The CKM angle γ from neutral B decays in BaBar

Viola Sordini, CKM 2008 - Roma

BABAR

LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE

La Sapienza
Università degli Studi di Roma

Outline

- The CKM angle γ and the r_B ratios

- Some news on $\sin(2\beta+\gamma)$ from $B\to D^{(*)\mp}\pi^{\pm}(\rho^{\pm})$

- Time dependent Dalitz analysis of $B\to D^{\mp}K^0\pi^{\pm}$ decays for the determination of $2\beta+\gamma$

- The $B^0\to D^0K^{*0}$ system
  - ADS analysis of $B^0\to D^0K^{*0}$ decays for the determination of the ratio $r_S = |A(b\to u)|/|A(b\to c)|$
  - Dalitz analysis of $B^0\to D^0K^{*0}$ decays for the determination of γ

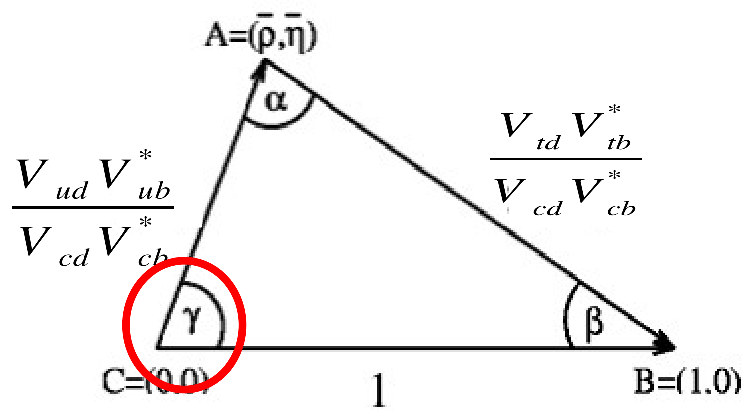
- Conclusions

The CKM angle γ

Wolfenstein parametrization:

$$V_{CKM} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} = \begin{pmatrix} 1-\frac{\lambda^2}{2} & \lambda & A\lambda^3(\bar{\rho}-i\bar{\eta}) \\ -\lambda & 1-\frac{\lambda^2}{2} & A\lambda^2 \\ A\lambda^3(1-\bar{\rho}-i\bar{\eta}) & -A\lambda^2 & 1 \end{pmatrix}$$

$\lambda \sim 0.22, A \sim 0.8$



$$\gamma = arg\{-\frac{V_{ud}V_{ub}^*}{V_{cd}V_{cb}^*}\}$$

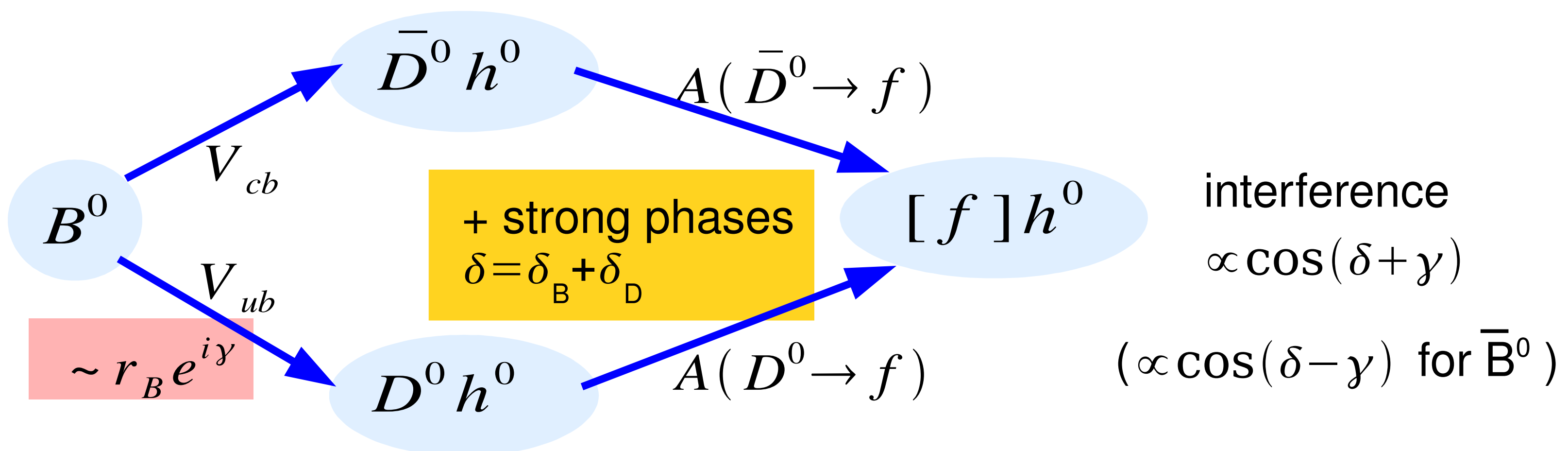
In Wolfenstein parametrization, $V_{ub} = \sqrt{\bar{\rho}^2+\bar{\eta}^2}\, e^{-i\gamma} \rightarrow \gamma$ is the phase of V_{ub}^*

