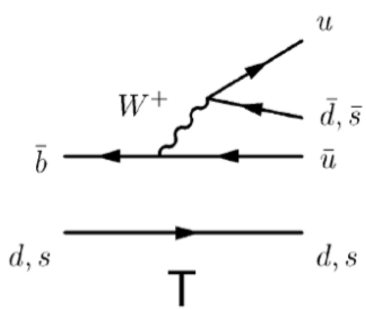
Charmless B decays

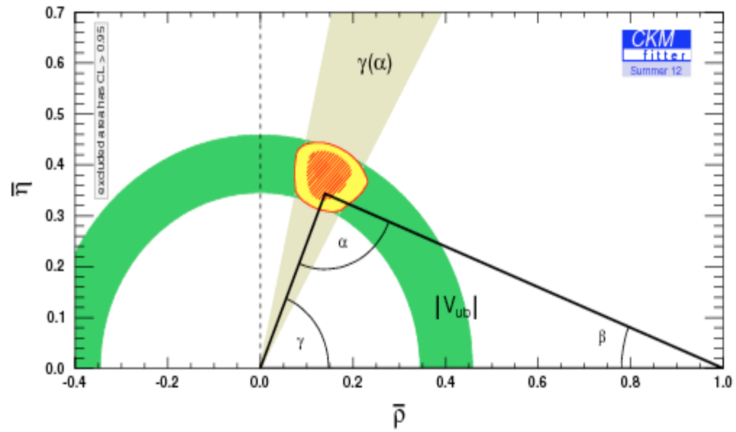
Marc Grabalosa
On behalf of the LHCb Collaboration

LPC - ClermontFerrand

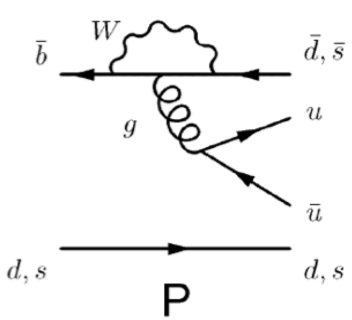
- Motivation/LHCb
- 2-body charmless decays
- 3-body charmless decays
- VV charmless decays

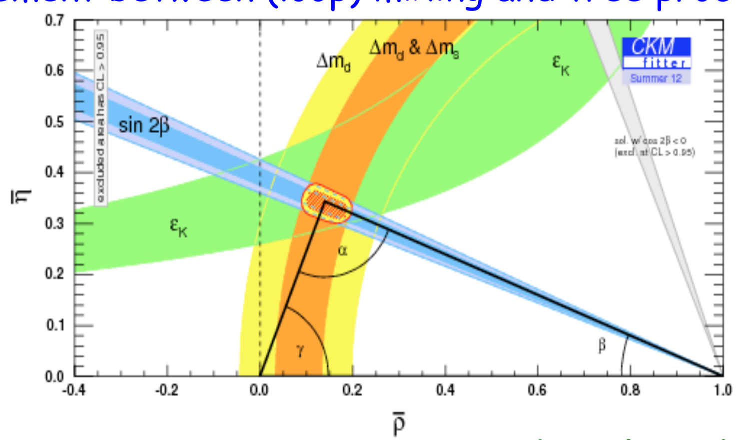
- **Motivation**
  - Tree processes (b→u) can be used to test SM looking for deviation in the CKM structure
  - Loop processes (b→s, b→d) are FCNC and new particle may appear in the loops





Fair agreement between (loop) mixing and tree processes





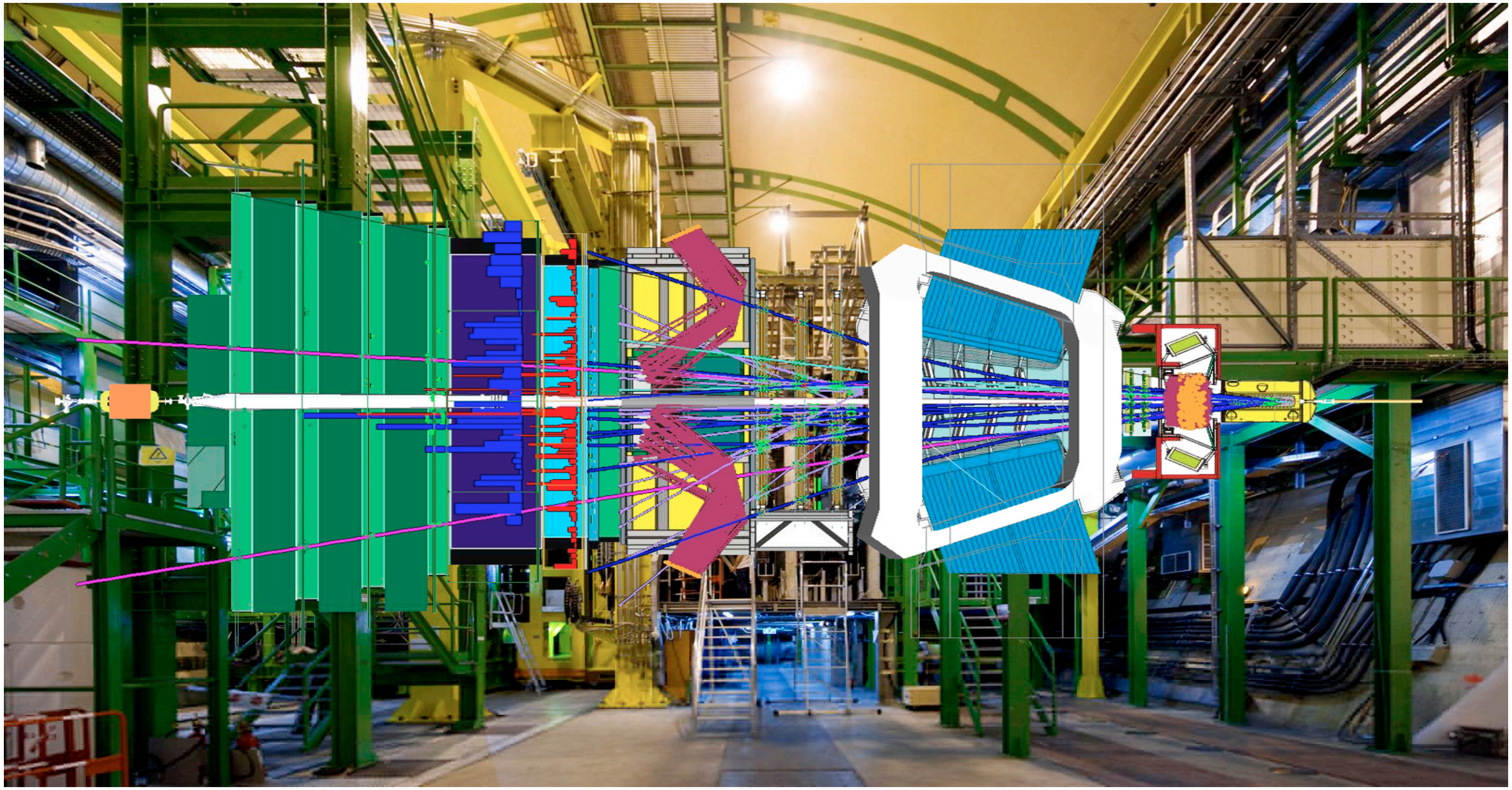
Mainly meson mixing observables

More in Michael Sokoloff talk

- LHCb

  Single arm spectrometer
  ~3fb^{-1} data
  37 pb^{-1} 2010
  1 fb^{-1} 2011
  2 fb^{-1} 2012

High trigger efficiency
Excellent tracking system
Time, impact parameter resolution
Mass resolution
Excellent Particle Identification
Flavour Tagging

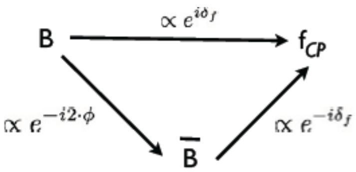


Charmless 2 body decays (neutral B decays)

- Mixed induced CPV (non flavour specific decays)

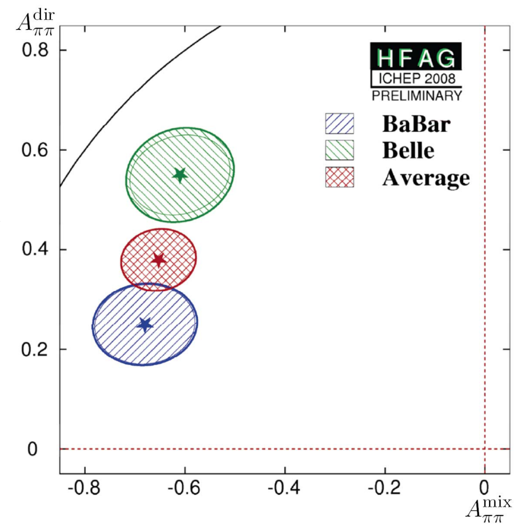
LHCb-CONF-2012-007

0.69 fb^{-1}



$$A_{CP}(t) = \frac{A_{\rm dir}\cos(\Delta m t) + A_{\rm mix}\sin(\Delta m t)}{\cosh(\frac{\Delta\Gamma}{2}t) - A_{\Delta}\sinh(\frac{\Delta\Gamma}{2}t)}$$

