \pm 50 \;\mathrm{MeV}/c^2$)

$$\mathrm{PDF} = (1-\alpha)\epsilon_\theta(\theta_1)\epsilon_\theta(\theta_2)\ \mathrm{I}(\theta_1,\theta_2,\varphi)$$
$$+\,\alpha(1+\beta\cos\theta_1)(1+\beta\cos\theta_2)\epsilon_\theta(\theta_1)\epsilon_\theta(\theta_2)$$

- Background fraction, α, determined from the B_s^0 mass fit. Background shape from the B_s^0 mass sidebands.



Parameter	Value
$f_L = \lvert A_0\rvert^2$	0.30 ± 0.12
$\lvert A_\parallel\rvert^2$	0.30 ± 0.10
$\delta_\parallel$	1.47 ± 1.85

Systematics on f_L

- Angular acceptance: Fit in various regions of the K^{*0} phase space, and IP of the daughters. (10%)
- Non uniform proper time acceptance: 3%
- Correction data/MC: Change the correction by 100% and check the effect in f_L (7%)
  - Experimental error not accounted for in the simulation.
  - Interference with other partial waves in the $K\pi$ system.

$$f_L = 0.30 \pm 0.12(stat) \pm 0.04(syst)$$

Outline

Determination of BR

$$\mathcal{B}\left(B_s^0 \to K^{*0}\bar{K}^{*0}\right) = \lambda_{f_L} \times \frac{\epsilon^{sel}_{B^0\to J/\psi K^{*0}}}{\epsilon^{sel}_{B_s^0\to K^{*0}\bar{K}^{*0}}} \times \frac{\epsilon^{trig}_{B^0\to J/\psi K^{*0}}}{\epsilon^{trig}_{B_s^0\to K^{*0}\bar{K}^{*0}}} \times \frac{N_{B_s^0\to K^{*0}\bar{K}^{*0}}}{N_{B^0\to J/\psi K^{*0}}} \times \mathcal{B}_{vis}(B^0 \to J/\psi K^{*0}) \times \frac{f_d}{f_s} \times \frac{9}{4},$$

$$\mathcal{B}(B_s^0 \to K^{*0}\bar{K}^{*0}) = (2.81 \pm 0.46(stat) \pm 0.45(syst) \pm 0.34(f_s/f_d)) \times 10^{-5}$$

Systematic effect	Error (%)
Background subtraction	4.7
Selection efficiency	3.4
Trigger efficiency	11.0
K^{*0} $\bar{K}^{*0}$ purity	5.0
Global angular acceptance	7.2
$\mathcal{B}(B^0 \to J/\psi K^{*0})$ and $\mathcal{B}(J/\psi \to \mu^+\mu^-)$	4.6
Total	15.9

Outline

Conclusions

- Clear $B_s^0 \to K^{*0}\overline{K}^{*0}$ signal has been discovered (10.9σ) with 35 pb^{-1}. Analysis of the $K^+\pi^-(K^-\pi^+)$ mass distribution shows that most of the signal comes from $B_s^0 \to K^{*0}\overline{K}^{*0}$, with some S-wave contribution.

- The K^{*0} longitudinal polarization fraction has been measured:

$$f_L = 0.30 \pm 0.12(stat) \pm 0.04(syst)$$

  Remarkable difference between $B_s^0 \to K^{*0}\overline{K}^{*0}$ and $B^0 \to K^{*0}\overline{K}^{*0}$, which are strict U-spin partners (BaBar:$f_L = 0.80^{+0.10}_{-0.12}(stat) \pm 0.04(syst)$).

- Sizeable $f_\perp$ (CP-odd) contribution ($f_\perp = 0.38 \pm 0.11(stat.) \pm 0.04(syst.)$).