The angle determined exploiting the interference between b→u and b→c transitions in B→Dπ and B→DK decays

Interference scheme

Interference in the B→Dπ and B→DK system allows the determination of γ

$$|A_1 + A_2 e^{i\phi}|^2 = A_1^2 + A_2^2 + 2A_1 A_2 \cos(\phi)$$



Main characters: γ, r_B , δ

Sensitivity to γ is driven by the ratio **r_B= |A(b→u)|/|A(b→c)|** (channel-dependent).

$\sin(2\beta+\gamma)$ from $B \to D^{(*)\mp}\pi^{\pm}(\rho^{\pm})$: some news...

Relative weak phase within Cabibbo-favoured amplitude ($B^0 \to D^- \pi^+$) and Cabibbo-suppressed ($B^0 \to D^+ \pi^-$) one gives sensitivity to γ.

When combined with the B_d mixing phase $\to 2\beta+\gamma$.

Size of CP violating effect proportional to $r_{D\pi} = |A(B^0 \to D^+ \pi^-)|/|A(B^0 \to D^- \pi^+)|$ ~0.02.

Assuming SU(3) and neglecting annihilation contributions, one can estimate $BR(B^0 \to D^{(*)+}\pi^-(\rho^-))$ and r_D ratios from **$BR(B^0 \to D_s^{(*)+}\pi^-(\rho^-))$**

New Babar measurement (`Phys.Rev.D78:032005,2008`):

- tests the hypothesis of negligible annihilation (from $B^0 \to D_s^- K^+$ BR) contribution
- measures:

$$BR(B^0 \to D_s^+ \pi^-) = (2.5 \pm 0.4 \pm 0.2)\,10^{-5}$$
$$BR(B^0 \to D_s^{*+} \pi^-) = (2.6^{+0.5}_{-0.4} \pm 0.2)\,10^{-5}$$
$$BR(B^0 \to D_s^+ \rho^-) = (1.1^{+0.9}_{-0.8} \pm 0.3)\,10^{-5}$$

$\rightarrow$

$$r_{D\pi} = (1.78^{+0.14}_{-0.13} \pm 0.08 \pm 0.10)\%$$
$$r_{D^*\pi} = (1.81^{+0.16}_{-0.15} \pm 0.09 \pm 0.10)\%$$
$$r_{D\rho} = (0.71^{+0.29}_{-0.27} \pm 0.10 \pm 0.04)\%$$

SU(3)
no annihilation
$f_{D(*)s}/f_{D(*)} = 1.24 \pm 0.07$

all amplitude ratios below 2%: very low sensitivity to $\sin(2\beta+\gamma)$ in $B \to D^{\mp}\pi^{\pm}(\rho^{\pm})$ channels!