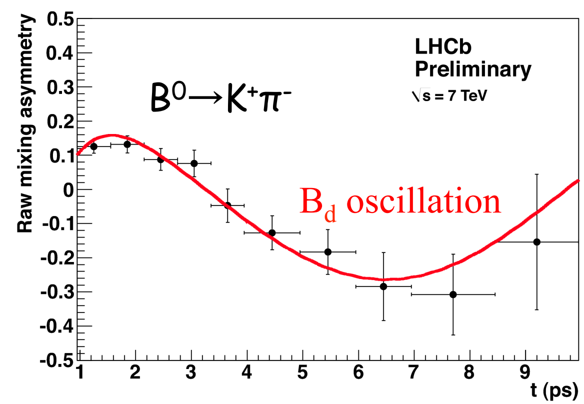
- Some tensions between Belle and BaBar in ππ channel →



- LHCb: Time-dependent analysis on:
  - $B^0 \rightarrow \pi\pi$
  - $B^0_s \rightarrow KK$
  - Tagged time-dependent analysis

  Calibrated with $B^0 \rightarrow K^+\pi^-$

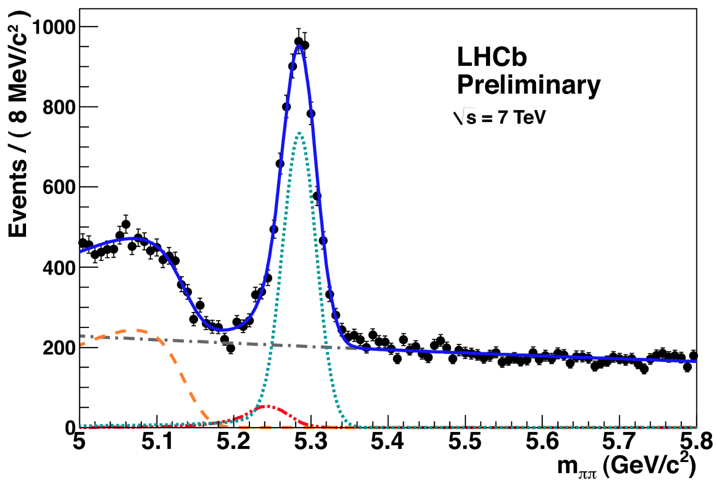
- $\Delta m_d = 0.484 \pm 0.019\ ps^{-1}$
- Tagging power $\varepsilon_{eff} = (2.3\pm0.1)\%$ (OS only)

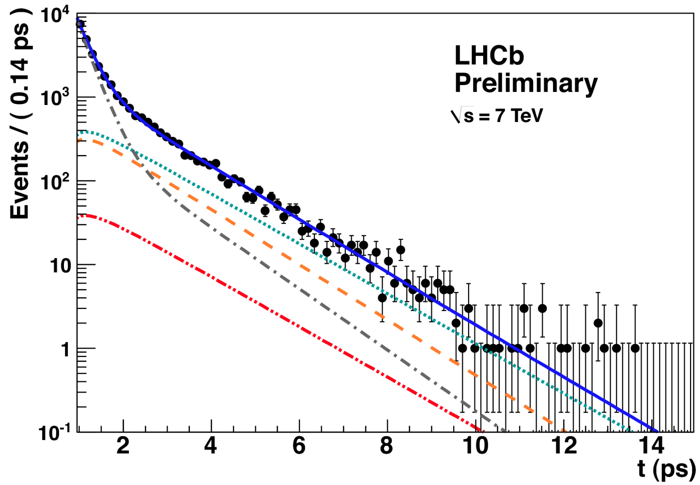


See Katharina Kreplin talk

Charmless 2 body decays ($B^0 \to \pi^+\pi^-$)

- Time-dependent $B^0 \to \pi^+\pi^-$ 0.69 fb^{-1} LHCb-CONF-2012-007

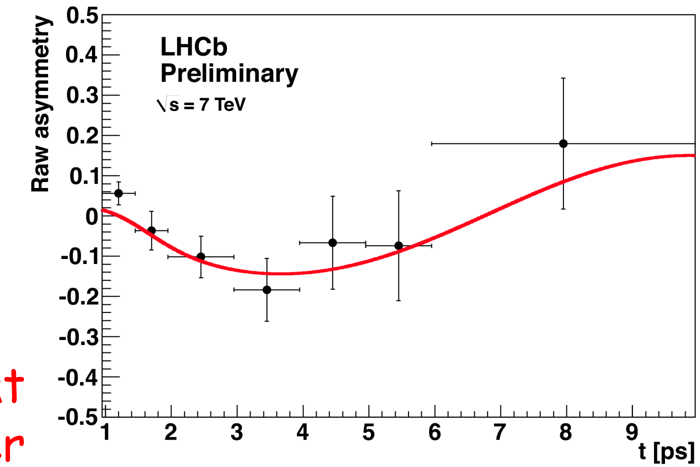




Preliminary results

$\Delta m_d = 0.499 \pm 0.032 \pm 0.003\ ps^{-1}$
(from LHCb-CONF-2011-010)

$A_{\pi\pi}^{dir} = 0.11 \pm 0.21(stat) \pm 0.03(syst)$
$A_{\pi\pi}^{mix} = -0.56 \pm 0.17(stat) \pm 0.03(syst)\ (3.2\sigma)$
$\rho(A_{\pi\pi}^{dir}, A_{\pi\pi}^{mix}) = -0.34$ (stat only)



First $B^0 \to \pi^+\pi^-$ CP asymmetry measurement at hadron collider

Charmless 2 body decays (neutral B decays)

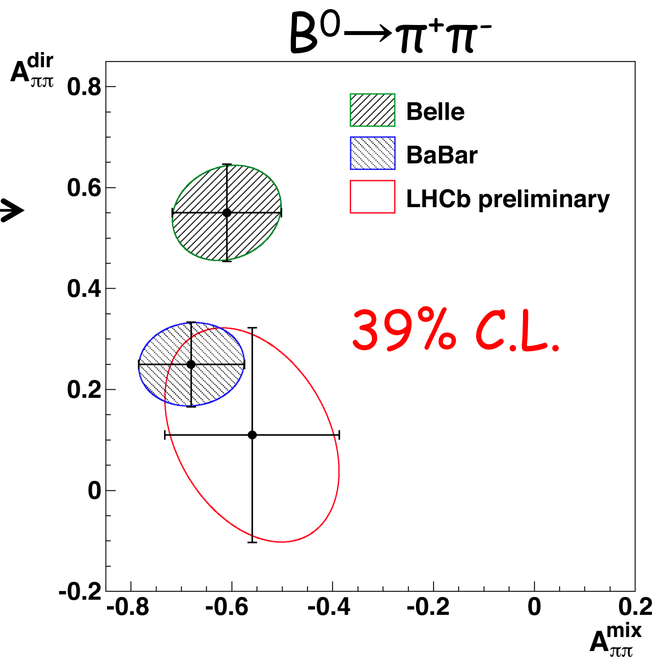
- $B^0 \to \pi^+\pi^-$ and $B^0_s \to K^+K^-$ 0.69 fb^{-1} LHCb-CONF-2012-007

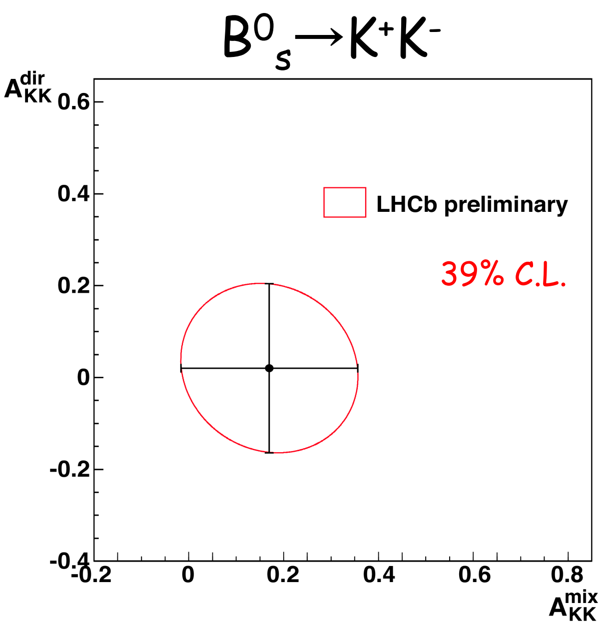
First evidence (3.2σ) time-dependent CPV at hadron colider

Preliminary LHCb results favours BaBar →

Statistically limited but already contributing to constrain CKM angle α

CP asymmetry in $B_s \to K^+K^-$ measured for first time





Improvements expected:
- $3fb^{-1}$ recorded
- SS tagging

Charmless 2 body decays ($B_{d,s} \to K\pi$)

- Direct CP violation ($B^0 \to K\pi$)

