LHCb γ results: time-dependent and combination

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on behalf of LHCb

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outline

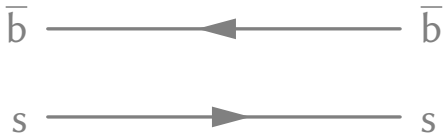
- review of time-dependent results in $B_s \longrightarrow D_s K$
- LHCb γ combination (2011 data set): shown for the first time
  - from $B^{\pm} \longrightarrow DK^{\pm}$
  - from $B^{\pm} \longrightarrow D\pi^{\pm}$
  - both
- late breaking news: $B^{\pm} \rightarrow DK^{\pm}$ γ combination including 2012 data
- summary

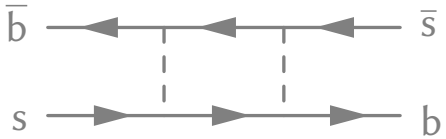
time-dependent γ

time-dependent γ

$B_s \longrightarrow D_s K$ basics

- interference between mixing and decay:

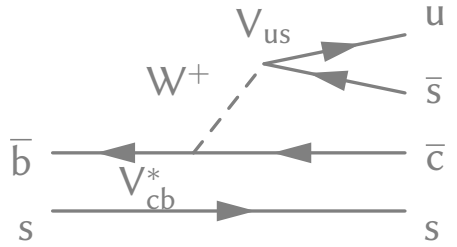


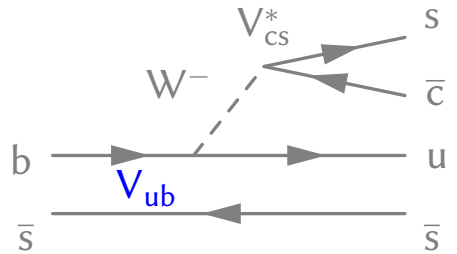


$$B_S^0 \xrightarrow{1} B_S^0 \xrightarrow{A_B} D_S^- K^+$$

$$B_S^0 \longrightarrow \overline{B_S^0} \xrightarrow{A_B r_{B_s} e^{i(\delta-\gamma)}} D_S^- K^+$$

$e^{-i\phi_m}$





- not colour-suppessed $\Rightarrow$ large interference
- weak phases γ, ϕ_m (mixing), strong phase δ
- sensitive to $\gamma + \phi_m$, but ϕ_m small effect

  e.g. in $B_s \longrightarrow J/\psi\phi$ [LHCb-CONF-2012-002]

- measure 4 decay rates:
  $\Gamma_{B_s^0 \longrightarrow D_s^- K^+}(t)$, $\Gamma_{B_s^0 \longrightarrow D_s^+ K^-}(t)$, $\Gamma_{\overline{B_s^0} \longrightarrow D_s^- K^+}(t)$, $\Gamma_{\overline{B_s^0} \longrightarrow D_s^+ K^-}(t)$

$B_s \longrightarrow D_s K$ decay rate equations

- work out decay of B_s^0, $\bar{B}_s^0$ to final states $f(D_s^- K^+)$, $\bar{f}\,(D_s^+ K^-)$[1]:

$$\lambda_{D_s^- K^+} = \frac{V_{tb}^* V_{ts}}{V_{tb} V_{ts}^*} \frac{V_{ub} V_{cs}^*}{V_{cb}^* V_{us}} \left| \frac{A_{\bar{f}}}{A_f} \right| e^{i\delta} = |\lambda_{D_s^- K^+}| e^{i(\delta - (\gamma + \phi_m))}$$

$$\lambda_{D_s^+ K^-} = \frac{V_{tb} V_{ts}^*}{V_{tb}^* V_{ts}} \frac{V_{ub}^* V_{cs}}{V_{cb} V_{us}^*} \left| \frac{A_{\bar{f}}}{A_f} \right| e^{i\delta} = |\lambda_{D_s^- K^+}| e^{i(\delta + (\gamma + \phi_m))}$$

$$D_f = \frac{2\Re\lambda_{D_s^- K^+}}{1 + |\lambda_{D_s^- K^+}|^2} \qquad D_{\bar{f}} = \frac{2\Re\lambda_{D_s^+ K^-}}{1 + |\lambda_{D_s^+ K^-}|^2} \qquad C_f = \frac{1 - |\lambda_{D_s^- K^+}|^2}{1 + |\lambda_{D_s^- K^+}|^2}$$

$$C_{\bar{f}} = \frac{1 - |\lambda_{D_s^+ K^-}|^2}{1 + |\lambda_{D_s^+ K^-}|^2} \qquad S_f = \frac{2\Im\lambda_{D_s^- K^+}}{1 + |\lambda_{D_s^- K^+}|^2} \qquad S_{\bar{f}} = \frac{2\Im\lambda_{D_s^+ K^-}}{1 + |\lambda_{D_s^+ K^-}|^2}$$

$$\begin{aligned}
\frac{d\Gamma_{B_s^0 \to f}(t)}{dt\, e^{-\Gamma t}} &\sim |A_f|^2 (1 + |\lambda_f|^2) \left(\cosh\left(\tfrac{\Delta\Gamma t}{2}\right) - D_f \sinh\left(\tfrac{\Delta\Gamma t}{2}\right) + C_f \cos(\Delta m t) - S_f \sin(\Delta m t) \right) \\
\frac{d\Gamma_{\bar{B}_s^0 \to f}(t)}{dt\, e^{-\Gamma t}} &\sim |A_f|^2 \left| \frac{p}{q} \right|^2 (1 + |\lambda_f|^2) \left(\cosh\left(\tfrac{\Delta\Gamma t}{2}\right) - D_f \sinh\left(\tfrac{\Delta\Gamma t}{2}\right) - C_f \cos(\Delta m t) + S_f \sin(\Delta m t) \right) \\
\frac{d\Gamma_{\bar{B}_s^0 \to \bar{f}}(t)}{dt\, e^{-\Gamma t}} &\sim |\bar{A}_{\bar{f}}|^2 (1 + |\bar{\lambda}_{\bar{f}}|^2) \left(\cosh\left(\tfrac{\Delta\Gamma t}{2}\right) - D_{\bar{f}} \sinh\left(\tfrac{\Delta\Gamma t}{2}\right) + C_{\bar{f}} \cos(\Delta m t) - S_{\bar{f}} \sin(\Delta m t) \right) \\
\frac{d\Gamma_{B_s^0 \to \bar{f}}(t)}{dt\, e^{-\Gamma t}} &\sim |\bar{A}_{\bar{f}}|^2 \left| \frac{q}{p} \right|^2 (1 + |\bar{\lambda}_{\bar{f}}|^2) \left(\cosh\left(\tfrac{\Delta\Gamma t}{2}\right) - D_{\bar{f}} \sinh\left(\tfrac{\Delta\Gamma t}{2}\right) - C_{\bar{f}} \cos(\Delta m t) + S_{\bar{f}} \sin(\Delta m t) \right)
\end{aligned}$$

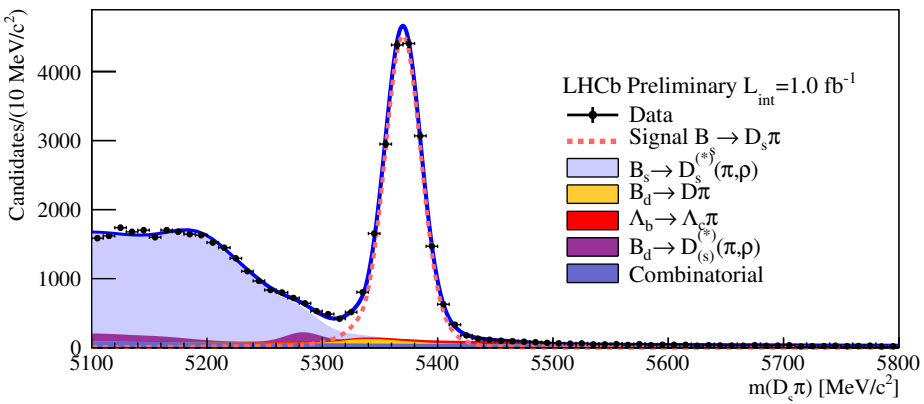
[1] use convention where $\Delta m_s = m_H - m_L > 0$ and $\Delta\Gamma = \Gamma_L - \Gamma_H > 0$

mass fit

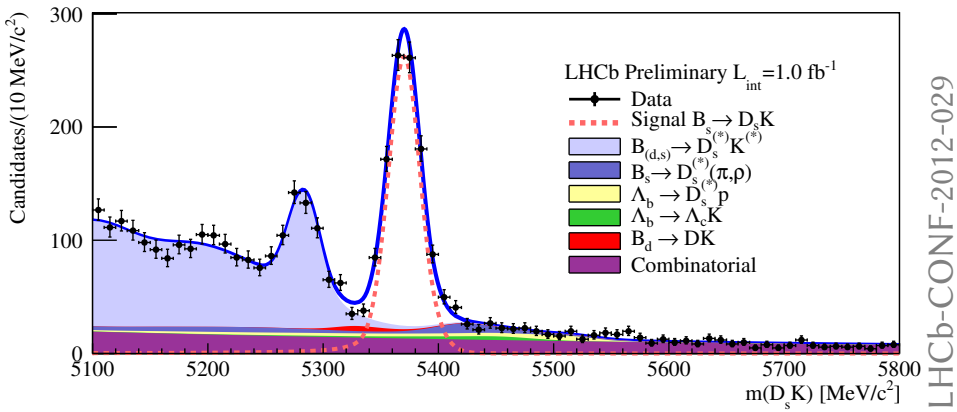
- select D_sK and $D_s\pi$ (control channel) with same selection (BDT)
- optimise S/B for D_sK (data-driven)
- split sample according to LHCb magnet polarity, D_s final state ($KK\pi$, $K\pi\pi$, $\pi\pi\pi$)

$\rightarrow$ simultaneous fit in six categories

- about 28k $D_s\pi$ and 1.4k D_sK events in the LHCb 2011 sample with excellent S/B



$D_s\pi$



D_sK

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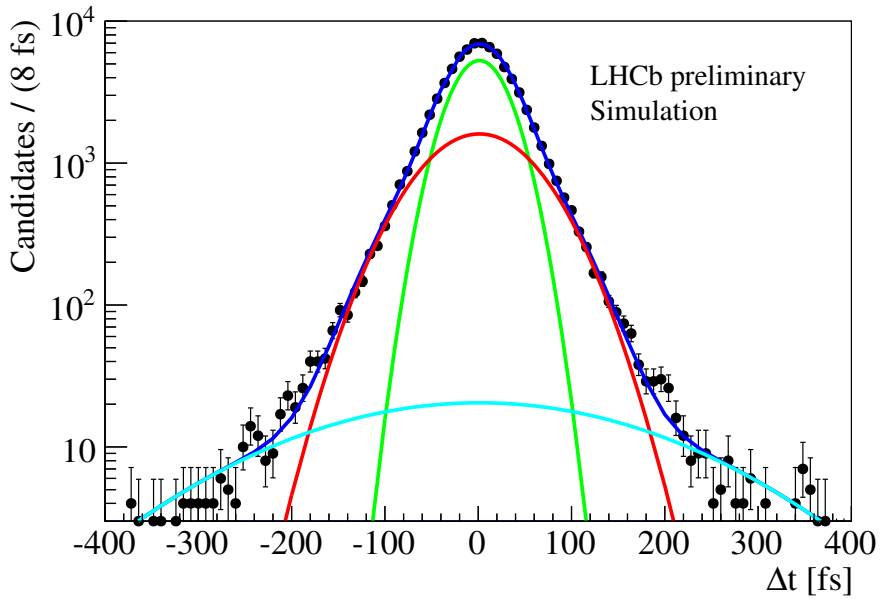
time fit: acceptance, resolution

- time acceptance:
  - get a(t) for D_sK and $D_s\pi$ in MC
  - fit a(t) for $D_s\pi$ in data (assume τ_{B_s} known)
  - then apply $D_sK/D_s\pi$ ratio from MC to get D_sK acceptance in data

- decay time resolution:
- decay time of B_s is only known to finite precision

$\longrightarrow$ need to know decay time resolution very well to measure C_f, S_f, $S_{\bar{f}}$ coefficients!

