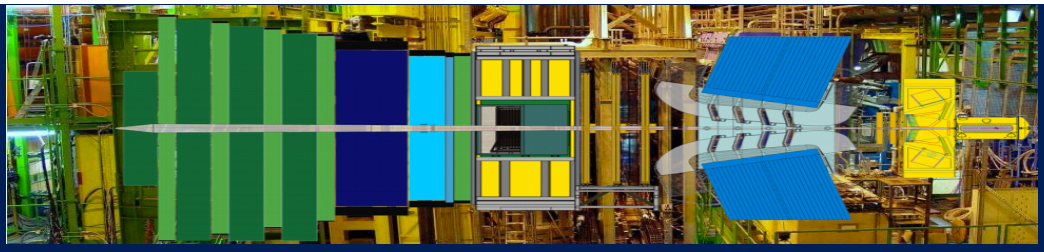

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Time-dependent CP violation in $B^0 \to \pi^+\pi^-$ and $B_s^0 \to K^+K^-$ decays at LHCb

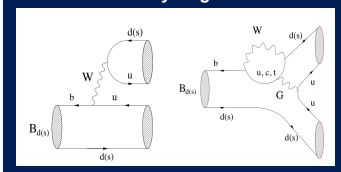
Stefano Perazzini – INFN Bologna
On behalf of the LHCb Collaboration

Abstract

Using an integrated luminosity of 0.69 fb^{-1} collected by LHCb in 2011, we report measurements of direct and mixing-induced CP violation in $B^0 \to \pi^+\pi^-$ and $B_s^0 \to K^+K^-$ decays. The measurements of the $B^0 \to \pi^+\pi^-$ asymmetries are compatible with those from the B factories and yield 3.2σ evidence of mixing-induced CP violation, whereas the $B_s^0 \to K^+K^-$ asymmetries are measured for the first time ever.

The $B^0 \to \pi^+\pi^-$ and $B_s^0 \to K^+K^-$ decays

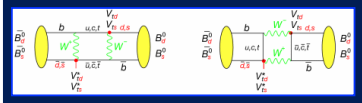
Decay diagrams



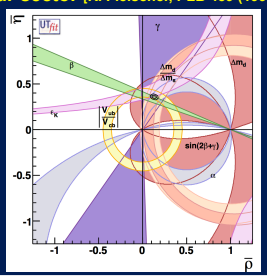
- Decay diagrams involve CKM matrix elements related to the **γ angle** of the Unitarity Triangle
- **B^0 and B_s^0 mixing phases** enter the amplitudes via mixing diagrams

Sensitive probe for New Physics in the flavour sector [R. Fleischer, PLB 459 (1999) 306]

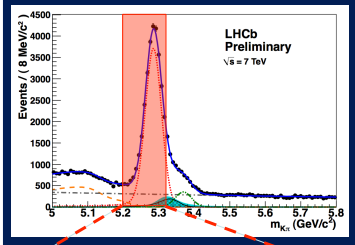
Mixing diagrams

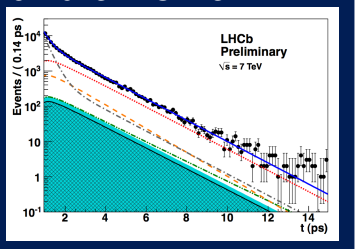


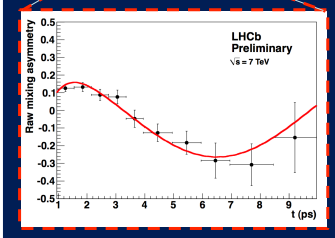
- Cons:
  - Hadronic uncertainties due to QCD penguin diagrams
- Pros:
  - New particles may appear inside loop diagrams as virtual contributions
  - Room for New Physics



$B \to K\pi$ mass and time fit







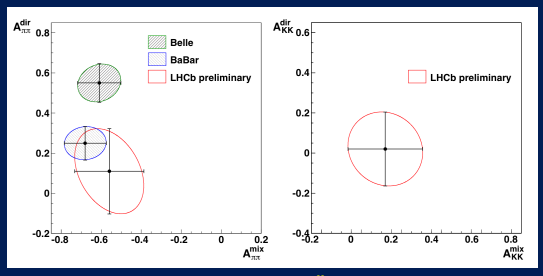
- **Flavour tagging performances and B^0 and B_s^0 production asymmetries are determined**