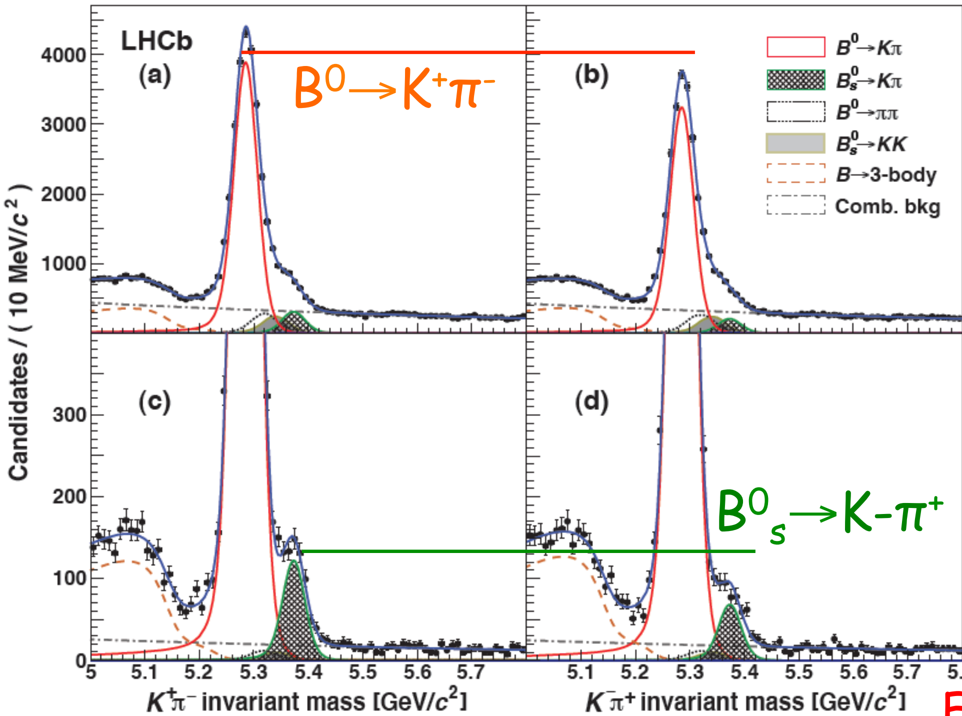
$$A_{CP}(B_s^0 \to \pi K) = \frac{\Gamma(\bar{B}_s^0 \to \pi^- K^+) - \Gamma(B_s^0 \to \pi^+ K^-)}{\Gamma(\bar{B}_s^0 \to \pi^- K^+) + \Gamma(B_s^0 \to \pi^+ K^-)}.$$

$$A_{CP}(B^0 \to K\pi) = \frac{\Gamma(\bar{B}^0 \to K^-\pi^+) - \Gamma(B^0 \to K^+\pi^-)}{\Gamma(\bar{B}^0 \to K^-\pi^+) + \Gamma(B^0 \to K^+\pi^-)}$$

- Compare the decay rates of self-tagged modes
  - Different optimizations for B_d/B_s
  - PID is a keypoint
  - Raw asymmetry must be corrected for detection asymmetry and B production asymmetry

1.0 fb^{-1}

$$\mathcal{A}_{CP} = \mathcal{A}_{Raw} - (\mathcal{A}_{Det.} + \kappa \mathcal{A}_{Prod.})$$



1. A_{Det} determined from large D decay samples
2. κ dilution from mixing/acceptance
3. A_{Prod} determined from time dependence

Total correction is small (~1%)

LHCb-PAPER-2013-018
arXiv: 1304.6173

$$A_{CP}(B^0 \to K^+\pi^-) = -0.080 \pm 0.007\,(\text{stat}) \pm 0.003\,(\text{syst}),$$

$$A_{CP}(B_s^0 \to K^-\pi^+) = 0.27 \pm 0.04\,(\text{stat}) \pm 0.01\,(\text{syst}).$$

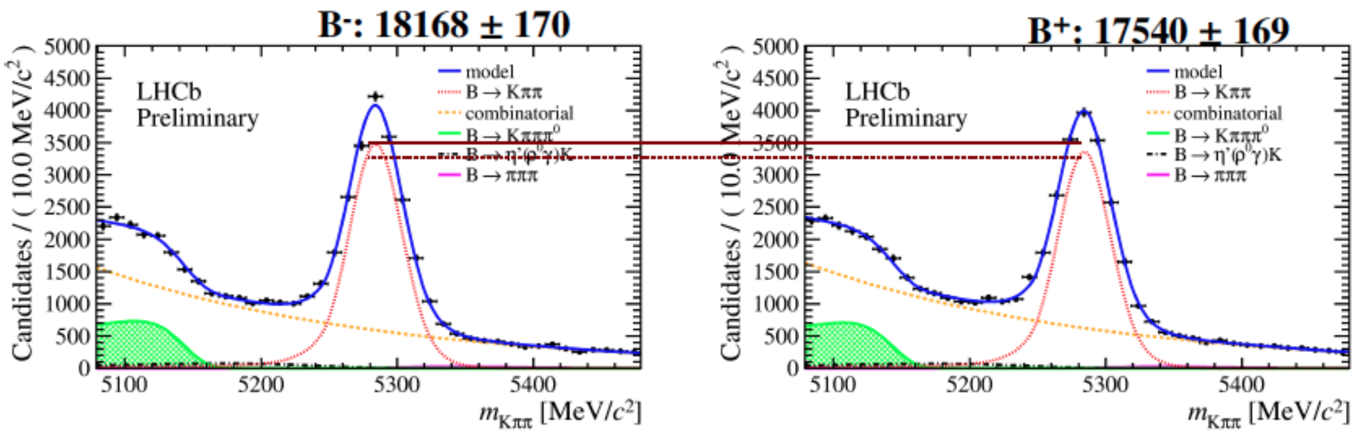
First observation CP violation in B_s decays

Charmless 3-body decays (charged B^+/B^-)

- Direct CP violation

- Compare the decay rates of B+/B- (Kππ,KKK,KKπ, πππ,…)
- Go from raw asymmetries to CP asymmetries as in 2-body case

$A_{CP}^{raw}(K\pi\pi) = +0.018 \pm 0.007$



1.0 fb⁻¹

LHCb-CONF-2012-018 (Khh)

LHCb-CONF-2012-028 (πKK, πππ)

$$A_{CP} = A_{CP}^{RAW} - (A_{CP}^{Det.} + A_{CP}^{Prod.})$$

$A_{CP}^{Det.}$ and $A_{CP}^{Prod.}$ are determined from the control channel $B^{\pm} \to J/\psi K^{\pm}$

$A_{CP}(B\to K\pi\pi) = +0.034 \pm 0.009(\text{stat}) \pm 0.004(\text{syst}) \pm 0.007(J/\psi\ K)$ 2.8 σ

$A_{CP}(B\to KKK) = -0.046 \pm 0.009(\text{stat}) \pm 0.005(\text{syst}) \pm 0.007(J/\psi\ K)$ 3.7 σ

$A_{CP}(B\to \pi\pi\pi) = +0.120 \pm 0.020(\text{stat}) \pm 0.019(\text{syst}) \pm 0.007(J/\psi\ K)$ 4.2 σ

$A_{CP}(B\to \pi KK) = -0.153 \pm 0.046(\text{stat}) \pm 0.019(\text{syst}) \pm 0.007(J/\psi\ K)$ 3.0 σ

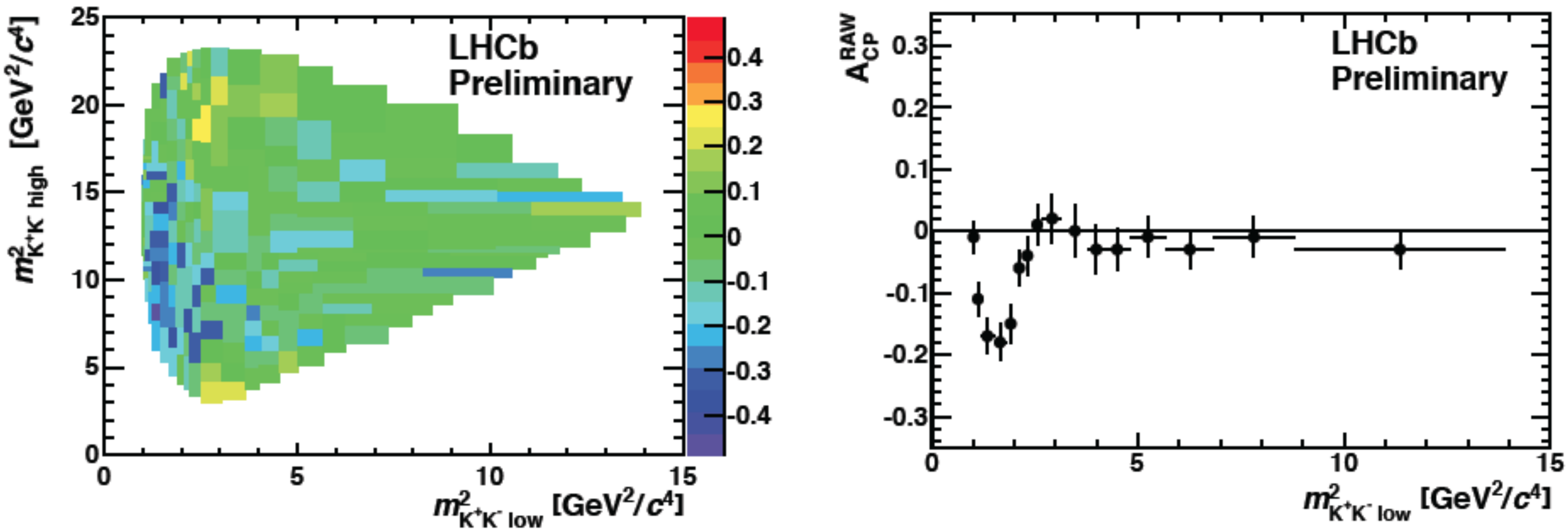
Charmless 3-body decays (charged B^+/B^-)

- Dalitz in 3-body charmless

LHCb-CONF-2012-018/028

- CP asymmetries observed in the Dalitz Plane (i.e B KKK)