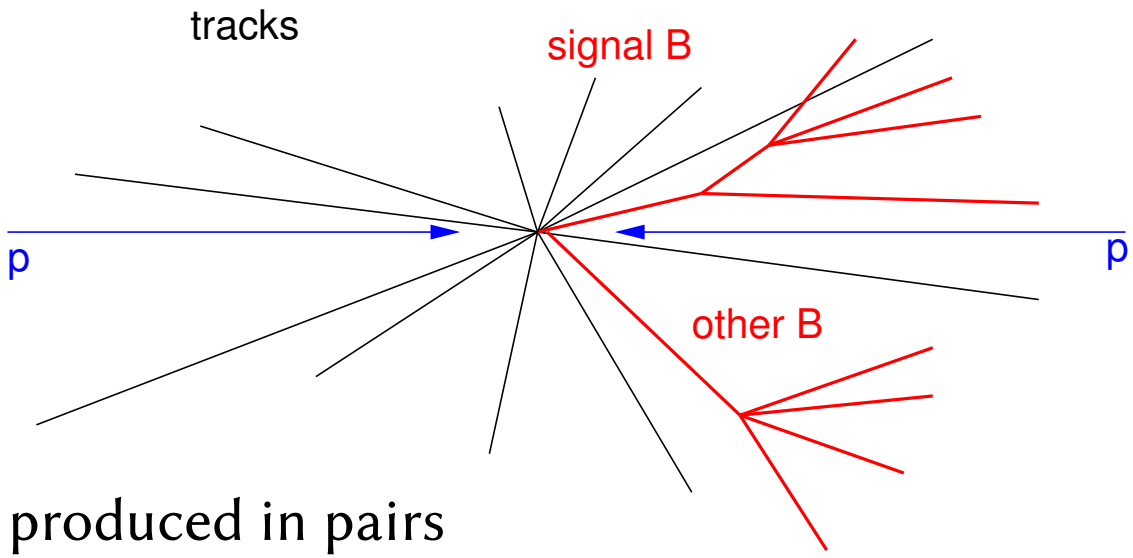
- take resolution model from MC



- know by how much data and MC differ: scale width of MC up by 1.15, so about ~ 50 fs in data

time fit: flavour tagging

- need to know flavour at production: B_s or $\overline{B_s}$?

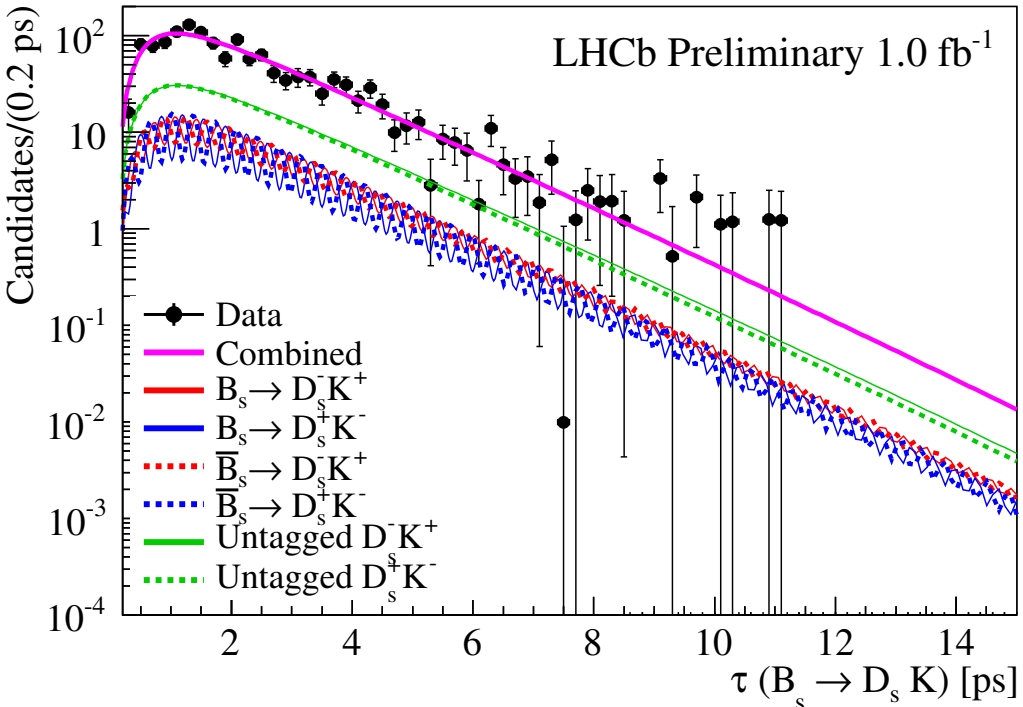


- b quarks are produced in pairs
- can learn something from other B in the event: opposite side tagging
  - can "guess" initial flavour $\epsilon_{\text{tag}} = 40\%$ of D_sK events
  - guess wrong in $\langle\eta\rangle = 39.2\%$ of cases on average
  - use event-by-event mistag prediction to increase sensitivity
    - tagging calibration from $B^+ \longrightarrow J/\psi K^+$, check using $B_s \longrightarrow D_s\pi$

$\rightarrow$ data sample as "powerful" as perfectly tagged sample of $\epsilon_{\text{eff.}} = \epsilon_{\text{tag}}(1-2\eta)^2 = 1.9\%$ the size

time fit: results

- here's our preliminary result (2011 data, $1\,\mathrm{fb}^{-1}$)



$$C_f = 1.01 \pm 0.50 \pm 0.23$$
$$S_f = -1.25 \pm 0.56 \pm 0.24$$
$$S_{\bar{f}} = 0.08 \pm 0.68 \pm 0.28$$
$$D_f = -1.33 \pm 0.60 \pm 0.26$$
$$D_{\bar{f}} = -0.81 \pm 0.56 \pm 0.26$$

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- 1st measurement of time-dependent CP parameters in $B_s \to D_s K$
- while that is reason enough to celebrate, there's work ahead
  - by construction: $C_f, D_f, S_f, D_{\bar{f}}, S_{\bar{f}} \in [-1, 1]$
  - uncertainties still too large to test this
  - do not extract γ just yet: correlations between systematics not known yet...

systematics, outlook

- main sources of systematic uncertainty

	C_f	S_f	$S_{\bar{f}}$	D_f	$D_{\bar{f}}$
Toy corrected central value	1.01	-1.25	0.08	-1.33	-0.81
Statistical uncertainty	0.50	0.56	0.68	0.60	0.56
Systematic uncertainties (σ_{stat})					
Decay-time bias	0.03	0.05	0.05	0.00	0.00
Decay-time resolution	0.11	0.08	0.09	0.00	0.00
Tagging calibration	0.23	0.17	0.16	0.00	0.00
Backgrounds	0.15	0.07	0.07	0.07	0.07
Fixed parameters	0.15	0.22	0.20	0.40	0.42
Asymmetries	0.12	0.01	0.04	0.00	0.02
Momentum/length scale	0.00	0.00	0.00	0.00	0.00
k-factors	0.27	0.27	0.27	0.08	0.08
Bias correction	0.03	0.03	0.03	0.03	0.03
Total systematic (σ_{stat})	0.46	0.50	0.35	0.43	0.46

- outlook: improve for the paper:
  - better tagging: include same side kaon tagging
  - better treatment of acceptance (drives systematics on D_f, $\overline{D_{\bar{f}}}$)
  - k-factors: backgrounds need special treatment of decay time due to misid/partial reconstruction (technically difficult)
  - per-event decay time error

γ combination

γ combination

γ combination: approach

- use various (fit) parameters α_i:

$B^\pm \to Dh^\pm$	CP-violating weak phase $\Gamma(B^- \to D^0 K^-)/\Gamma(B^- \to D^0 \pi^-)$	γ R_{cab}
$B^\pm \to D\pi^\pm$	$A(B^- \to \overline{D^0}\pi^-)/A(B^- \to D^0\pi^-) = r_B^\pi e^{i(\delta_B^\pi - \gamma)}$	r_B^π, δ_B^π
$B^\pm \to DK^\pm$	$A(B^- \to \overline{D^0}K^-)/A(B^- \to D^0 K^-) = r_B e^{i(\delta_B - \gamma)}$	r_B, δ_B
$D \to K^\pm\pi^\mp$	$A(D^0 \to \pi^- K^+)/A(D^0 \to K^-\pi^+) = r_{K\pi} e^{-i\delta_{K\pi}}$	$r_{K\pi}$, $-\delta_{K\pi}$
$D \to K^\pm\pi^\mp\pi^+\pi^-$	amplitude ratio and effective strong phase diff. coherence factor	$r_{K3\pi}$, $-\delta_{K3\pi}$ $\kappa_{K3\pi}$
direct CP	in $D \to K^+K^-$	$A_{CP}^{D\to KK}$
asymmetries	in $D \to \pi^+\pi^-$	$A_{CP}^{D\to\pi\pi}$
Other D system parameters	D mixing Cabibbo-favoured rates	x_D, y_D $\Gamma(D \to K\pi)$ $\Gamma(D \to K\pi\pi\pi)$

- frequentist approach:
  - express various observables $\vec{A}_i$ in terms of fit parameters
  - use a χ^2-derived likelihood contribution f_i for the various measurements

$$f_i \propto \exp\left(-\chi^2\right) \propto \exp\left(-(\vec{A}_i(\vec{\alpha}_i) - \vec{A}_{i,obs})^T V_i^{-1} (\vec{A}_i(\vec{\alpha}_i) - \vec{A}_{i,obs})\right)$$

  - then combine:

$$\mathcal{L}(\vec{\alpha}) = \prod_i f_i(\vec{A}_i^{obs} | \vec{A}_i(\vec{\alpha}_i))$$

inputs

- LHCb GGSZ model-independent measurement $B^{\pm} \to DK^{\pm}$ with $D \longrightarrow K^0_S h^+ h^-$ $(1\,fb^{-1})$ [arXiv:1209.5869]
  - strong phase of D decay over Dalitz plane taken from CLEO [arXiv:0903.1681]
  - inputs: $x_{\pm}$, $y_{\pm}$
- GLW/ADS modes $B^{\pm} \to Dh^{\pm}$ with $D \longrightarrow h^+ h^-$ $(1\,fb^{-1})$