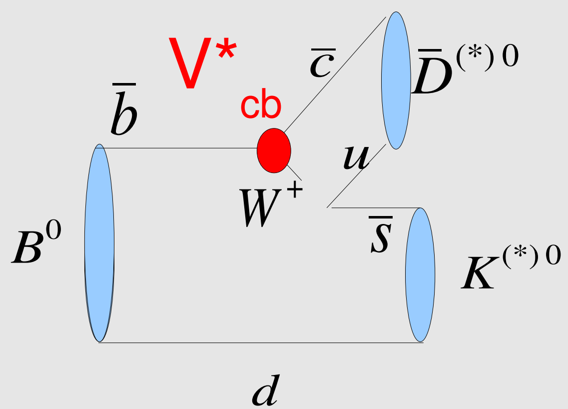
γ in neutral B→DK decays

Viola Sordini, CKM 2008 - Roma

Relative weak phase between V_{ub} and V_{cb} CKM elements, studied in the B→DK system, in the interference between b→c and b→u transitions when both the B0 and B0bar decay to the same final state.

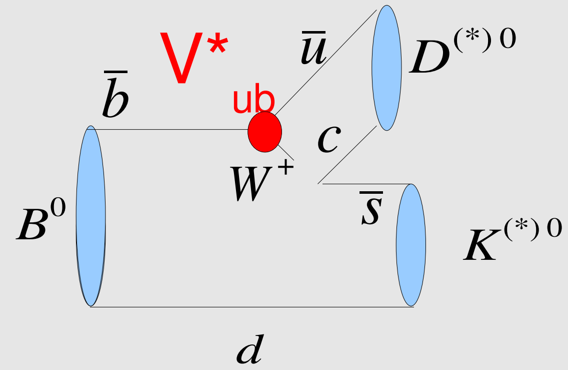
b→c transition

$$B^0 \to \overline{D}^{(*)0} K^{*0}$$



b→u transition

$$B^0 \to D^{(*)0} K^{(*)0}$$



The B0 and B0bar mix, time dependent analyses, sensitivity to ($2\beta+\gamma$)

If the flavour of the neutral B can be determined, sensitivity to γ

the r_B ratios

Sensitivity to γ in each channel driven by the ratio **r_B= |A(b→u)|/|A(b→c)|**

$$r_B(D^0K^+) = \frac{|A(B^+\to D^0K^+)|}{|A(B^+\to \bar{D}^0K^+)|} = \frac{|V_{cs}V_{ub}^*|}{|V_{us}V_{cb}^*|}\frac{|\bar{C}+A|}{|T+C|}$$

$$r_B(D^0K^0) = \frac{|A(B^0\to D^0K^0)|}{|A(B^0\to \bar{D}^0K^0)|} = \frac{|V_{cs}V_{ub}^*|}{|V_{us}V_{cb}^*|}\frac{|\bar{C}|}{|C|}$$

T tree
C, $\bar{C}$ colour-suppressed
A annihilation
Hadronic elements, complex quantities.
|C|/|T|~0.3
|A|/|C|~0.2

R_b ~ 0.35

$$R_b = \frac{|V_{ud}V_{ub}^*|}{|V_{cd}V_{cb}^*|} = \sqrt{\bar{\rho}^2+\bar{\eta}^2} = \left(1-\frac{\lambda^2}{2}\right)\frac{1}{\lambda}\left|\frac{V_{ub}}{V_{cb}}\right|$$

For the $B^+ \to D^{(*)0}K^+$, the r_B ratio is of the order ~0.1 (in amplitude!)

For the $B^0 \to D^{(*)0}K^{(*)0}$, the r_B ratio is expected to be of the order ~0.4

Need to be measured!