$1.0\ fb^{-1}$



- Large CPV at low m^2
- Not likely connected everywhere to the resonant structure in the Dalitz projections

$$A_{cp}(B^{\pm} \rightarrow \pi\pi\pi \text{ region}) = +0.622 \pm 0.075(\text{stat}) \pm 0.032(\text{syst}) \pm 0.007(J/\psi K^{\pm}) \quad 7.6\,\sigma$$

$$A_{cp}(B^{\pm} \rightarrow \pi KK \text{ region}) = -0.671 \pm 0.067(\text{stat}) \pm 0.028(\text{syst}) \pm 0.007(J/\psi K^{\pm}) \quad 9.2\,\sigma$$

- Full amplitude analysis is the next step

Charmless 3-body decays (neutral $B^0_{d,s}$)

- With neutral particles (Kshh)

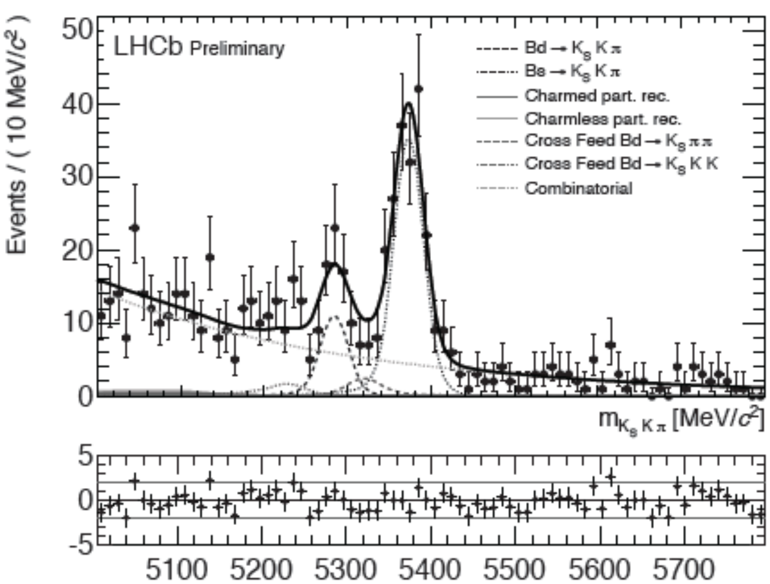
LHCb-CONF-2012-023

1.0 fb^{-1}

  - NP can enter through penguin diagrams

$$A_{CP}(\Delta t) = S_f \sin(\Delta m t) + C_f \cos(\Delta m t)$$

  - Future plans: Dalitz amplitude followed by time-dependent analysis
  - First step BR measurements



$$\frac{\mathcal{B}(B^0 \to K^0_S K^\pm \pi^\mp)}{\mathcal{B}(B^0 \to K^0_S \pi^+ \pi^-)} = 0.117 \pm 0.018\,(\text{stat.}) \pm 0.018\,(\text{syst.}),$$

$$\frac{\mathcal{B}(B^0 \to K^0_S K^+ K^-)}{\mathcal{B}(B^0 \to K^0_S \pi^+ \pi^-)} = 0.53 \pm 0.04\,(\text{stat.}) \pm 0.04\,(\text{syst.}),$$

$$\frac{\mathcal{B}(B^0_s \to K^0_S \pi^+ \pi^-)}{\mathcal{B}(B^0 \to K^0_S \pi^+ \pi^-)} = 0.24 \pm 0.06\,(\text{stat.}) \pm 0.04\,(\text{syst.}),$$

$$\frac{\mathcal{B}(B^0_s \to K^0_S K^\pm \pi^\mp)}{\mathcal{B}(B^0 \to K^0_S \pi^+ \pi^-)} = 1.96 \pm 0.15\,(\text{stat.}) \pm 0.20\,(\text{syst.}),$$

$$\frac{\mathcal{B}(B^0_s \to K^0_S K^+ K^-)}{\mathcal{B}(B^0 \to K^0_S \pi^+ \pi^-)} = 0.084 \pm 0.031\,(\text{stat.}) \pm 0.019\,(\text{syst.}).$$

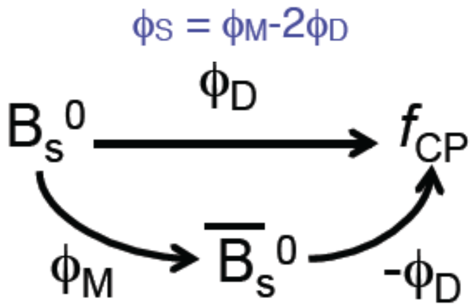
- Soon update results with improved selection

VV decays ($B_s^0 \to \phi\phi$)

- Mixing induced CPV in $B_s^0 \to \phi\phi$ ($K^+K^-K^+K^-$) 1.0 fb^{-1}

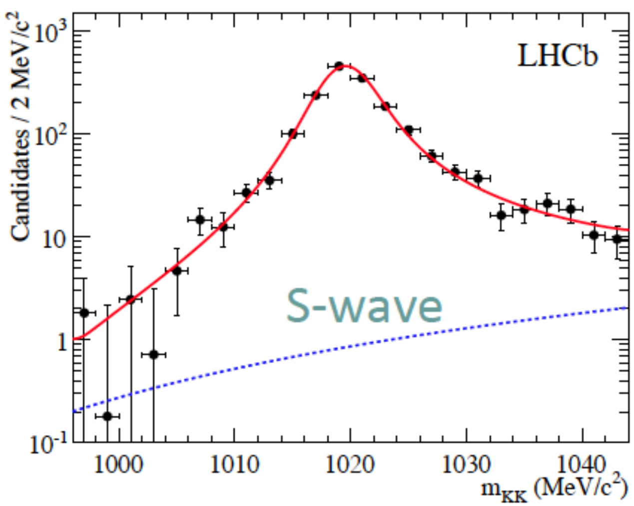
LHCb-PAPER-2013-007
arXiv:1303.7125[hep-ex]

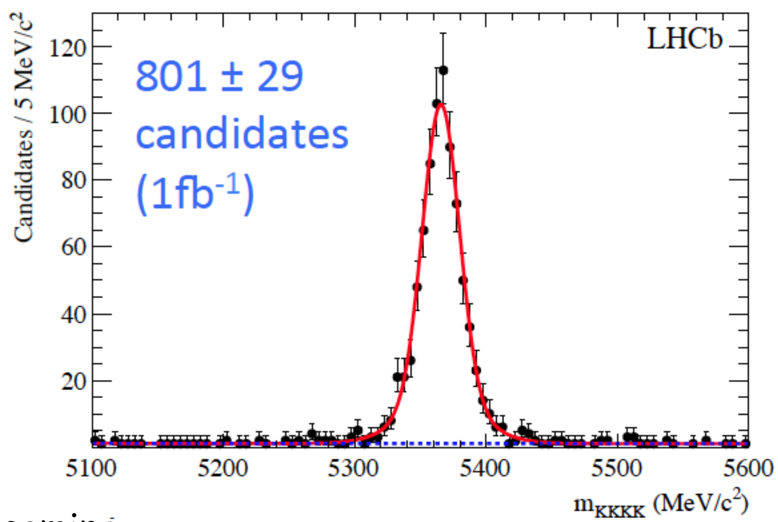
  - Study the CP violation asymmetry in interference between decay and mixing



ϕ_s is expected to be zero as cancellation of mixing and decay weak phases (dominated by V_{ts} in T, P transitions)

  - Key ingredients: Time-integrated analysis, amplitude (angular) analysis





Systematics dominated by the s-wave contamination and angular acceptance

Similar analysis on $B_s \to K^*K^*$ and more coming

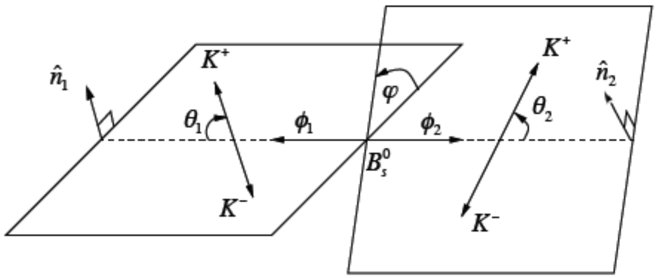
→ LHCb Collaboration, R. Aaij et al., Phys. Lett. B 709 (arXiv:1111.4183)

VV decays ($B_s^0 \to \phi\phi$)