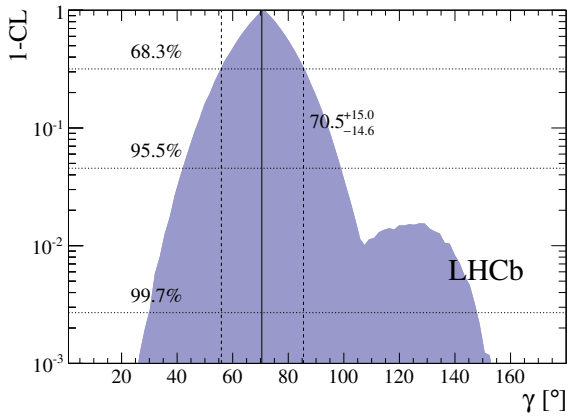
  [Phys. Lett. B712 (2012) 203] [arXiv:1203.3662]
  - inputs: $R^{K\pi}_{K/\pi}$, $R^{KK}_{K/\pi}$, $R^{\pi\pi}_{K/\pi}$, $A^{K\pi}_{\pi}$, $A^{K\pi}_{K}$, A^{KK}_{K}, $A^{\pi\pi}_{K}$, A^{KK}_{π}, $A^{\pi\pi}_{\pi}$, R^{-}_{K}, R^{+}_{K}, R^{-}_{π}, R^{+}_{π}
- ADS modes $B^{\pm} \to Dh^{\pm}$ with $D \longrightarrow K^{\pm}\pi^{\mp}\pi^{+}\pi^{-}$ $(1\,fb^{-1})$

  [LHCb-CONF-2012-030]
  - strong phase variation over D phase space absorbed in coherence factor $\kappa_{K3\pi}$
  - inputs: $R^{K3\pi}_{K/\pi}$, $A^{K3\pi}_{\pi}$, $A^{K3\pi}_{K}$, $R^{K3\pi}_{K-}$, $R^{K3\pi}_{K+}$, $R^{K3\pi}_{\pi-}$, $R^{K3\pi}_{\pi+}$

- for details on (most of) those measurements, see previous talk by Susan Haines

plug-in method

- evaluating confidence level for a parameter (e.g. γ), we use $\chi^2(\vec{\alpha}) = -2 \log \mathcal{L}(\vec{\alpha})$
- call best fit point $\vec{\alpha}_{\text{min}}$, $\chi^2_{\text{min}} = \chi^2(\vec{\alpha}_{\text{min}})$
- call best fit point $\vec{\alpha}'_{\text{min}}(\gamma_0)$ with γ fixed to $\gamma = \gamma_0$
  - get profile LH $\hat{\mathcal{L}}(\gamma_0) = \exp(-\chi^2(\vec{\alpha}'_{\text{min}})/2)$
- for each value of γ_0, get p-value (1-CL) with a MC procedure:
  1. calculate test statistic $\Delta\chi^2 = \chi^2(\vec{\alpha}'_{\text{min}}) - \chi^2(\vec{\alpha}_{\text{min}}) \geq 0$ for data
  2. generate a set of toys $\vec{A}_{\text{toy}}$ with parameters set to $\vec{\alpha}'_{\text{min}}$
  3. for each toy, calculate $\Delta\chi^{2'}$ as in step 1
  4. $1 - \text{CL} = \text{N}(\Delta\chi^2 < \Delta\chi^{2'})/\text{N}_{\text{toy}}$



[LHCb-PAPER-2013-020, in prep.]

systematic uncertainties

- plots and confidence limits above need to be corrected for
  - undercoverage
    - plug-in method does not guarantee coverage
    - evaluate actual coverage using toys: determine conf. intervals in toys, count how often the true value is inside

α	1σ ($\eta = 0.6827$)	2σ ($\eta = 0.9545$)	3σ ($\eta = 0.9973$)
$DK^{\pm}$ only	0.6646 ± 0.0067	0.9453 ± 0.0032	0.9911 ± 0.0013
$D\pi^{\pm}$ only	0.6532 ± 0.0048	0.9492 ± 0.0022	0.9912 ± 0.0009
$DK^{\pm}$ & $D\pi^{\pm}$	0.6616 ± 0.0067	0.9586 ± 0.0028	0.9958 ± 0.0009

    - scale up conf. intervals in data by η/α
  - correlations in systematic uncertainties for 2/4-body GLW/ADS modes
    - plots below assume zero correlations
    - need to correct by running toys with random correlation matrices
    - $B^{\pm} \to DK^{\pm}$ unaffected, $B^{\pm} \to D\pi^{\pm}$ largely affected
    - full combination needs confidence intervals scaled by a factor 1.07 (1.04 for second best intervals)

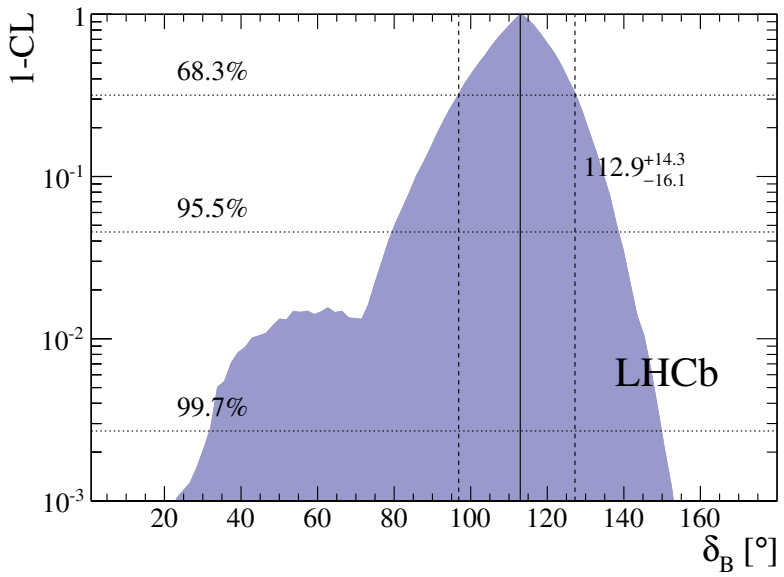
next: slideshow of plots...

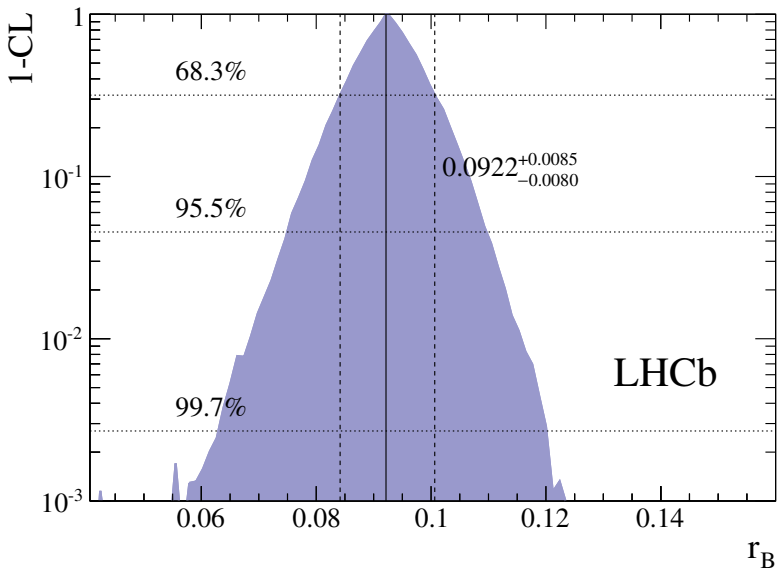
- all angles mod 180°
- use plugin method throughout to determine confidence intervals
- final confidence intervals need to be corrected for undercoverage, correlations (see previous slide)

γ combination: $B^{\pm} \to DK^{\pm}$ combination

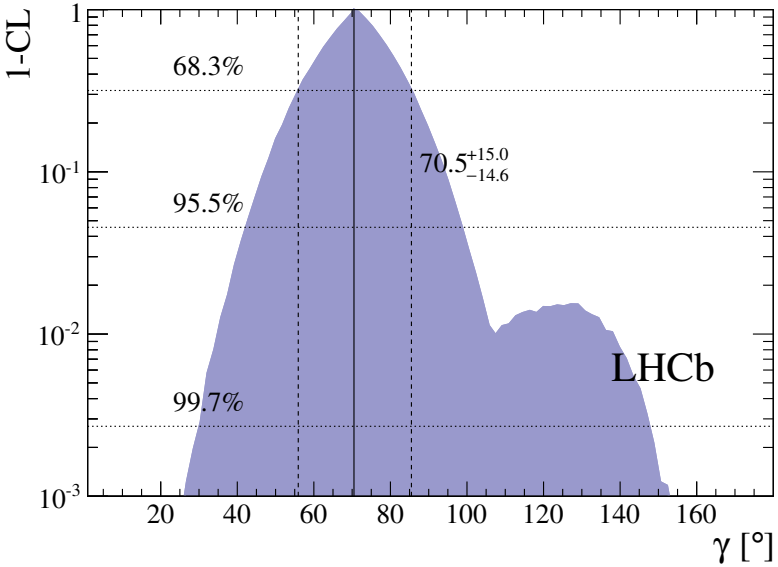
γ combination:
$B^{\pm} \to DK^{\pm}$ combination

$B^{\pm} \to DK^{\pm}$ results: r_B, δ_B, γ





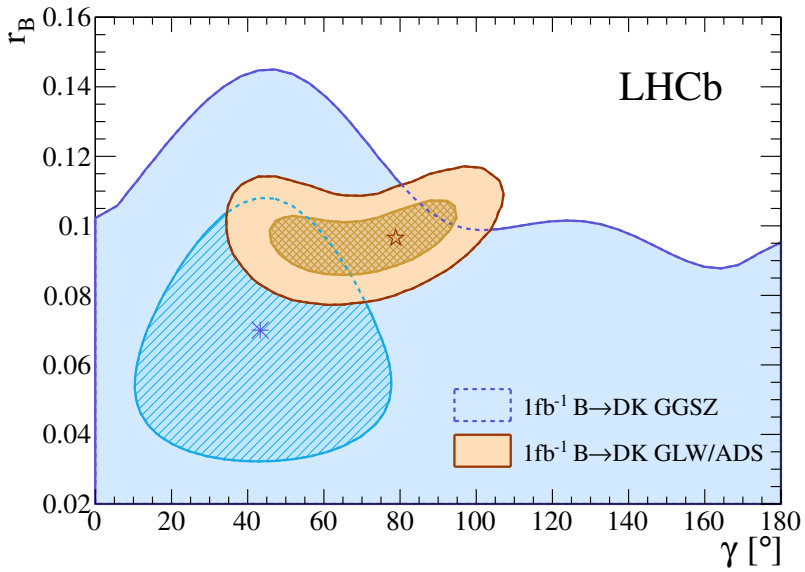
[LHCb-PAPER-2013-020, in prep.]