- A measurement of the branching fraction has been performed using as normalisation reference the channel $B^0 \to J/\psi K^{*0}$,

$$\mathcal{B}(B_s^0 \to K^{*0}\overline{K}^{*0}) = (2.81 \pm 0.46(stat) \pm 0.45(syst) \pm 0.34(f_s/f_d)) \times 10^{-5}$$

$\Delta\Gamma$ in the BR measurement

- $BR \sim \mathcal{A}_0^2 + \mathcal{A}_\parallel^2 + \mathcal{A}_\perp^2$

- Two mass eigenstates involved, with $\Delta\Gamma/\Gamma = \Gamma_L - \Gamma_H$ ($\sim 16\%$). Interesting LHCb preliminary measurement $\Delta\Gamma$ from $B_s^0 \to J/\psi\,\phi$ (See *LHCb* by Cibran Santamarina, Plenary session).

- Time integration enhances CP-even spin factors:

$$f_K = f_k^0 (1 + \eta_k \frac{\Delta\Gamma}{2\Gamma})$$

where $\eta_k = +1, +1, -1$ for $f = L, \parallel, \perp$.

- Therefore BR becomes sensitive to $\Delta\Gamma$:

$$(BR)_{theo} = (BR)_{exp} \left(1 + \frac{\Delta\Gamma}{2\Gamma} (|A_0|^2 + |A_\parallel|^2 - |A_\perp|^2) \right)$$

only $\sim 3\%$ correction for SM values, apply on theory side.

Future analysis with proper time and flavour tagging

- Next step is time-dependent angular analysis to extract the mixing phase, ϕ_S.

$$\lambda_{B_s} = e^{i\phi_s} \frac{A(\bar{B}_s \to K^{*0}\bar{K}^{*0})}{A(B_s \to K^{*0}\bar{K}^{*0})}$$

- Eventually (LHCb upgrade) we want to measure all the direct C_{kl} and mixing S_{kl} asymmetries (12 of them), including interference terms[3]:

$$C_{kl} = \frac{f(1 - \lambda_k^* \lambda_l)}{f(1 + \lambda_k^* \lambda_l} \qquad S_{kl} = \frac{f(i(1 - \lambda_k^* \lambda_l))}{f(1 + \lambda_k^* \lambda_l}$$

where $f = Re$ (if $k = L$, $l = \parallel$) or $f = Im$ (if $k = L, \parallel$, $l = \perp$).

[3] R.Fleischer, M.Gronau arXiv:0709.4013v2 [hep-ph] (2007)

Thank you for your attention.

BACKUP

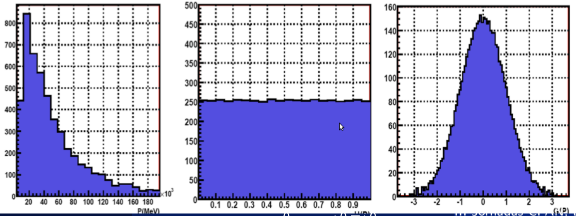
Geometrical Likelihood (I)

Training:

- Gaussianization:
  - Transform the variables X_i in [0,1] uniform distributed $U_i(X_i)$
  - Transform them into gaussian distributed: $G_i(X_i)$.
- Decorrelate and re-gaussianize:
  - Rotate to the symmetry axis and gaussianize again
  - Produce a set $\{S_i\}$ of uncorrelated gaussian distributed variables for the signal, and another different set $\{B_i\}$ for the background.

$$U_i(X_i) = \frac{\int_{Xmin}^{X_i} \rho(x_i')dx_i'}{\int_{Xmin}^{Xmax} \rho(x_i')dx_i'}$$

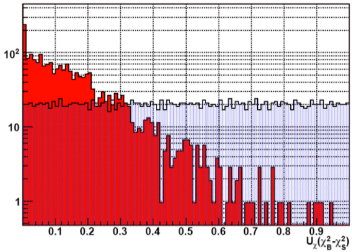
$$G_i(X_i) = \sqrt{2}erf^{-1}(2U_i(X_i) - 1)$$