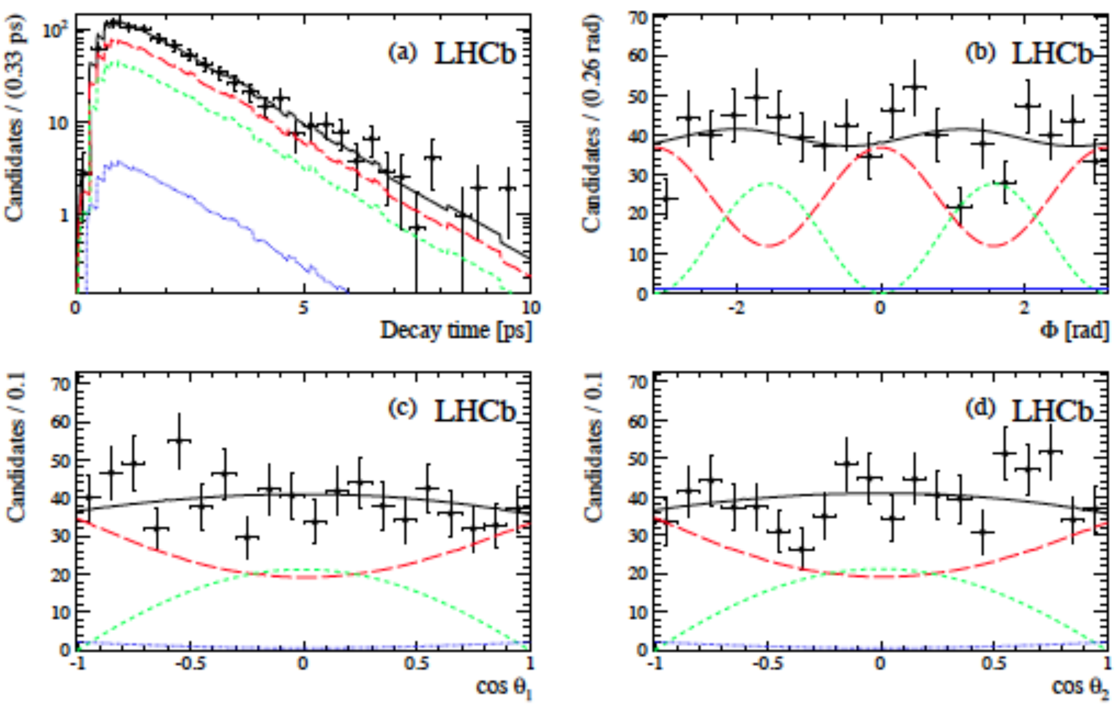
- Angular analysis (tagged time-dependent analysis)

1.0 fb^{-1}

LHCb-PAPER-2013-007
arXiv:1303.7125[hep-ex]



Parameter	Value	$\sigma_{stat.}$	$\sigma_{syst.}$
ϕ_s[rad] (68 % CL)		$[-2.37, -0.92]$	0.22
$\lvert A_0\rvert^2$	0.329	0.033	0.017
$\lvert A_\perp\rvert^2$	0.358	0.046	0.018
$\lvert A_S\rvert^2$	0.016	$^{+0.024}_{-0.012}$	0.009
δ_1 [rad]	2.19	0.44	0.12
δ_2 [rad]	-1.47	0.48	0.10
δ_S [rad]	0.65	$^{+0.89}_{-1.65}$	0.33



Total
CP–even
CP–odd
S–wave

Γ_S and $\Delta\Gamma_S$ from $B_s^0 \to J/\psi\phi$
LHCB-PAPER-2013-002 in preparation.
$\Delta m_S = (17.73 \pm 0.05)ps^{-1}$, LHCb-CONF-2011-050.

$\phi_S \in [-2.46, -0.76]$ rad at 68% CL

Conclusion

- Charmless are very interesting channels to check the SM and look for NP
- 2-body (γ, ϕ_s)
  - B→hh addressing both direct and mixing-induced CP violation

$$A_{CP}(B^0 \to K^+\pi^-) = -0.080 \pm 0.007\,(\text{stat}) \pm 0.003\,(\text{syst}),$$

$$A_{CP}(B_s^0 \to K^-\pi^+) = 0.27 \pm 0.04\,(\text{stat}) \pm 0.01\,(\text{syst}).$$

- 3-body (α, γ, ϕ_s, ϕ_d)
  - B→3h: BF and integrated CP asymmetries are measured

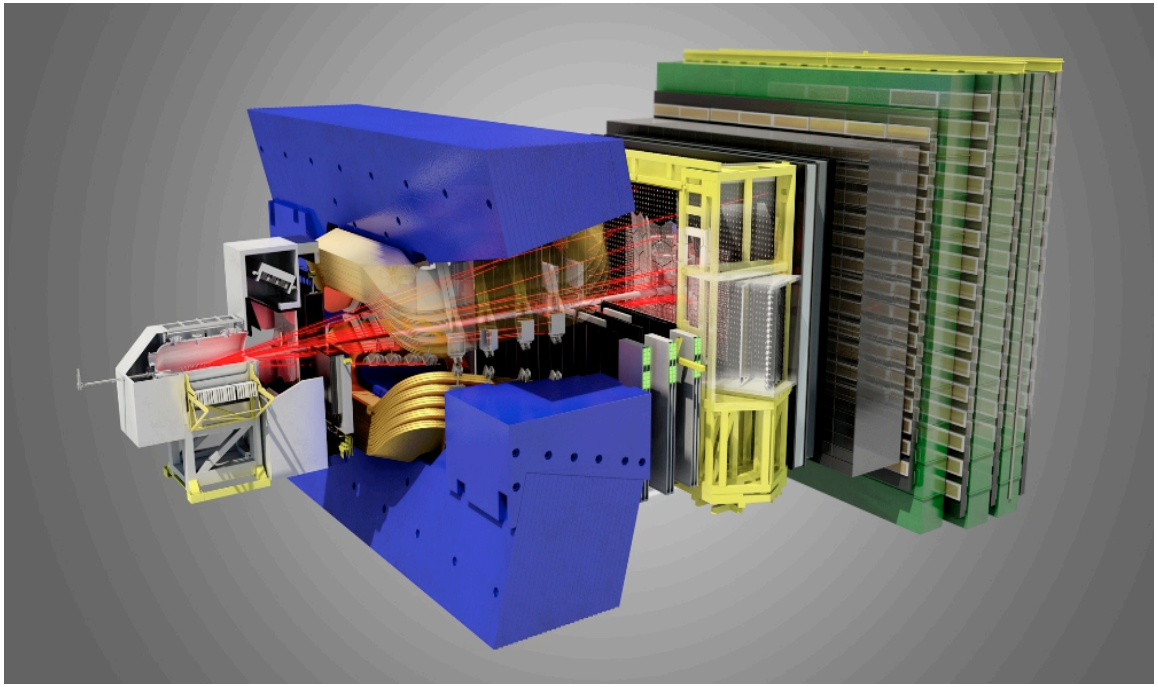
$A_{CP}(B\to K\pi\pi)$ = +0.034 ± 0.009(stat) ± 0.004(syst) ± 0.007(J/ψ K)
$A_{CP}(B\to KKK)$ = -0.046 ± 0.009(stat) ± 0.005(syst) ± 0.007(J/ψ K)
$A_{CP}(B\to \pi\pi\pi)$ = +0.120 ± 0.020(stat) ± 0.019(syst) ± 0.007(J/ψ K)
$A_{CP}(B\to \pi KK)$ = -0.153 ± 0.046(stat) ± 0.019(syst) ± 0.007(J/ψ K)

  - B→$K_s$hh: Signal established (publications with 1fb^{-1} to come)
- 4-body decays(angular analysis) (γ, ϕ_s)
  - $B_{d,s}$→VV ($\phi\phi$,K*K*,K*ρ,$\rho\rho$,..) Amplitude time-dependent analysis published with 1fb^{-1}.
  - More will follow
- Prospects for 3fb^{-1}:
  - Statistic improvement, amplitude analysis and addition of SS tagging

BackUp

Resolution

momentum resolution:
$\Delta p / p$ = 0.4 % at 5 GeV/c to 0.6 % at 100 GeV/c
ECAL resolution (nominal):
1 % + 10 % / $\sqrt{E[GeV]}$
impact parameter resolution:
20 μm for high-pT tracks
invariant mass resolution:
~8 MeV/c2 for B → J/ψ X decays with constraint on J/ψ mass
~22 MeV/c2 for two-body B decays
~100 MeV/c2 for Bs → φ γ, dominated by photon contribution
decay time resolution:
45 fs for Bs → J/ψ φ and for Bs → Ds π



Efficiencies

percentage of working detector channels:
~ 99 % for all sub-detectors
data taking efficiency:
> 90 %
data good for analyses:
> 99 %
trigger efficiencies:
~ 90 % for dimuon channels
~ 30 % for multi-body hadronic final states
track reconstruction efficiency:
> 96 % for long tracks
electron ID efficiency:
~ 90 % for ~ 5 % e→h mis-id probability
kaon ID efficiency:
~ 95 % for ~ 5 % π→K mis-id probability
muon ID efficiency:
~ 97 % for 1-3 % π→μ mis-id probability

Acceptance

pseudorapidity:
$2 < \eta < 5$

Charmless 2 body decays (protons)

- Branching fractions

arXiv:1206.2794

$$\mathcal{B}(B^0 \to \pi^+\pi^-)/\mathcal{B}(B^0 \to K^+\pi^-) = 0.262 \pm 0.009 \pm 0.017$$

$$(f_s/f_d)\cdot\mathcal{B}(B_s^0 \to K^+K^-)/\mathcal{B}(B^0 \to K^+\pi^-) = 0.316 \pm 0.009 \pm 0.019$$

$$(f_s/f_d)\cdot\mathcal{B}(B_s^0 \to \pi^+K^-)/\mathcal{B}(B^0 \to K^+\pi^-) = 0.074 \pm 0.006 \pm 0.006$$

$$(f_d/f_s)\cdot\mathcal{B}(B^0 \to K^+K^-)/\mathcal{B}(B_s^0 \to K^+K^-) = 0.018^{+0.008}_{-0.007} \pm 0.009$$

$$(f_s/f_d)\cdot\mathcal{B}(B_s^0 \to \pi^+\pi^-)/\mathcal{B}(B^0 \to \pi^+\pi^-) = 0.050^{+0.011}_{-0.009} \pm 0.004$$

$$\mathcal{B}(\Lambda_b^0 \to p\pi^-)/\mathcal{B}(\Lambda_b^0 \to pK^-) = 0.86 \pm 0.08 \pm 0.05$$ (world's most precise)