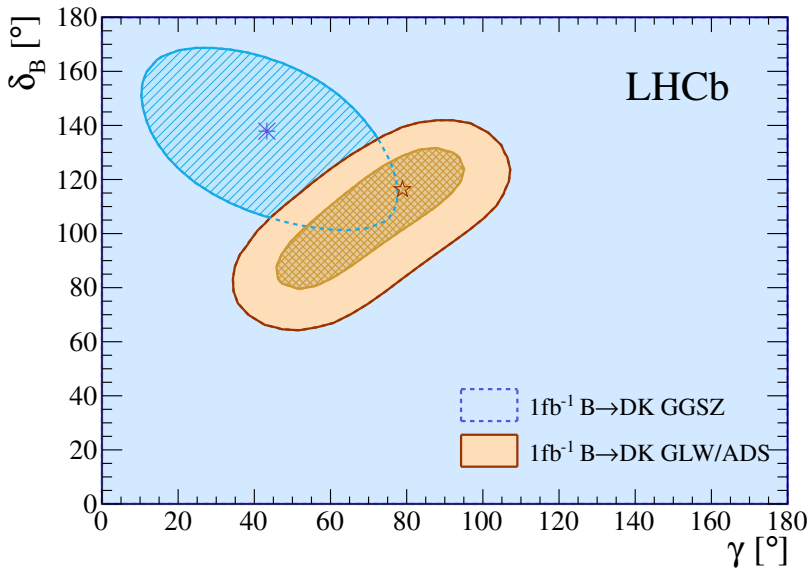


[LHCb-PAPER-2013-020, in prep.]

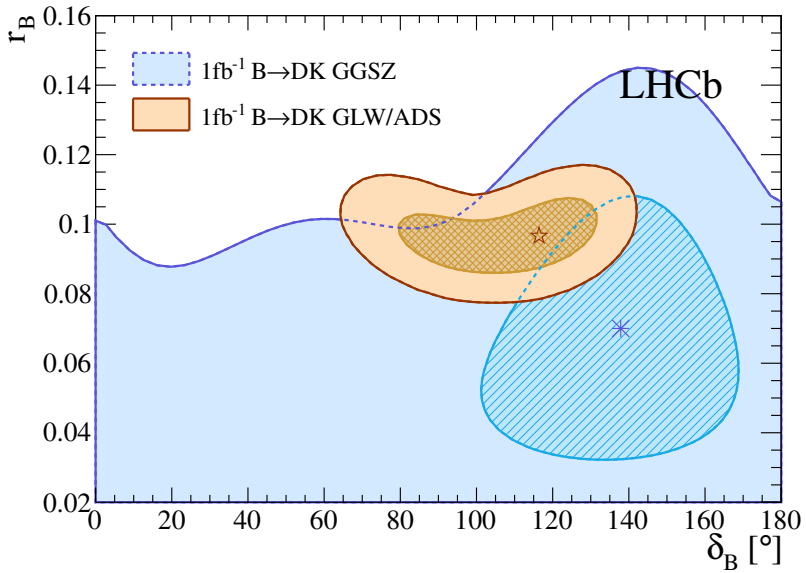
	best fit	68% CL	95% CL
δ_B	113°	[96, 127]°	[80, 138]°
r_B	0.0922	[0.0842, 0.1008]	[0.075, 0.109]
γ	70.5°	[55.7, 85.6]°	[42.9, 98.4]°

$B^{\pm} \to DK^{\pm}$: contours





[LHCb-PAPER-2013-020, in prep.]



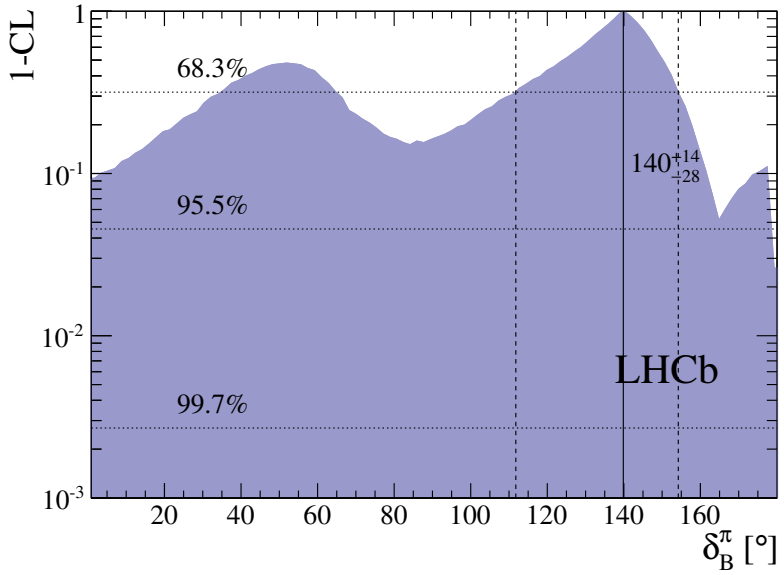
[LHCb-PAPER-2013-020, in prep.]

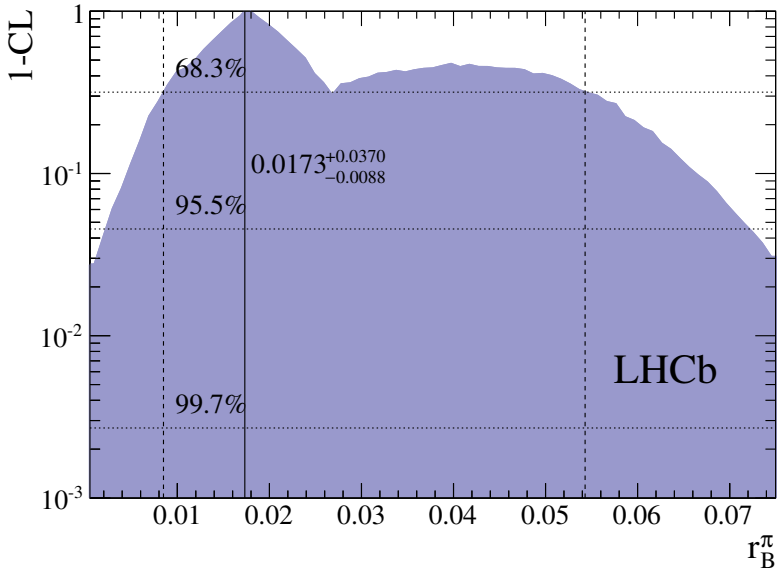
- blue: GGSZ
- orange: ADS/GLW
- stars, crosses: local minima

γ combination: $B^{\pm} \to D\pi^{\pm}$ combination

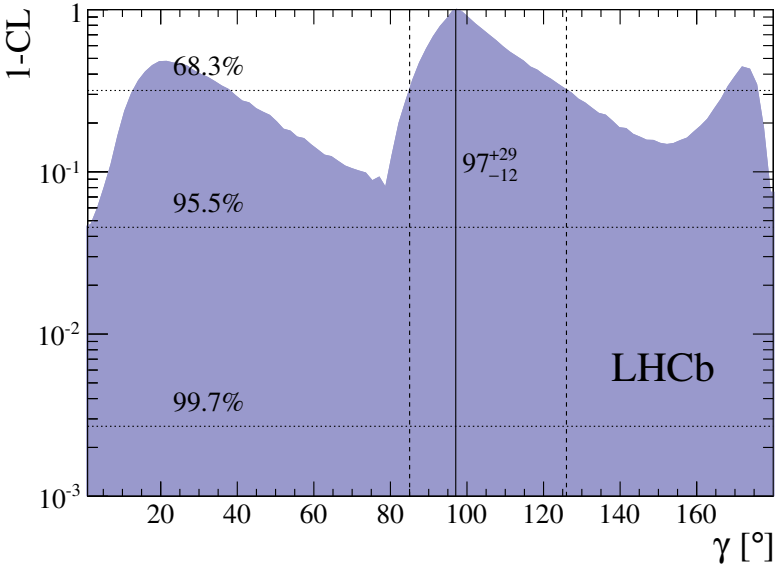
γ combination:
$B^{\pm} \to D\pi^{\pm}$ combination

$B^{\pm} \to D\pi^{\pm}$ results: r_B^{π}, δ_B^{π}, γ





[LHCb-PAPER-2013-020, in prep.]



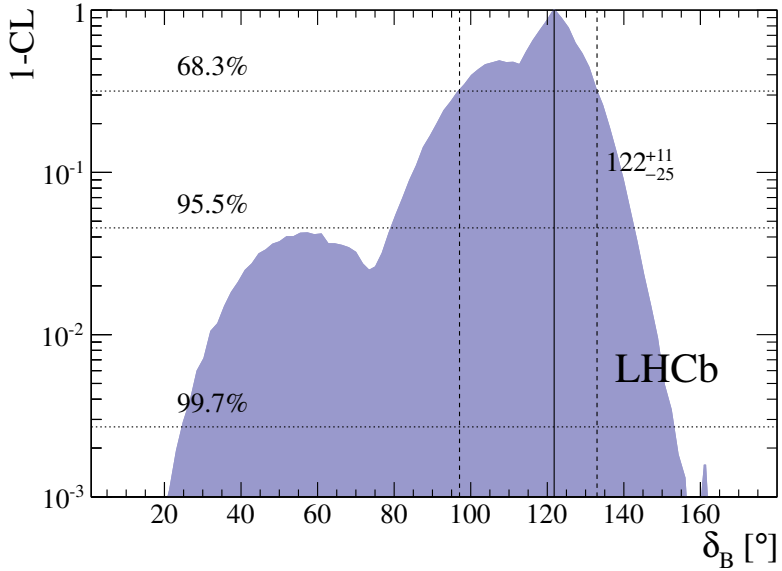
[LHCb-PAPER-2013-020, in prep.]