Time dependent Dalitz plot analysis of $B \to D^{\mp} K^0 \pi^{\pm}$

Phys.Rev.D77:071102,2008

- $D^{**0}[D\pi]K^0$ states, interference between b→u and b→c transitions through the mixing
- one B fully reconstructed in $D^{\mp}K^0\pi^{\pm}$, the flavour of the other one identified at decay
- three-body $\bar{B}$ decay: **$2\beta+\gamma$** (2-fold ambiguity) from analysis of Dalitz distribution ($\vec{x}$) as a function of proper time difference Δt.

Likelihood:

$$P(\vec{x},\Delta t,\xi,\eta)=\frac{A_c^2(\vec{x})+A_u^2(\vec{x})}{2}\frac{e^{\frac{-|\Delta t|}{\tau_b}}}{4\tau_B}\{1-\eta\xi C(\vec{x})\cos(\Delta m_d\Delta t)+\xi S_\eta(\vec{x})\sin(\Delta m_d\Delta t)\}$$

$$S_\eta(\vec{x})=\frac{2\,Im(A_c(\vec{x})A_u(\vec{x})e^{i(2\beta+\gamma)+\eta i(\Phi_c(\vec{x})-\Phi_u(\vec{x}))})}{A_c^2(\vec{x})+A_u^2(\vec{x})} \qquad C(\vec{x})=\frac{A_c^2(\vec{x})-A_u^2(\vec{x})}{A_c^2(\vec{x})+A_u^2(\vec{x})}$$

$$\xi=1\,(-1)\,\text{for}\,B^0(\bar{B}^0) \qquad \eta=1\,(-1)\,\text{for}\,D^+(D^-)$$

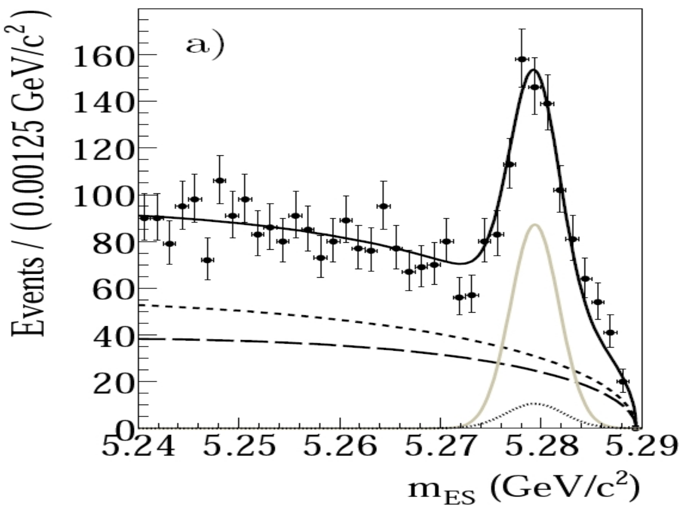
- B Dalitz distribution written as a sum of intermediate 2-body states with resonances
- amplitudes A_c and phases Φ_c, Φ_u floated in the fit. Ratio $r=|A_u/A_c|$ fixed to 0.3 (±0.1 variation included in systematics)

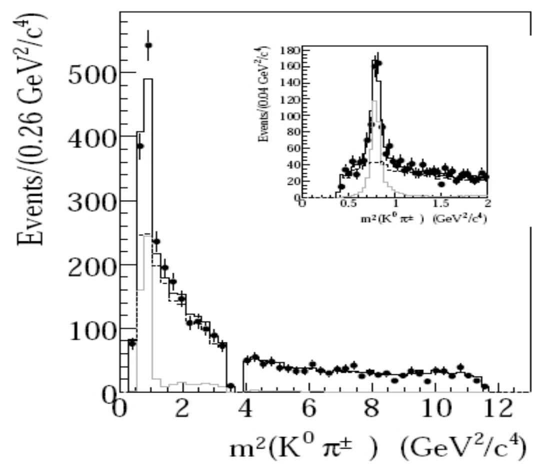
Time dependent Dalitz plot analysis of $B \to D^{\mp} K^0 \pi^{\pm}$, results on $2\beta+\gamma$