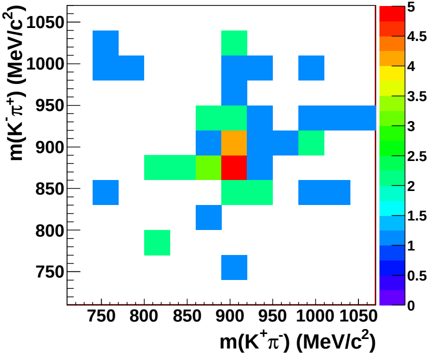
Geometrical Likelihood (II)

Apply the method to the signal and background samples.
For each event:

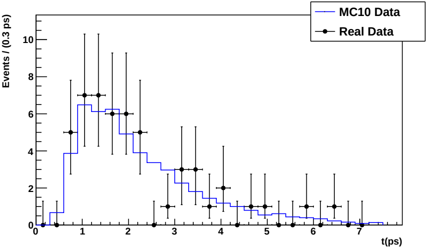
- Calculate the χ^2 for the signal hypothesis, $\chi^2_S = \sum S_i^2$.
- Calculate the χ^2 for the background hypothesis, $\chi^2_B = \sum B_i^2$.
- Calculate $\Delta\chi^2 = \chi^2_B - \chi^2_S$ and transform it into a uniform variable $U_{\chi^2}(\Delta\chi^2)$ in [0,1] for the signal, so that the background will cluster near 0.



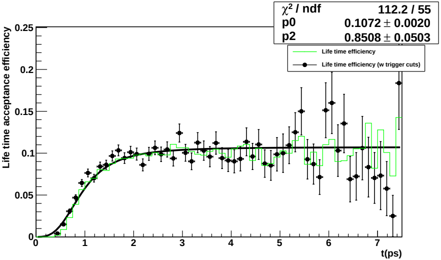
$K^+\pi^-$ and $K^-\pi^+$ mass distribution



B_s^0 propertime



Effect of selection cuts in lifetime acceptance.

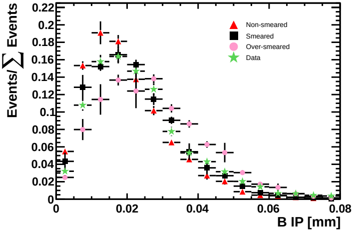


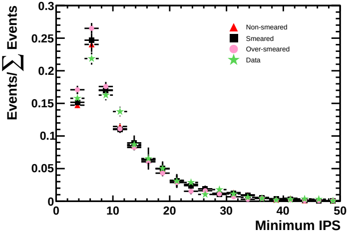
$$\varepsilon(t) = p_0 \left(\frac{t^3}{t^3 + p_2} \right)$$

Ratio of selection efficiencies (I)

- Smeared MC: Change initial state of the tracks.
- Data always bound by non-smeared and over-smeared MC.
- Systematic uncertainty: 2%

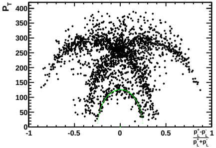
	ϵ^{sel} (%)
$B^0 \to K^{*0}\overline{K}^{*0}$	0.370 ± 0.005
$B^0 \to J/\psi\, K^{*0}$	0.547 ± 0.007
ratio	0.678 ± 0.013

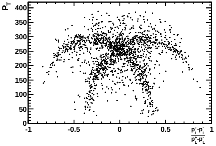




Ratio of selection efficiencies (II)

- K PID cuts $\rightarrow$ Comparison data/MC using $B^0 \rightarrow J/\psi\, K^{*0}$ data (tighter K^{*0} mass cut).