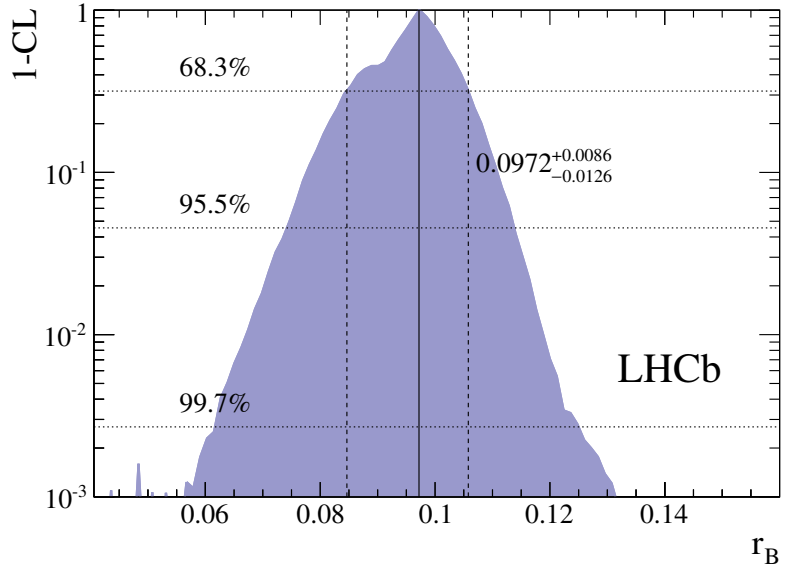
	best fit	68% CL	95% CL
δ_B^{π}	140°	[35, 65]°, [111, 154]°	[1, 165]°
r_B^{π}	0.0173	[0.0086, 0.0.054]	[0.001, 0.0.071]
γ	97°	[13.0, 36.6]° [85, 125]° [167.4, 175.9]°	[0.9, 180.0]°

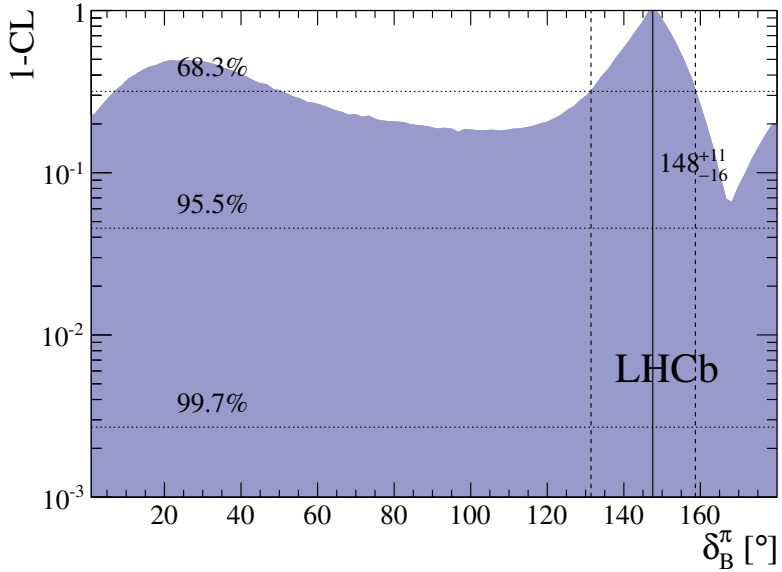
γ combination: $B^{\pm} \to DK^{\pm}$ & $B^{\pm} \to D\pi^{\pm}$ combination

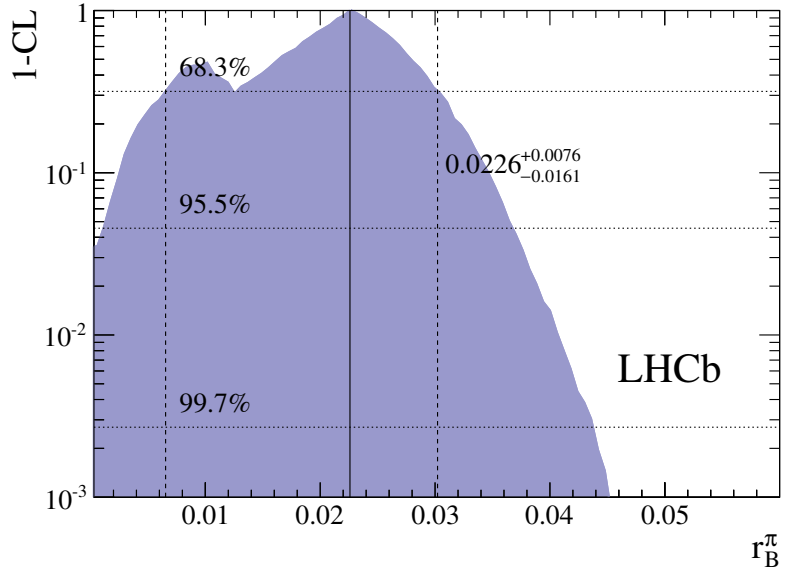
γ combination: $B^{\pm} \to DK^{\pm}$ and $B^{\pm} \to D\pi^{\pm}$ combination

$B^{\pm} \to DK^{\pm}$ & $B^{\pm} \to D\pi^{\pm}$ results: δ_B, r_B, r_B^{π}, δ_B^{π}





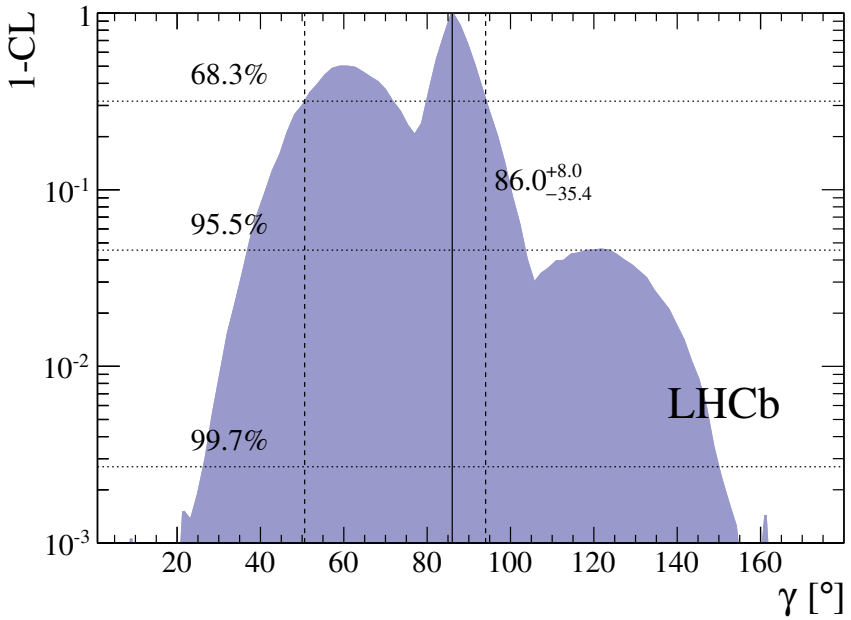




[LHCb-PAPER-2013-020, in prep.]

[LHCb-PAPER-2013-020, in prep.]

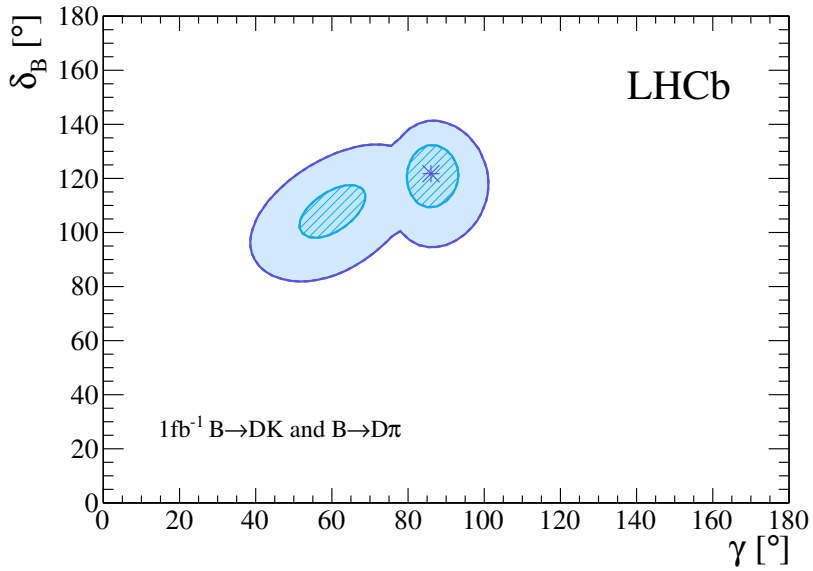
$B^{\pm} \to DK^{\pm}$ & $B^{\pm} \to D\pi^{\pm}$ results: γ

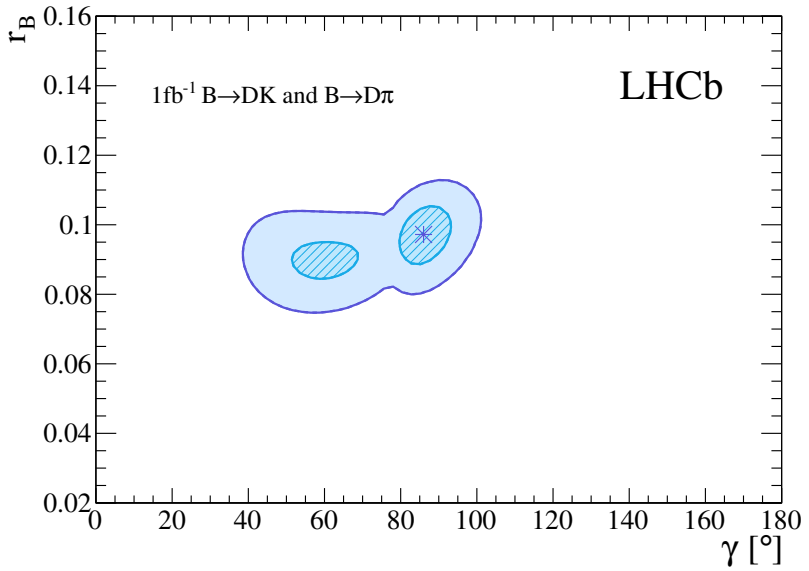


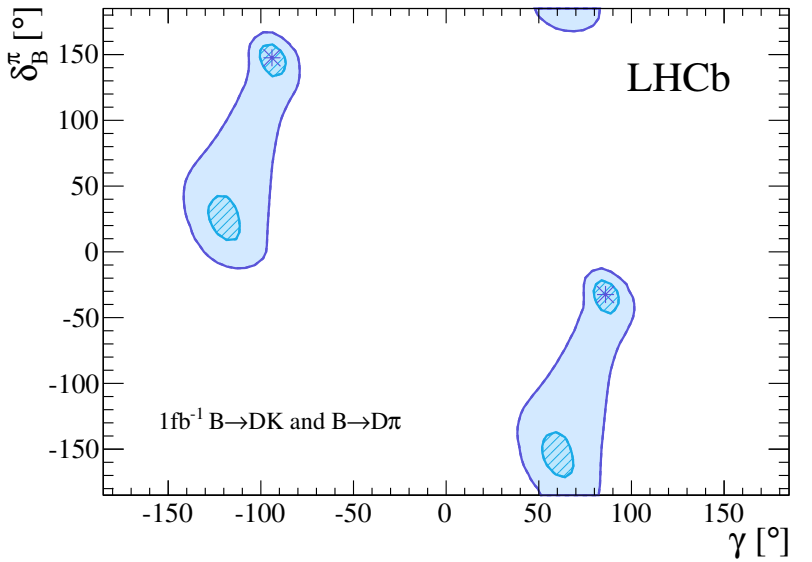
[LHCb-PAPER-2013-020, in prep.]