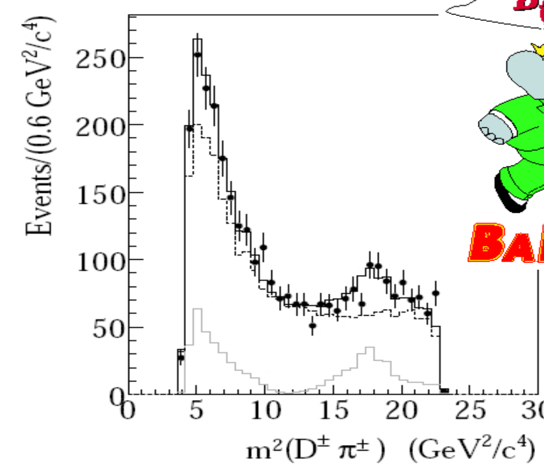
Phys.Rev.D77:071102,2008

Analysis performed on 347 millions of BB pairs.

Number of signal events N=558±34 (likelihood fit on m_{ES}, ΔE and event shape variables)



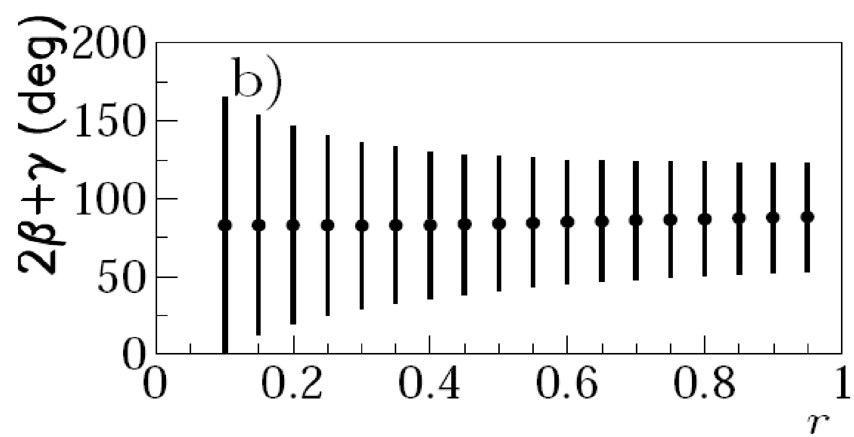




$$2\beta+\gamma=(83\pm53\pm20)^o(mod.180^o)$$

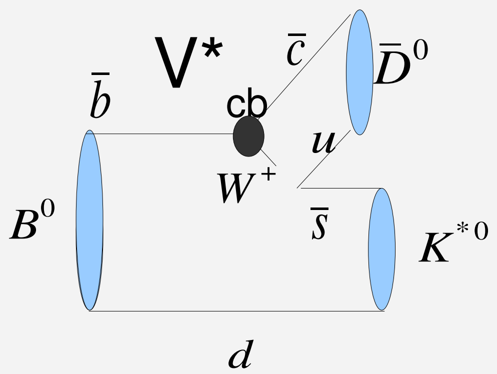
error statistically dominated, main systematics from the background Dalitz plot parametrization

Behaviour of the error for different fixed r values: scan of **$2\beta+\gamma$** as a function of $r=|A_c/A_u|$



$B^0 \to D^0 K(892)^{*0}[K^+\pi^-]$: a self tagging system

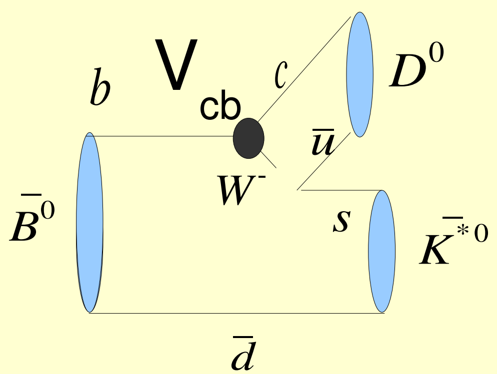
Other Babar analyses exploit the $B^0 \to D^0 K^{*0}[K^+\pi^-]$ system