With $\mathcal{B}(B^0 \to K^+\pi^-) = (19.4 \pm 0.6)\times 10^{-6}$ (HFAG) and $f_s/f_d = 0.267^{+0.021}_{-0.020}$ PRD 85 (2012), 032008

$$\mathcal{B}(B^0 \to \pi^+\pi^-) = (5.08 \pm 0.17 \pm 0.37)\times 10^{-6}$$

$$\mathcal{B}(B_s^0 \to K^+K^-) = (23.0 \pm 0.7 \pm 2.3)\times 10^{-6}$$ (world's most precise)

$$\mathcal{B}(B_s^0 \to \pi^+K^-) = (5.4 \pm 0.4 \pm 0.6)\times 10^{-6}$$ (world's most precise)

$$\mathcal{B}(B^0 \to K^+K^-) = (0.11^{+0.05}_{-0.04} \pm 0.06)\times 10^{-6}$$ (world's most precise)

$$\mathcal{B}(B_s^0 \to \pi^+\pi^-) = (0.95^{+0.21}_{-0.17} \pm 0.13)\times 10^{-6}$$ (5.3σ, first observation)

- Time-dependent $B^0_s \to KK$

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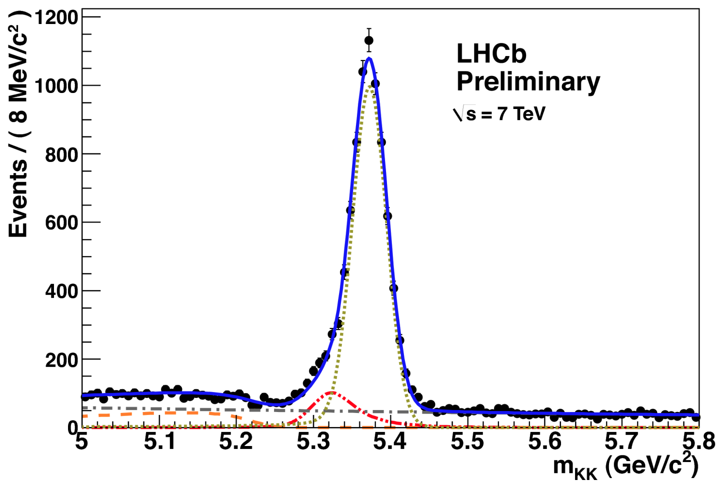
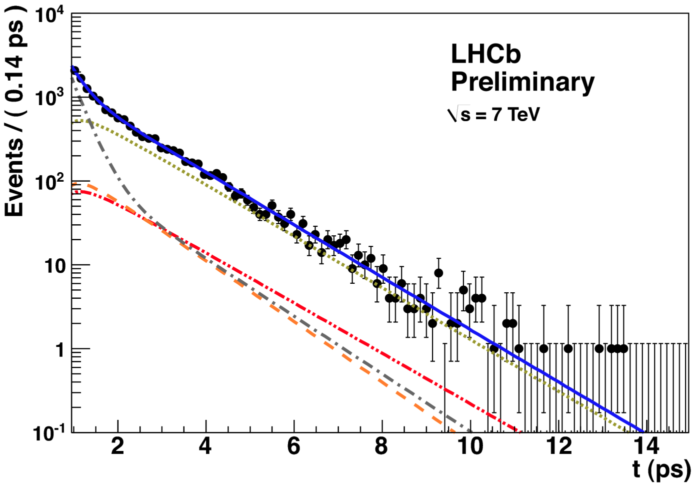
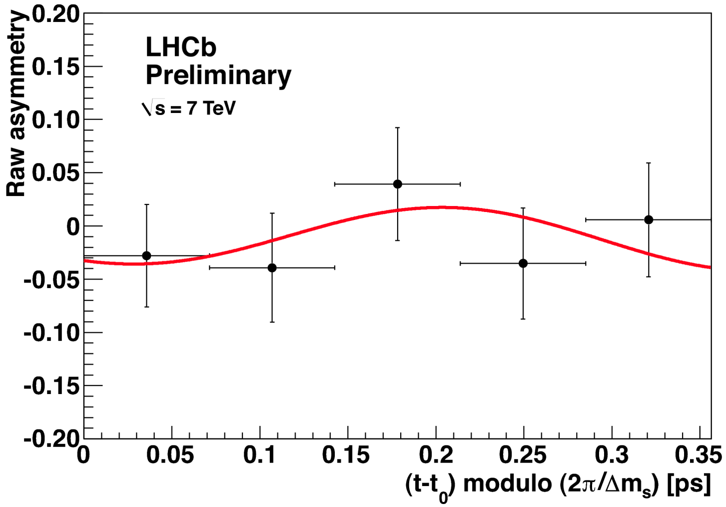




Preliminary results

Δm_s from $B_s \to D_s \pi$ PLB 709(2012)177)
$\Delta\Gamma_s$ from $B_s \to J/\psi\ \phi$ PRL 108(2012)101803

$A_{kk}^{dir} = 0.02 \pm 0.18(stat) \pm 0.04(syst)$
$A_{kk}^{mix} = 0.17 \pm 0.18(stat) \pm 0.05(syst)$
$\rho(A_{kk}^{dir}, A_{kk}^{mix}) = -0.10$ (stat only)



First $B^0_s \to KK$ CP asymmetry measurement

Charmless 3-body decays (charged B^+/B^-)

- $K\pi\pi$ and KKK

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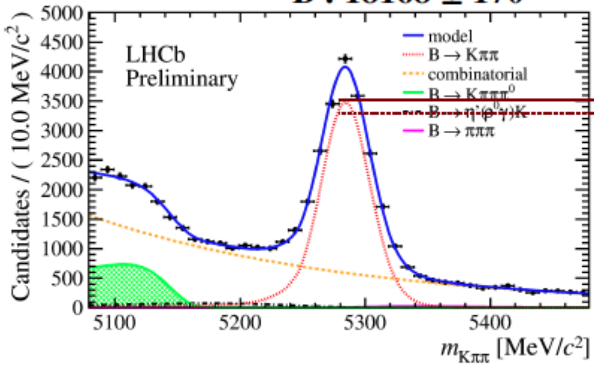
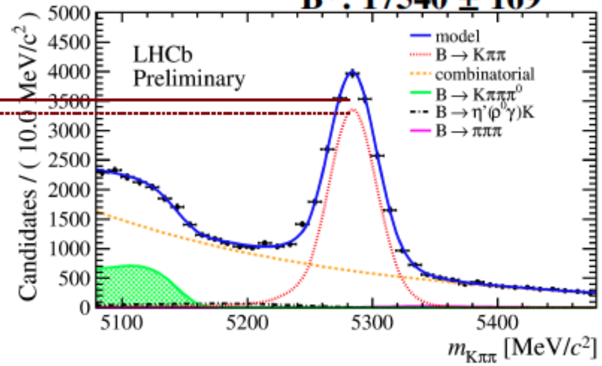
B^-: 18168 ± 170

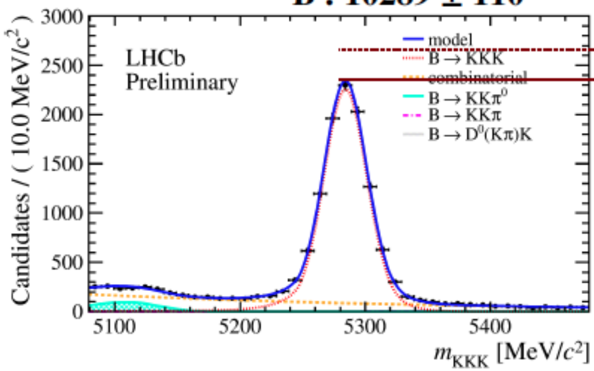


B^+: 17540 ± 169

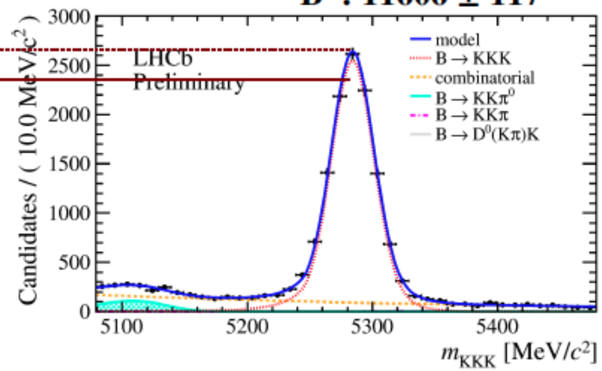


$A_{cp}^{raw}(K\pi\pi) = +0.018 \pm 0.007$

B^-: 10289 ± 110



B^+: 11606 ± 117



$A_{cp}^{raw}(KKK) = -0.060 \pm 0.007$

$A_{cp}(B^\pm \to K\pi\pi) = +0.034 \pm 0.009(stat) \pm 0.004(syst) \pm 0.007(J/\psi K)$ — **2.8σ**