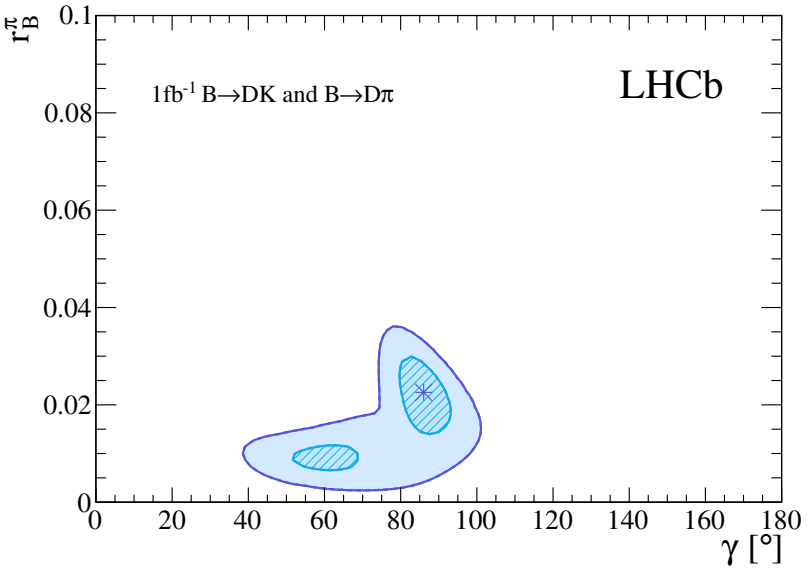
γ	86.0°	
68% CL	$[50.6, 72.1]^{\circ}$	$[80.0, 94.0]^{\circ}$
95% CL	$[38, 103]^{\circ}$	
δ_B	122°	
68% CL	$[97, 133]^{\circ}$	
95% CL	$[80, 143]^{\circ}$	
r_B	0.0972	
68% CL	[0.0847, 0.1059]	
95% CL	[0.075, 0.113]	
δ_B^{π}	148°	
68% CL	$[8, 48]^{\circ}$	$[131, 159]^{\circ}$
95% CL	$[1, 180]^{\circ}$	
r_B^{π}	0.0226	
68% CL	[0.0066, 0.0123]	[0.0125, 0.0302]
95% CL	[0.0003, 0.0365]	

$B^{\pm} \to DK^{\pm}$ + $B^{\pm} \to D\pi^{\pm}$: contours









[LHCb-PAPER-2013-020, in prep.]

[LHCb-PAPER-2013-020, in prep.]

final results including corrections (1 fb^{-1} result)

- $B^{\pm} \to DK^{\pm}$ only

$$\gamma \in [55.3, 86.0]^{\circ} \quad @\,68\%\ \mathrm{CL}\,,$$
$$\gamma \in [42.6, 98.7]^{\circ} \quad @\,95\%\ \mathrm{CL}\,,$$

- $B^{\pm} \to D\pi^{\pm}$ only

$$\gamma \in [80.1, 136.5]^{\circ} \quad \text{or} \quad [10.0, 43.3]^{\circ} \quad \text{or} \quad [165.2, 177.2]^{\circ} \quad @\,68\%\ \mathrm{CL}$$

- full combination

$$\gamma \in [49.6, 73.4]^{\circ} \quad \text{or} \quad [79.6, 94.6]^{\circ} \quad @\,68\%\ \mathrm{CL}\,,$$
$$\gamma \in [36.5, 106.0]^{\circ} \quad @\,95\%\ \mathrm{CL}\,.$$

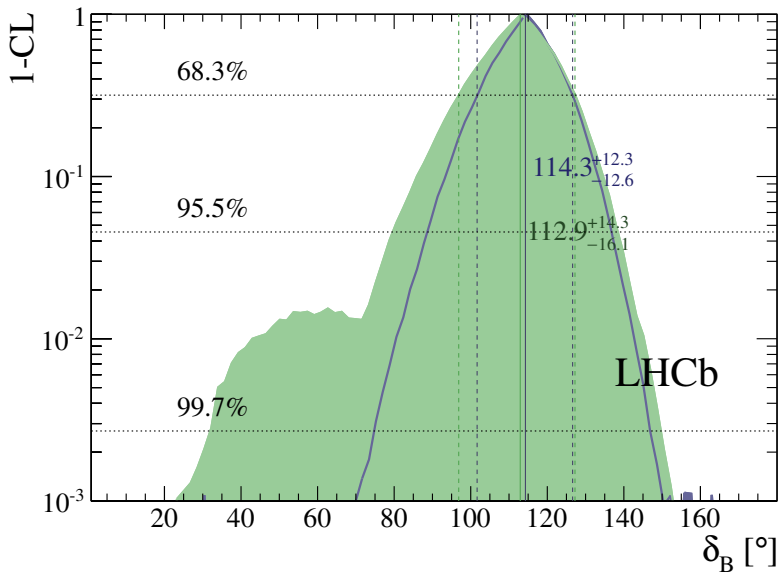
γ combination: $B^{\pm} \to DK^{\pm}$ incl. 2012 data

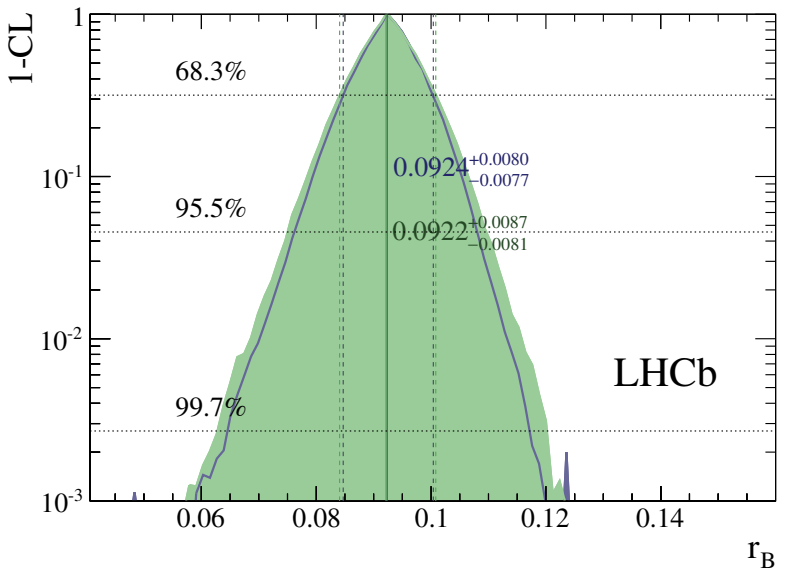
γ combination: $B^{\pm} \to DK^{\pm}$ combination including 2012 data

inputs

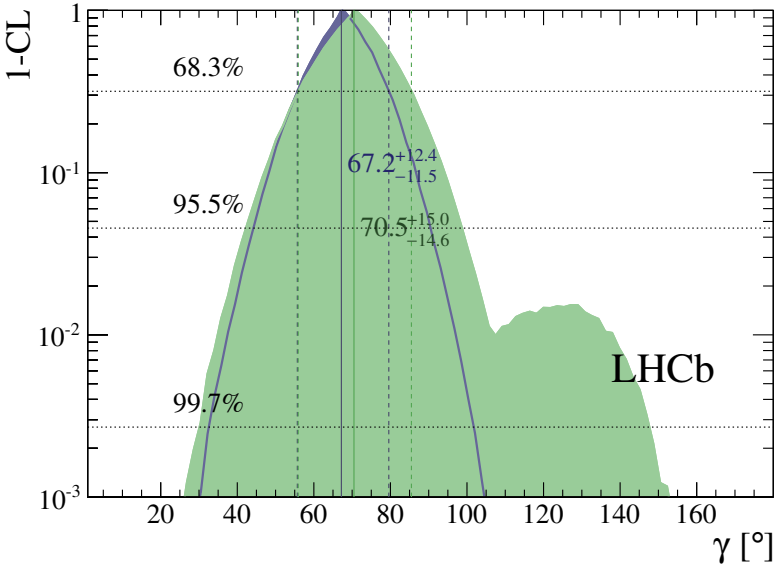
- LHCb GGSZ model-independent measurement $B^{\pm} \to DK^{\pm}$ with $D \longrightarrow K^0_S h^+ h^-$ ($1\,fb^{-1}$, 2011) [arXiv:1209.5869]
  - strong phase of D decay over Dalitz plane taken from CLEO [arXiv:0903.1681]
  - inputs: $x_{\pm}$, $y_{\pm}$
- LHCb GGSZ model-independent measurement $B^{\pm} \to DK^{\pm}$ with $D \longrightarrow K^0_S h^+ h^-$ ($2\,fb^{-1}$, 2012) [LHCb-CONF-2013-004]
- GLW/ADS modes $B^{\pm} \to DK^{\pm}$ with $D \longrightarrow h^+ h^-$ ($1\,fb^{-1}$, 2011) [Phys. Lett. B712 (2012) 203] [arXiv:1203.3662]
  - inputs: $A_K^{K\pi}$, A_K^{KK}, $A_K^{\pi\pi}$, R_K^-, R_K^+
- ADS modes $B^{\pm} \to DK^{\pm}$ with $D \longrightarrow K^{\pm}\pi^{\mp}\pi^+\pi^-$ ($1\,fb^{-1}$, 2011) [LHCb-CONF-2012-030]
  - strong phase variation over D phase space absorbed in coherence factor $\kappa_{K3\pi}$
  - inputs: $A_K^{K3\pi}$, $R_{K-}^{K3\pi}$, $R_{K+}^{K3\pi}$

$B^{\pm} \to DK^{\pm}$ results: r_B, δ_B, γ





[LHCb-CONF-2013-006, in prep., prelim.]

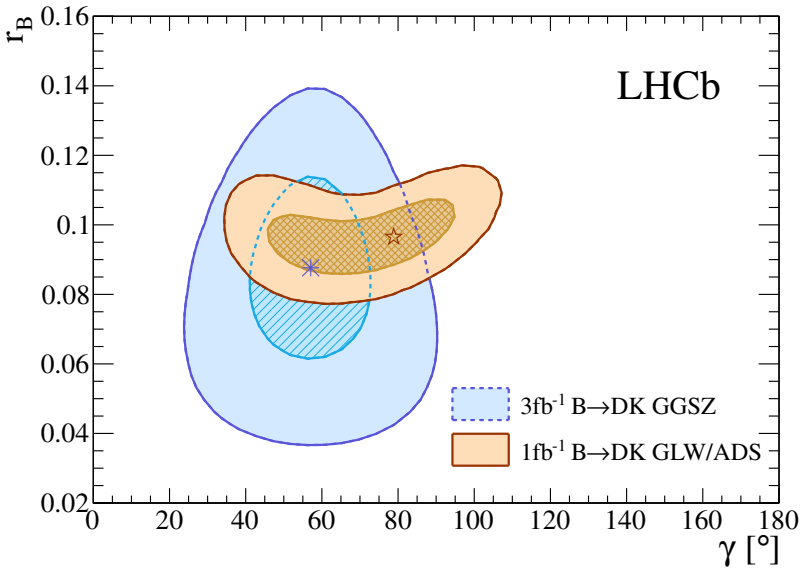


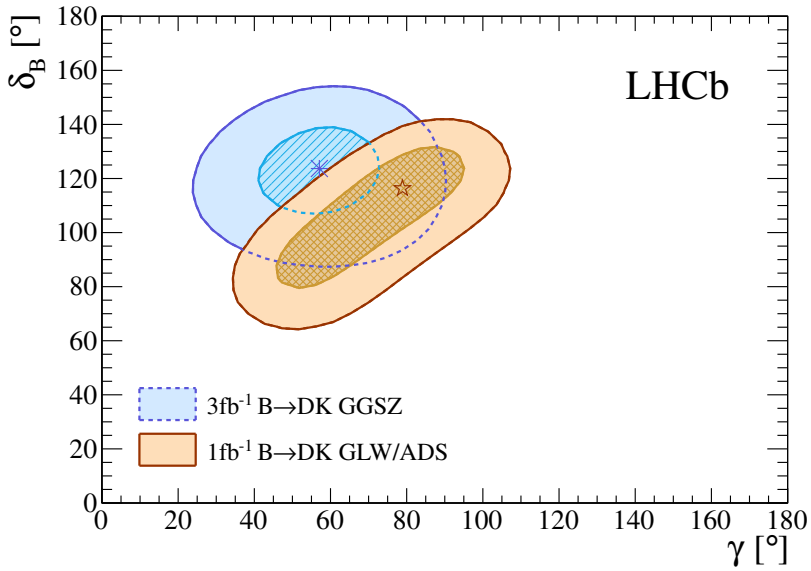
[LHCb-CONF-2013-006, in prep., prelim.]