$$B^0 \to \overline{D}^{(*)0} K^{*0}$$

A B^0 always decays into a K^{*0} in the final state, which decays into $K^+\pi^-$

$$K^{*0} \to K^+ \pi^-$$



$$\overline{B}^0 \to D^{(*)0} \overline{K}^{*0}$$

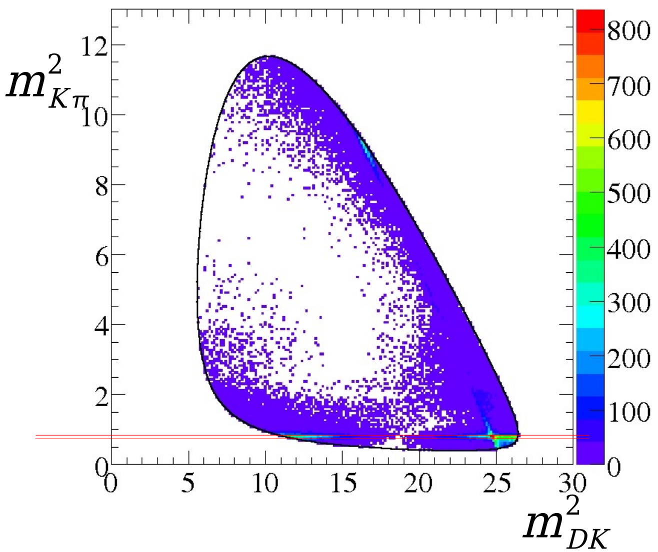
A $\overline{B}^0$ always decays into a $\overline{K}^{*0}$ in the final state, which decays into $K^-\pi^+$

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

The charge of the kaon in the final state identifies the flavour of the neutral B, sensitivity to γ

$B^0 \to D^0 K^{*0}[K^+\pi^-]$: the ratio r_S

Natural width of the K* has to be considered, effective parameters are introduced:



M.Gronau, Phys.Lett. B557 (2003) 198-206

$$r_S^2 \equiv \frac{\Gamma(B^0 \to D^0 K^+ \pi^-)}{\Gamma(B^0 \to \overline{D}^0 K^+ \pi^-)} = \frac{\int dp\ A_u^2(p)}{\int dp\ A_c^2(p)},$$

$$k e^{i\delta_S} \equiv \frac{\int dp\ A_c(p) A_u(p) e^{i\delta(p)}}{\sqrt{\int dp\ A_c^2(p) \ \int dp\ A_u^2(p)}},$$

$B \to DK^*(K\pi)$
p indicates the point on the $B \to DK\pi$ Dalitz plot

where k accounts for contributions of non-K^{*0}(892) resonances and in principle is an additional unknown (in case of two-body B decay,$k \to 1$, $r_S \to r_B$, $\delta_S \to \delta_B$) .

It is evaluated to be 0.95+-0.03 with a simulation study.

S.Pruvot, M.-H.Schune, V.Sordini, A.Stocchi in hep-ph/0703292
(to appear in Nagoya CKM workshop proceedings)

Integrals over the $B \to DK\pi$ Dalitz plot in a region corresponding to the K*.
Quantities dependent on the cuts applied on the Dalitz plot plane (cuts on K* mass and helicity) !

The ADS method

D.Atwood, I.Dunietz and A.Soni, Phys.Rev.Lett. 78, 3257 (1997)

V_{ub} suppressed $B^0 \to D^0 K^{*0}$ — favoured (CA) $D^0 \to f$

V_{cb} favoured $B^0 \to \bar{D}^0 K^{*0}$ — suppressed (DCS) $\bar{D}^0 \to f$

$f = K^-\pi^+, K^-\pi^+\pi^0, K^-\pi^+\pi^+\pi^-$

Same final state

"opposite sign" events (the kaon from the K* and the one from the D have **OPPOSITE** charge)

$$R_{ADS} \equiv \frac{\Gamma(B^0 \to f\, K^{*0}) + \Gamma(\overline{B^0} \to \bar{f}\, \overline{K^{*0}})}{\Gamma(B^0 \to \bar{f}\, K^{*0}) + \Gamma(B^0 \to f\, K^{*0})}$$