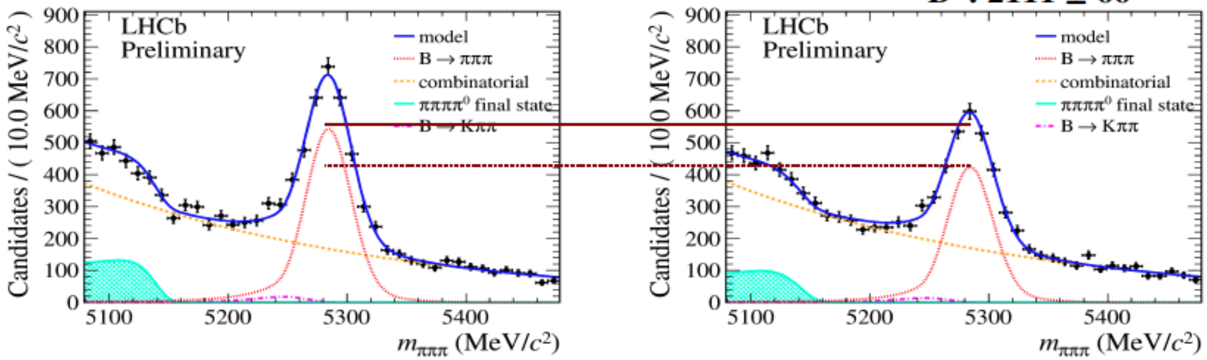
$A_{cp}(B^\pm \to KKK) = -0.046 \pm 0.009(stat) \pm 0.005(syst) \pm 0.007(J/\psi K)$ — **3.7σ**

Charmless 3-body decays (charged B^+/B^-)

- $\pi\pi\pi$ and πKK

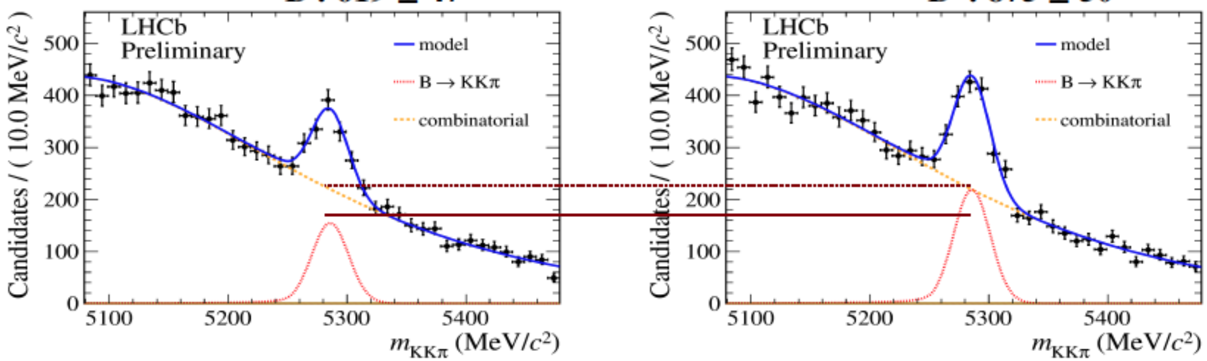
LHCb-CONF-2012-028

B^-: 2718 ± 71 **B^+: 2111 ± 66**



$A^{raw}_{cp}(\pi\pi\pi) = +0.125 \pm 0.020$

B^-: 619 ± 47 **B^+: 875 ± 50**



$A^{raw}_{cp}(\pi KK) = -0.171 \pm 0.046$

$A_{cp}(B^\pm \to \pi\pi\pi) = +0.120 \pm 0.020(\text{stat}) \pm 0.019(\text{syst}) \pm 0.007(J/\psi K)$ — **4.2σ**

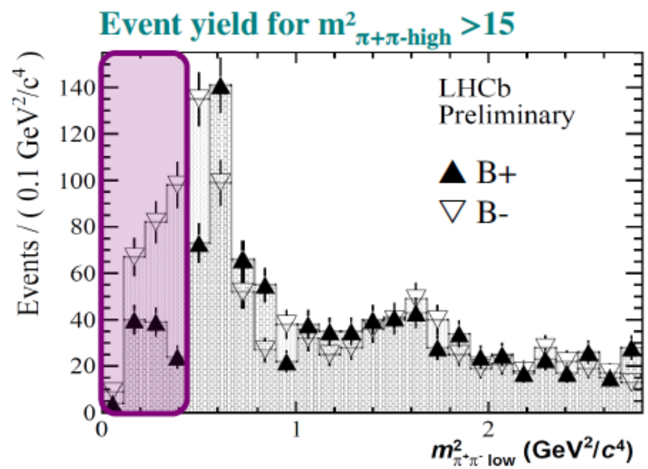
$A_{cp}(B^\pm \to \pi KK) = -0.153 \pm 0.046(\text{stat}) \pm 0.019(\text{syst}) \pm 0.007(J/\psi K)$ — **3.0σ**

Charmless 3-body decays (charged B^+/B^-)

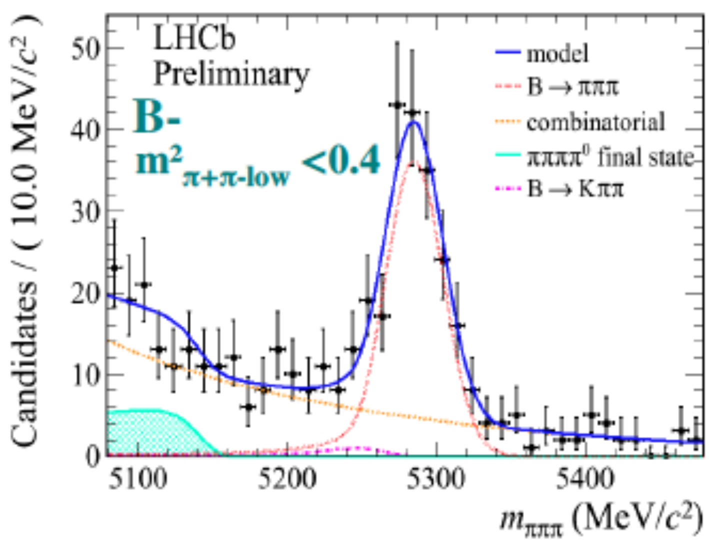
- $B \to \pi\pi\pi$ large CPV region

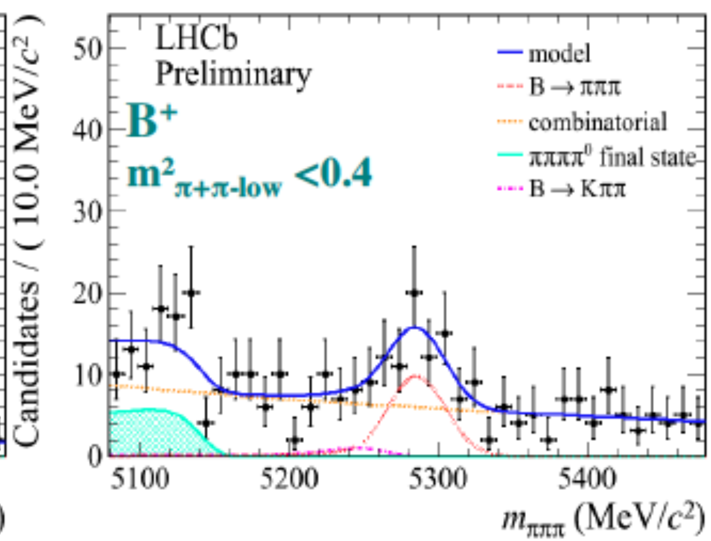
LHCb-CONF-2012-028

Very large CPV in a region not associated to a resonance



$$A_{cp}(B^\pm \to \pi\pi\pi \text{ region}) = +0.622 \pm 0.075(\text{stat}) \pm 0.032(\text{syst}) \pm 0.007(J/\psi K^\pm)$$





Charmless 3-body decays (with protons)

- 3-body charmless with ppbK

LHCb-PAPER-2012-047

  - Relative branching fractions and upper limits

$$\frac{\mathcal{B}(B^+ \to p\bar{p}K^+)_{\rm total}}{\mathcal{B}(B^+ \to J/\psi K^+ \to p\bar{p}K^+)} = 4.91 \pm 0.19\,({\rm stat}) \pm 0.14\,({\rm syst}),$$

$$\frac{\mathcal{B}(B^+ \to p\bar{p}K^+)_{M_{p\bar{p}}<2.85\,{\rm GeV}/c^2}}{\mathcal{B}(B^+ \to J/\psi K^+ \to p\bar{p}K^+)} = 2.02 \pm 0.10\,({\rm stat}) \pm 0.08\,({\rm syst}),$$

$$\frac{\mathcal{B}(B^+ \to \eta_c(1S)K^+ \to p\bar{p}K^+)}{\mathcal{B}(B^+ \to J/\psi K^+ \to p\bar{p}K^+)} = 0.578 \pm 0.035\,({\rm stat}) \pm 0.025\,({\rm syst}),$$

$$\frac{\mathcal{B}(B^+ \to \psi(2S)K^+ \to p\bar{p}K^+)}{\mathcal{B}(B^+ \to J/\psi K^+ \to p\bar{p}K^+)} = 0.080 \pm 0.012\,({\rm stat}) \pm 0.009\,({\rm syst}),$$

$$\frac{\mathcal{B}(\eta_c(2S) \to p\bar{p})}{\mathcal{B}(\eta_c(2S) \to K\bar{K}\pi)} < 3.1 \times 10^{-2}$$

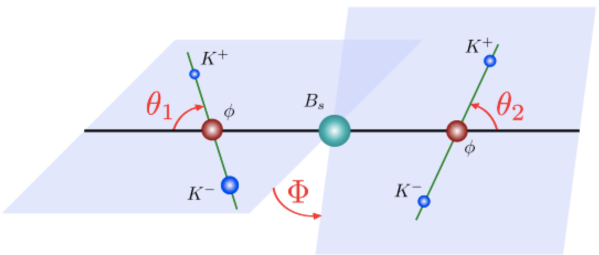
$$\frac{\mathcal{B}(X(3872) \to p\bar{p})}{\mathcal{B}(X(3872) \to J/\psi\pi^+\pi^-)} < 2.0 \times 10^{-3}$$