K^{*0} P_T range (GeV/c)	$\frac{\epsilon_{data}}{\epsilon_{MC}}$ with $\Delta_{LL}(K-\pi)_K > 0$	$\frac{\epsilon_{data}}{\epsilon_{MC}}$ with $\Delta_{LL}(K-\pi)_K > 2$
0-2.5	0.920 ± 0.015	0.934 ± 0.019
2.5-5	0.897 ± 0.013	0.888 ± 0.014
> 5	0.944 ± 0.026	0.915 ± 0.031

- $\mathcal{B}$ correction factor due to PID discrepancies: $k_{PID} = 1.098 \pm 0.019$
- Kaon PID systematic: 1.7%

- Total systematic uncertainty from selection efficiencies: 3.4%

Ratio of trigger efficiencies

- $B^0 \to J/\psi K^{*0}$: Accept events only when the trigger decisions were not initiated by muon-tagged tracks from the signal.
- Data driven method to determine trigger effciencies[4] for $B^0 \to J/\psi K^{*0} \Rightarrow -9\%$ correction
- Systematic uncertainty: 11%

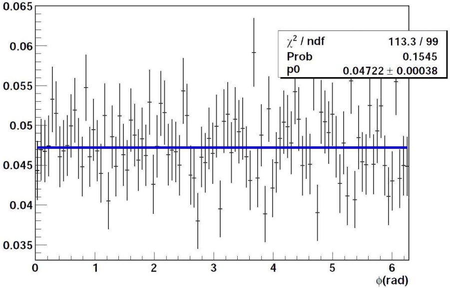
	ϵ^{trig} (%)
$B^0 \to K^{*0}\overline{K}^{*0}$	37.12 ± 0.39
$B^0 \to J/\psi K^{*0}$	31.16 ± 0.63
ratio	1.191 ± 0.027

- Detector occupancies are larger by a 10% in the real data $\Rightarrow +4.5\%$ correction

[4] E. Lopez Asamar et al., LHCb-PUB-2007-073

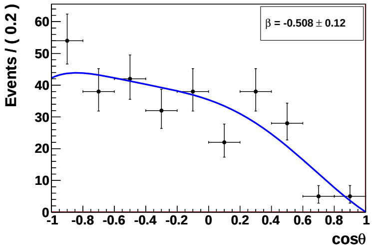
Angular acceptance

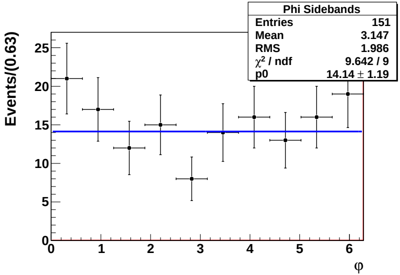
- Flat acceptance in φ



Background

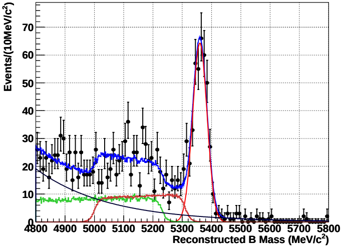
- Two side bands of 200 MeV/c^2 width each, left and right to the signal window ($m_{B_s} \pm 50\ \mathrm{MeV}/c^2$).
- $\cos\theta$ dependence was parametrized as $\epsilon_\theta \times (1 + \beta\cos\theta)$
- Flat φ distribution is consistent with the data.





BR: Cross-Check using $B_s \to D_s\pi$

- Same final state $(K^+\pi^-K^-\pi^+)$ but different topology.
- Selection harmonized, where possible, the $B_s^0 \to K^{*0}\overline{K}^{*0}$ one. Efficiency evaluated from MC10 $\epsilon^{sel/gen} = 2.16\%$.
- Trigger efficiency evaluated from MC $\epsilon^{trig/sel} = 42.3\%$
- Generator efficiency $\epsilon^{gen} = 16.1\%$



$$\mathcal{B}(B_s^0 \to K^{*0}\overline{K}^{*0}) = [2.45 \pm 0.41(stat.) \pm 0.37(B.R.)] \times 10^{-5}$$

- Systematic error dominated by the knowledge of $\mathcal{B}(B_s \to D_s\pi)$.