→ $V_{cb} DCS + V_{ub} CA$

→ $V_{cb} CA + V_{ub} DCS$

"same sign" events (the kaon from the K* and the one from the D have the **SAME** charge)

$$R_{ADS}(K\pi) \equiv \frac{\Gamma(B^0 \to K^-\pi^+[K^+\pi^-]_{K^{*0}}) + \Gamma(\overline{B^0} \to K^+\pi^-[K^-\pi^+]_{K^{*0}})}{\Gamma(B^0 \to) K^+\pi^-[K^+\pi^-]_{K^{*0}} + \Gamma(B^0 \to K^-\pi^+[K^-\pi^+]_{K^{*0}})}$$

The ADS method multi-body D decay

The three R_{ADS} ratios can be written as:

$$R_{ADS}(K\pi) = r_S^2 + r_D^2(K\pi) + 2\,k\,r_S\,r_D(K\pi)\cos(\delta_D(K\pi)+\delta_S)\cos\gamma$$

$$R_{ADS}(K\pi\pi^0) = r_S^2 + r_D^2(K\pi\pi^0) + 2\,k\,k_D(K\pi\pi^0)\,r_S\,r_D(K\pi\pi^0)\cos(\delta_D(K\pi\pi^0)+\delta_S)\cos\gamma$$

$$R_{ADS}(K3\pi) = r_S^2 + r_D^2(K3\pi) + 2\,k\,k_D(K3\pi)\,r_S\,r_D(K3\pi)\cos(\delta_D(K3\pi)+\delta_S)\cos\gamma$$

$$r_D = \sqrt{\frac{BR(D^0\to\bar{f})}{BR(D^0\to f)}}$$

δ_D relative strong phase between $D^0 \to f$ and $D^0 \to \bar{f}$

multi-body D final state

$$k_D e^{i\delta_D} = \frac{\int A_D \bar{A}_D e^{i(\bar{\delta}(m)-\delta(m))}\,dm}{\sqrt{\int |\bar{A}_D|^2\,dm \int |A_D|^2\,dm}}$$

$r_D \ll r_S$ ($r_D \sim 0.05$):