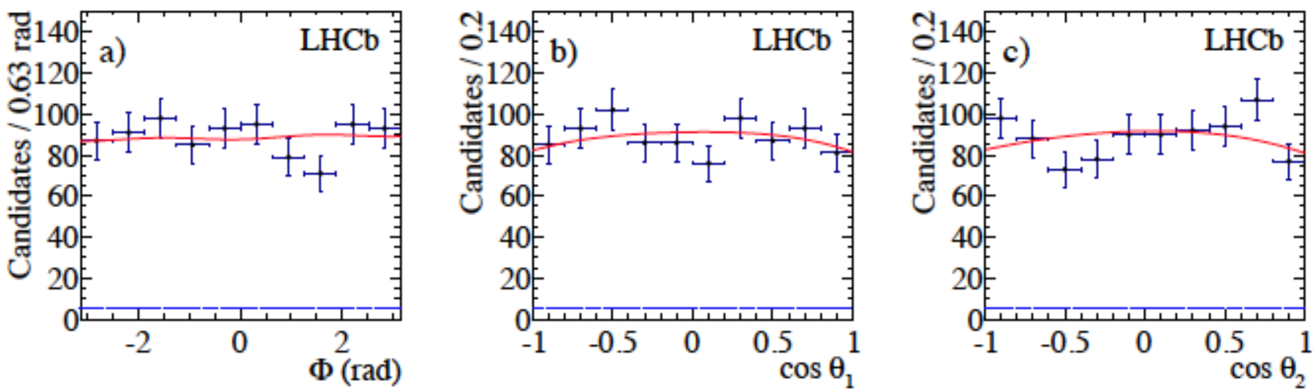
VV decays ($B_s^0 \to \phi\phi$)

- Previous angular analysis (untagged)

1.0 fb^{-1} LHCb-PAPER-2012-004 arXiv:1204.2813

$$
\begin{aligned}
|A_0|^2 &= 0.365 \pm 0.022\,(\text{stat}) \pm 0.012\,(\text{syst})\,, \\
|A_\perp|^2 &= 0.291 \pm 0.024\,(\text{stat}) \pm 0.010\,(\text{syst})\,, \\
\cos(\delta_\parallel) &= -0.844 \pm 0.068\,(\text{stat}) \pm 0.029\,(\text{syst})\,, \\
A_U &= -0.055 \pm 0.036\,(\text{stat}) \pm 0.018\,(\text{syst})\,, \\
A_V &= 0.010 \pm 0.036\,(\text{stat}) \pm 0.018\,(\text{syst})\,.
\end{aligned}
$$



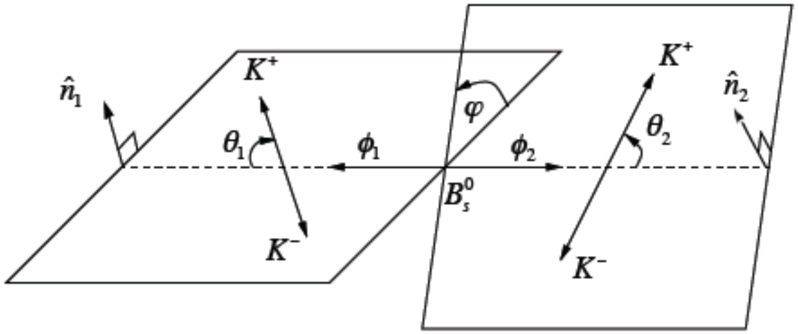


Untagged time-integrated analysis
Systematics dominated by the s-wave contamination and angular acceptance
Polarization in good agreement with CDF

VV decays ($B_s^0 \to \phi\phi$)

- Triple products

1.0 fb^{-1} LHCb-PAPER-2012-004 arXiv:1204.2813



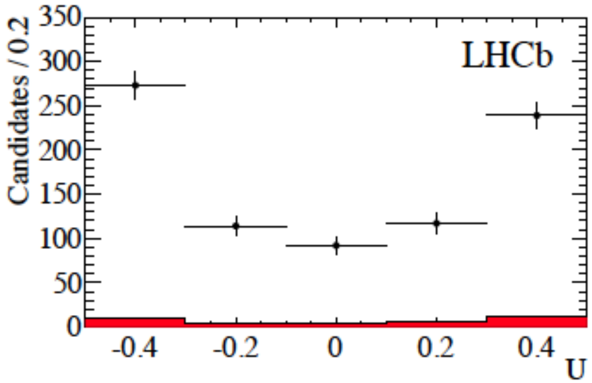
$$V = sign(\cos\theta_1\cos\theta_2)\sin\varphi = sign(\cos\theta_1\cos\theta_2)(\hat{n}_1\times\hat{n}_2)\cdot\hat{p}_1$$

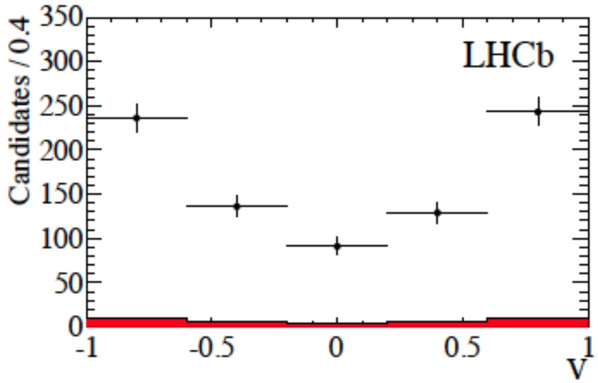
$$U = \frac{\sin 2\varphi}{2} = 2(\hat{n}_1\cdot\hat{n}_2)(\hat{n}_1\times\hat{n}_2)\cdot\hat{p}_1$$

$$A_V = \frac{N_V^+ - N_V^-}{N_V^+ + N_V^-} = -\frac{2\sqrt{2}}{\pi}\frac{\mathrm{Im}(A_\perp A_0^*)}{|A_0|^2+|A_\parallel|^2+|A_\perp|^2}$$

$$A_U = \frac{N_U^+ - N_U^-}{N_U^+ + N_U^-} = -\frac{4}{\pi}\frac{\mathrm{Im}(A_\perp A_\parallel^*)}{|A_0|^2+|A_\parallel|^2+|A_\perp|^2}$$

- Calculated as asymmetries in $U=\sin(2\phi)$ and $V=sign(\cos\theta_1\cos\theta_2)\sin\varphi$





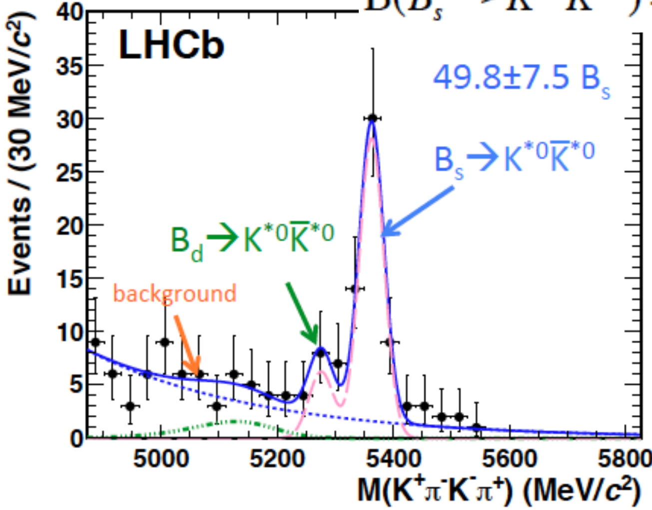
$$A_U = -0.055 \pm 0.036$$
$$A_V = 0.010 \pm 0.036$$

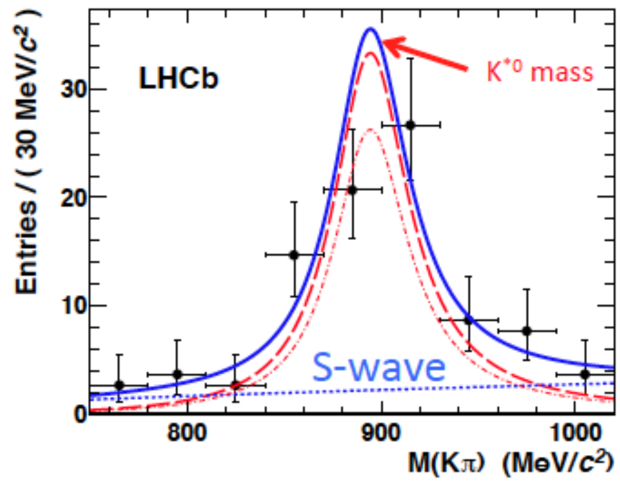
Systematics dominated by the time acceptance
Results in agreement with CDF measurements with no CPV

VV decays ($B_s^0 \to K^*K^*$)

- $B_s^0 \to K^*K^*$ ($K\pi K\pi$)
  - First observation with $35 pb^{-1}$

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





Non negligible S-wave component
Hints for the B_d peak

$$f_L = 0.30 \pm 0.12(stat) \pm 0.04(syst)$$
$$f_\perp = 0.38 \pm 0.11(stat) \pm 0.04(syst)$$

Untagged time-integrated angular fit to helicity angles
(remarkable difference wrt BaBar)

2011 + 2012 analysis to come

LHCb Collaboration, R. Aaij et al., Phys. Lett. B 709 (arXiv:1111.4183)