	best fit	68% CL	95% CL
δ_B	114.3°	[101.7, 126.6]°	[89.1, 136.5]°
r_B	0.0924	[0.0847, 0.1004]	[0.0766, 0.1077]
γ	67.2°	[55.7, 79.6]°	[44.6, 90.0]°

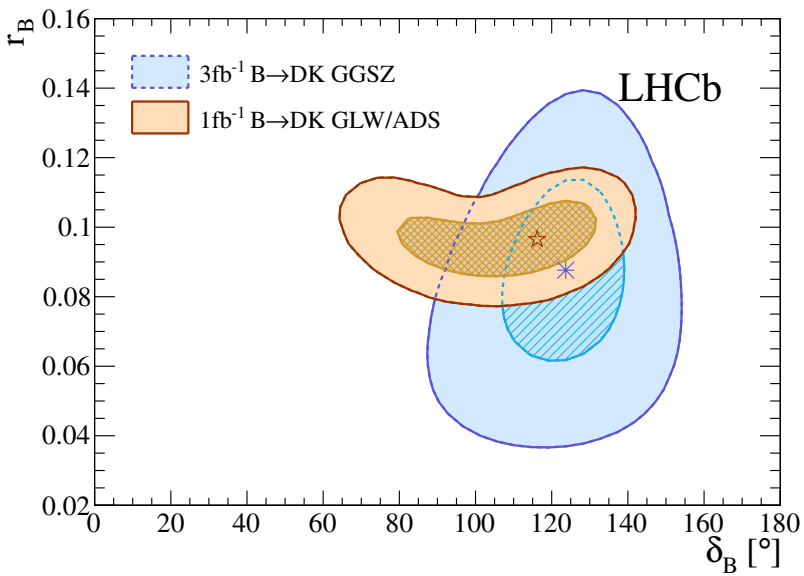
- 2011 $B^{\pm} \to DK^{\pm}$ combination
- 2011+2012 $B^{\pm} \to DK^{\pm}$ combination

$B^{\pm} \to DK^{\pm}$: contours





[LHCb-CONF-2013-006, in prep., prelim.]



[LHCb-CONF-2013-006, in prep., prelim.]

summary and outlook

summary and outlook

summary and outlook

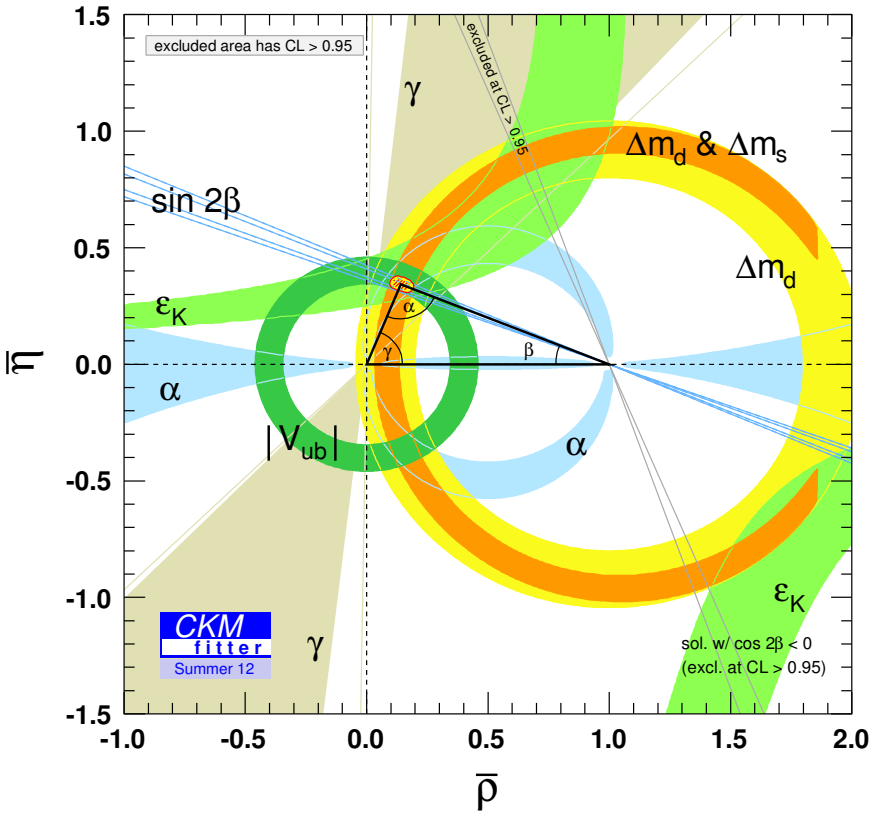
- LHCb-only γ combination paper to be released soon!
- current best LHCb γ combination: [LHCb-CONF-2013-006, in prep., prelim.]
  $B^{\pm} \to DK^{\pm}$ in 2011 ADS/GLW/GGSZ + 2012 GGSZ
  - $\gamma = (67.2 \pm 12.0)^{\circ}$
  - $\gamma \in [55.7, 79.6]^{\circ}$ @ 68% CL
  - $\gamma \in [44.6, 90.0]^{\circ}$ @ 95% CL
- LHCb fulfils its promise of excellent sentitivity to γ
  - compare to (see e.g. yesterday's talk by Concetta Cartaro):
    - BaBar: $(69^{+17}_{-16})^{\circ}$ [arXiv:1301.1029]
    - Belle: $(68^{+15}_{-14})^{\circ}$ [arXiv:1301.2033]

- time-dependent measurements also interesting for γ measurements
  - stay tuned for the paper of the $B_s \longrightarrow D_s K$ analysis and new results

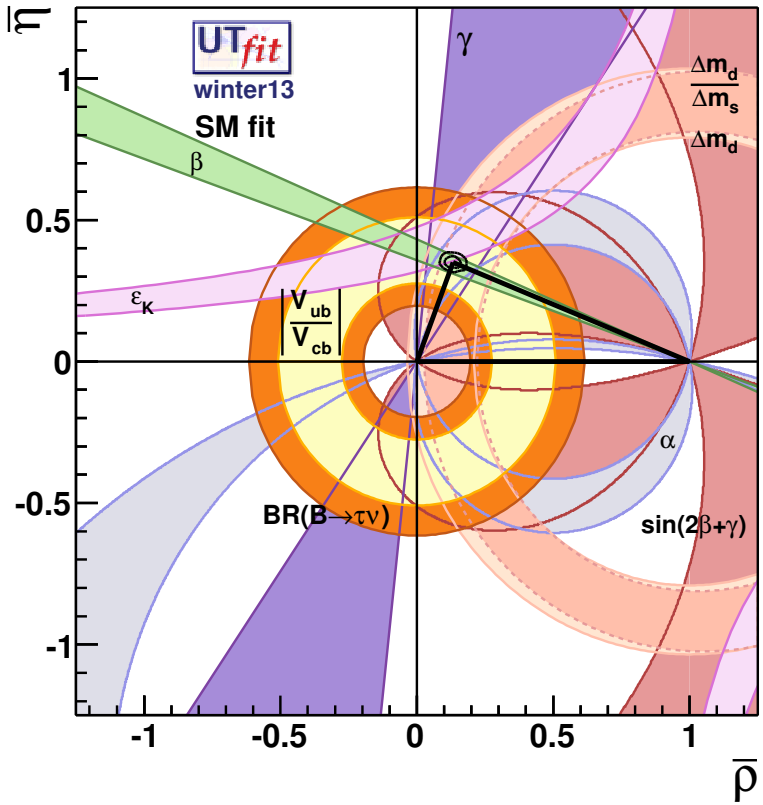
backup slides

backup slides

global CKM fits



[CKMFitter, ICHEP '12]



[UTfit, Moriond '13]

- CKMFitter: $\gamma = (67.7^{+4.1}_{-4.3})^\circ$, $\gamma = (66 \pm 12)^\circ$ tree-level fit
- UTFit: $\gamma = (69.2 \pm 3.2)^\circ$, $\gamma = (71.1 \pm 7.5)^\circ$ tree-level fit

ADS/GLW $B^{\pm} \to Dh^{\pm}$, $D \longrightarrow hh$: stat. correlations

	A_K^{KK}	A_π^{KK}	$A_K^{\pi\pi}$	$A_\pi^{\pi\pi}$	$A_K^{K\pi}$	$A_\pi^{K\pi}$	$R_{K/\pi}^{\pi\pi}$	$R_{K/\pi}^{KK}$	$R_{K/\pi}^{K\pi}$	R_K^-	R_π^-	R_K^+	R_π^+
A_K^{KK}	1	-0.029	0	0	0	0	-0.002	-0.034	-0.010	-0.001	0	0	0
A_π^{KK}		1	0	0	0	0	0	-0.003	0	0	0	0	0
$A_K^{\pi\pi}$			1	-0.032	0	0	-0.032	-0.002	-0.004	-0.001	0	0	0
$A_\pi^{\pi\pi}$				1	0	0	-0.004	0	0	0	0	0	0
$A_K^{K\pi}$					1	-0.045	0	0	0.003	0.004	0	-0.004	-0.001
$A_\pi^{K\pi}$						1	0	0	-0.001	0.004	0.002	-0.004	-0.002
$R_{K/\pi}^{\pi\pi}$							1	0.013	0.029	0.003	0.003	0.001	0.003
$R_{K/\pi}^{KK}$								1	0.053	0.005	0.005	0.002	0.004
$R_{K/\pi}^{K\pi}$									1	-0.038	0.016	-0.093	0.014
R_K^-										1	-0.023	0.012	0.006
R_π^-											1	0.005	0.008
R_K^+												1	-0.036
R_π^+													1