$A_P(B^0) = -0.015 \pm 0.013$

$A_P(B_s^0) = -0.03 \pm 0.06$

$\varepsilon D^2 = 2.3 \pm 0.1$

Final results



$A^{dir}_{\pi\pi} = 0.11 \pm 0.21 \pm 0.03$ **$A^{dir}_{KK} = 0.02 \pm 0.18 \pm 0.04$**
$A^{mix}_{\pi\pi} = -0.56 \pm 0.17 \pm 0.03$ **$A^{mix}_{KK} = 0.17 \pm 0.18 \pm 0.05$**

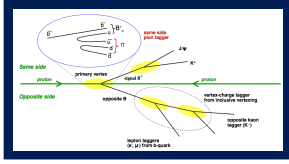
$B^0 \to \pi^+\pi^-$ results favour the existing BaBar measurement
$B_s^0 \to K^+K^-$ results are the world's first

Time dependent CP asymmetries

$$\mathcal{A}_{CP}(t) = \frac{\Gamma_{\bar{B}\to f}(t) - \Gamma_{B\to f}(t)}{\Gamma_{\bar{B}\to f}(t) + \Gamma_{B\to f}(t)} = \frac{\mathcal{A}^{dir}\cos(\Delta M t) + \mathcal{A}^{mix}\sin(\Delta M t)}{\cosh\left(\frac{\Delta\Gamma}{2}t\right) - \mathcal{A}^{\Delta\Gamma}\sinh\left(\frac{\Delta\Gamma}{2}t\right)}$$

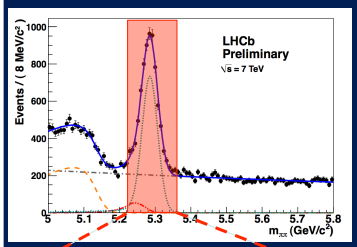
- **A^{dir}**: different decay amplitudes between B and $\bar{B}$
- **A^{mix}**: interference between decay and mixing processes

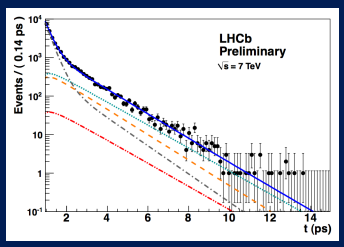
Flavour tagging

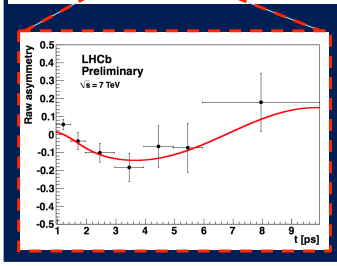


- Crucial aspect of the measurement:
  - Determination of the flavour of the B at the production
  - Performed analyzing particles from the other B decay
  - Here calibrated using $B^0 \to K\pi$ decay

$B^0 \to \pi^+\pi^-$ mass and time fit



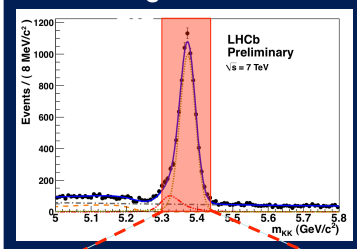


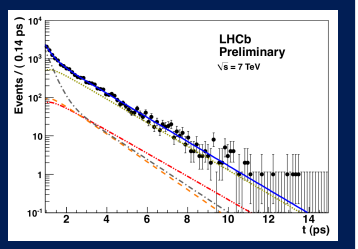


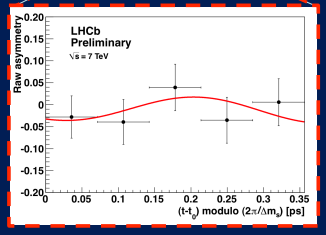
$$A^{dir}_{\pi\pi} = 0.11 \pm 0.21,$$
$$A^{mix}_{\pi\pi} = -0.56 \pm 0.17,$$
$$\rho(A^{dir}_{\pi\pi}, A^{mix}_{\pi\pi}) = -0.34.$$

Only statistical errors and correlation

$B_s^0 \to K^+K^-$ mass and time fit







$$A^{dir}_{KK} = 0.02 \pm 0.18,$$
$$A^{mix}_{KK} = 0.17 \pm 0.18,$$
$$\rho(A^{dir}_{KK}, A^{mix}_{KK}) = -0.10.$$

Only statistical errors and correlation