ADS/GLW $B^{\pm} \to Dh^{\pm}$, $D \longrightarrow K3\pi$: stat. correlations

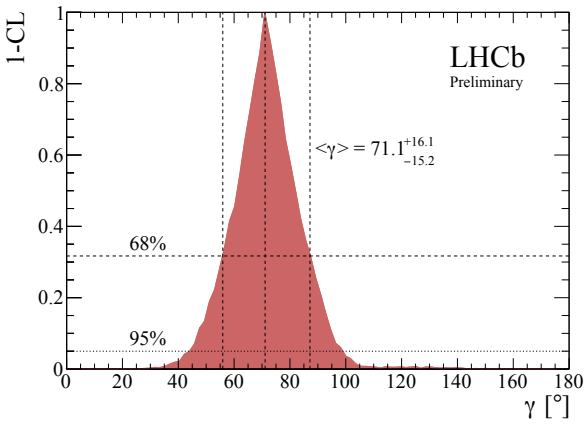
	$R_{K/\pi}^{K3\pi}$	$A_{K}^{K3\pi}$	$A_{\pi}^{K3\pi}$	$R_{K-}^{K3\pi}$	$R_{K+}^{K3\pi}$	$R_{\pi-}^{K3\pi}$	$R_{\pi+}^{K3\pi}$
$R_{K/\pi}^{K3\pi}$	1	0.003	0.001	-0.060	-0.024	0.017	0.021
$A_{K}^{K3\pi}$		1	-0.035	-0.007	0.006	-0.002	0.002
$A_{\pi}^{K3\pi}$			1	-0.006	0.008	-0.002	0.005
$R_{K-}^{K3\pi}$				1	0.043	0.006	0.029
$R_{K+}^{K3\pi}$					1	0.022	0.025
$R_{\pi-}^{K3\pi}$						1	0.032
$R_{\pi+}^{K3\pi}$							1

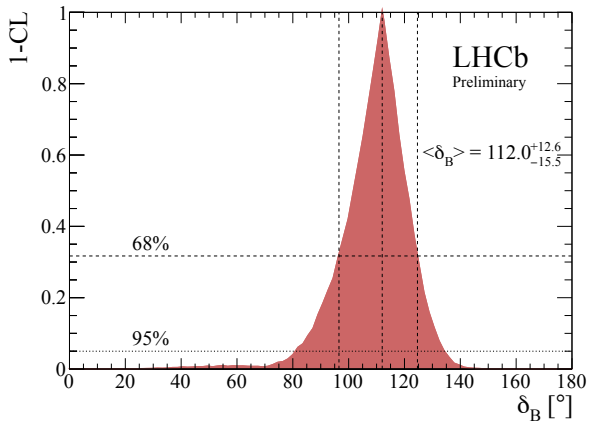
results from old CONF-2012-032 (1/3)

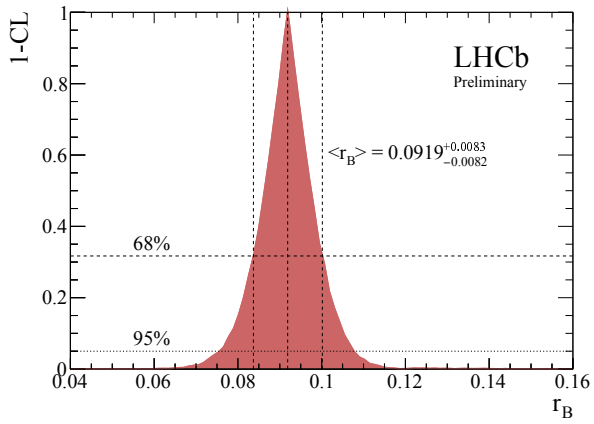
- old preliminary result from CKM 2012 had:
  - $B^{\pm} \to DK^{\pm}$ only: $\gamma = (71.1^{+16.6}_{-15.7})^{\circ}$
  - $B^{\pm} \to DK^{\pm}$ & $B^{\pm} \to D\pi^{\pm}$: best fit $\gamma = 85.1^{\circ}$, $\gamma \in ([61.8, 67.8] \text{ or } [77.9, 92.4])^{\circ}$ @ 68% CL
- main changes since then:
  - treatment of Δa_{CP}^{dir} changed: now constrain $A_{CP}^{D\to KK}$, $A_{CP}^{D\to\pi\pi}$ individually to their HFAG values (CONF only constrained Δa_{CP}^{dir})
  - include LHCb charm mixing result
  - include effect of possible systematic correlations
  - a lot of additional cross-checks

results from old CONF-2012-032 (2/3)

- $B^{\pm} \to DK^{\pm}$ combination:

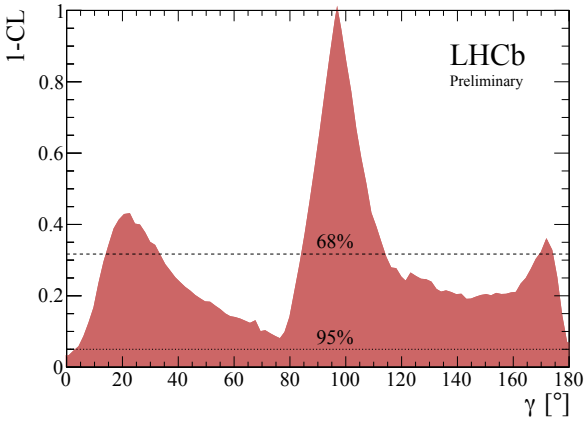


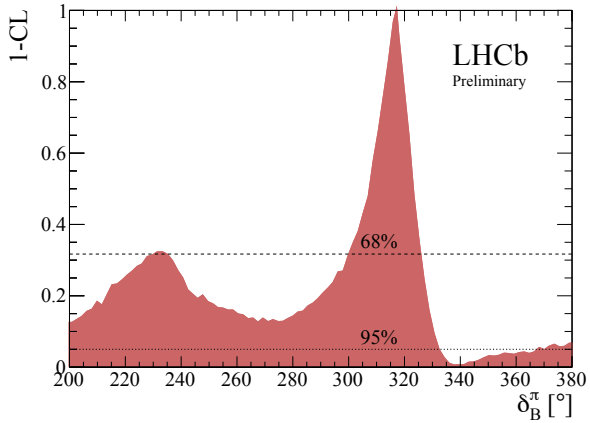


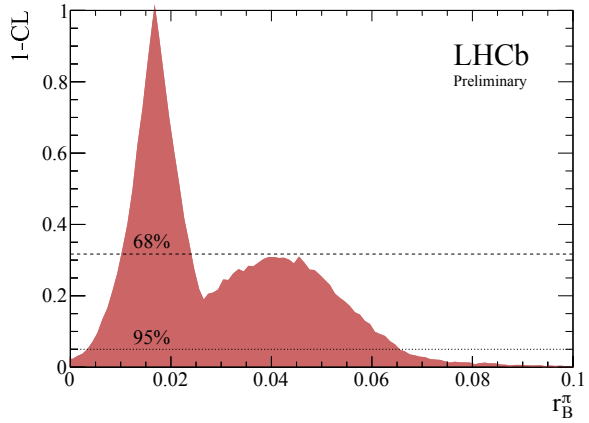


[LHCb-CONF-2013-032]

- $B^{\pm} \to D\pi^{\pm}$ combination:



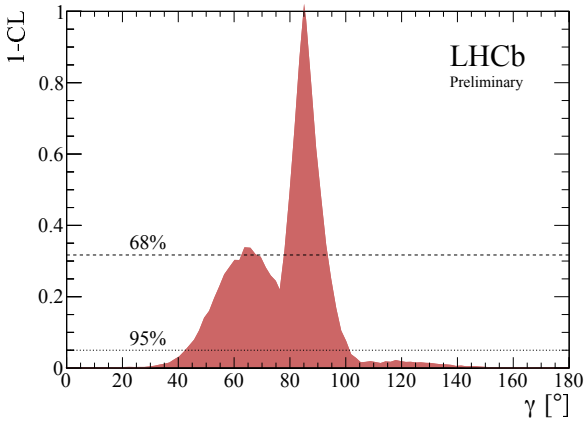


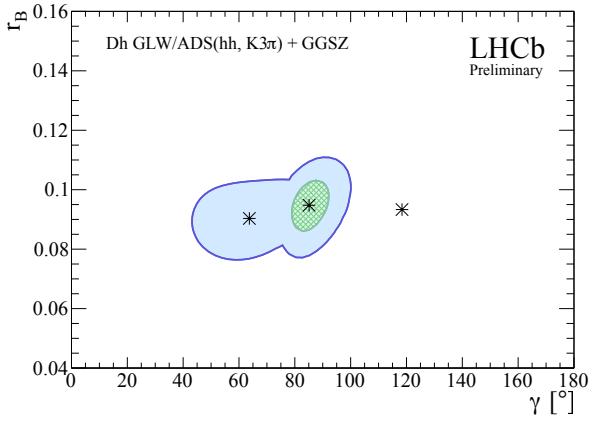


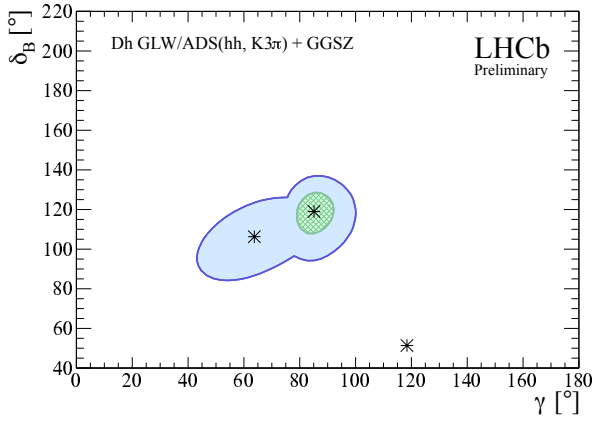
[LHCb-CONF-2013-032]

results from old CONF-2012-032 (3/3)

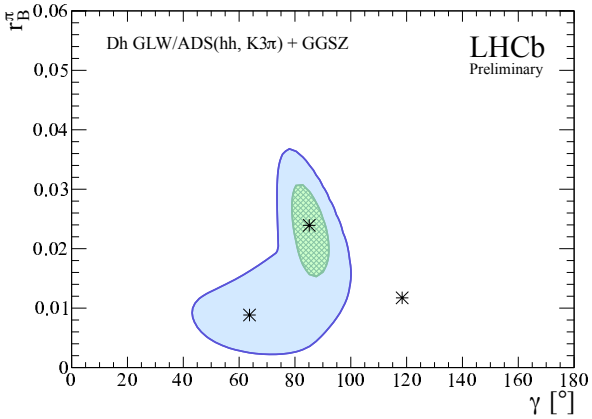
- $B^{\pm} \to DK^{\pm}$ & $B^{\pm} \to D\pi^{\pm}$ combination:

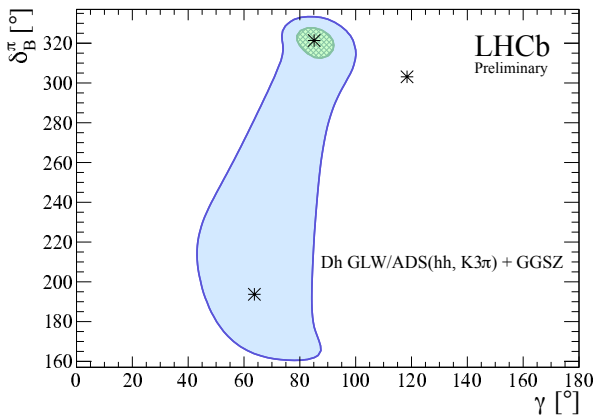






[LHCb-CONF-2013-032]





[LHCb-CONF-2013-032]