- low sensitivity to γ
- $R_{ADS} \sim r_S^2$

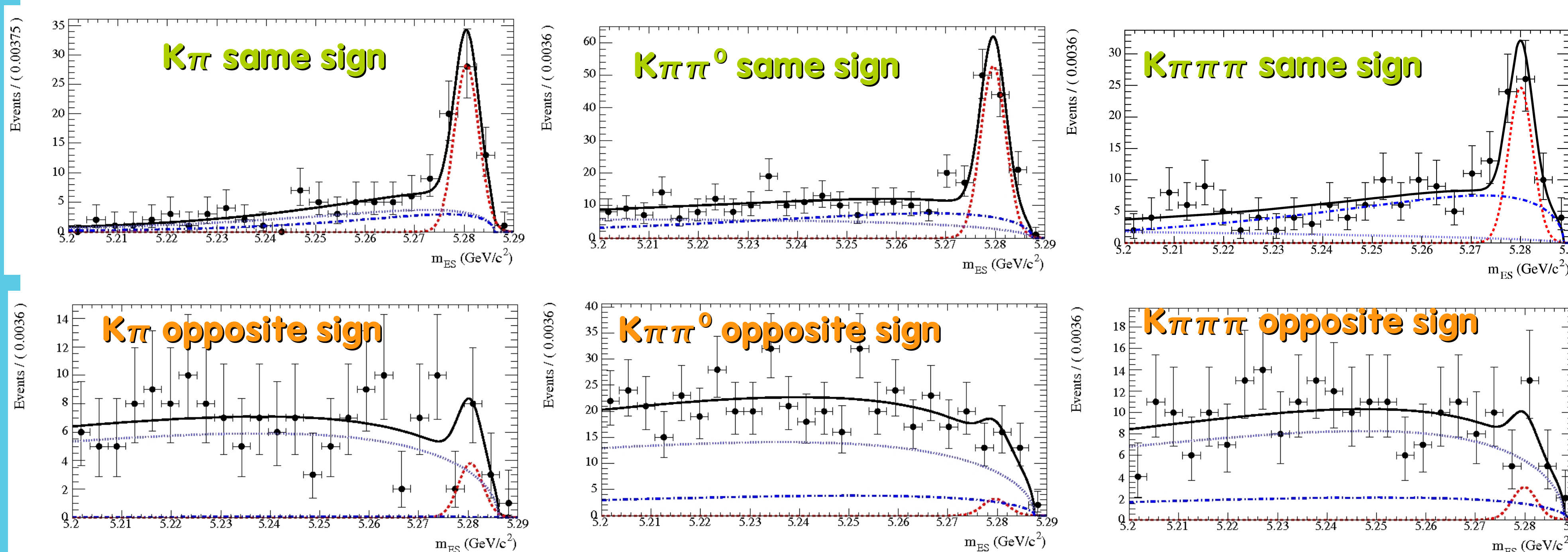
Ratios r_D measured. Input from CLEO-c on k_D and δ_D for $K\pi\pi^0$ and δ_D for $K\pi$

$B^0 \to D^0 K^{*0}[K^+\pi^-]$ ADS analysis
$(D^0 \to K^\mp\pi^\pm, K^\mp\pi^\pm\pi^0, K^\mp\pi^\pm\pi^\mp\pi^\pm)$

Preliminary, to be submitted to Phys.Rev.D

- analysis performed on 465 millions of BB pairs
- selection optimized on b→u events, maximizing $S/\sqrt{(S+B)}$
- likelihood fit to m_{ES} and event shape variables,

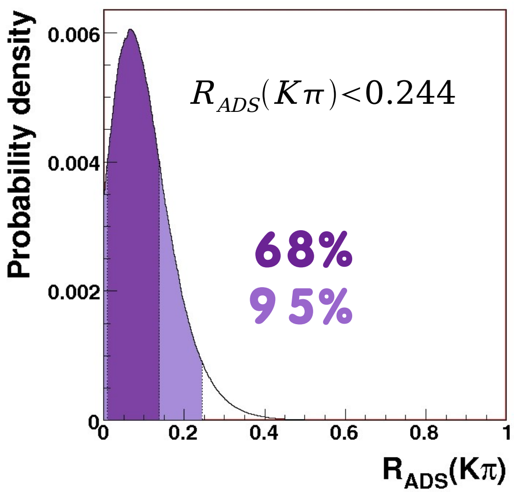
  total number of **opposite sign** events $N=24^{+14}_{-11}$ (2.2σ significance)
- statistically dominated. Main systematics from peaking background

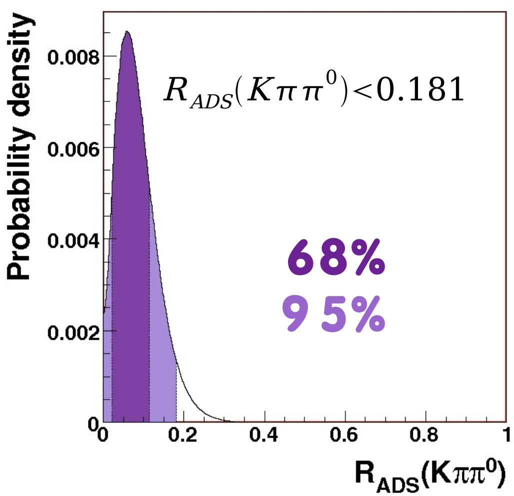


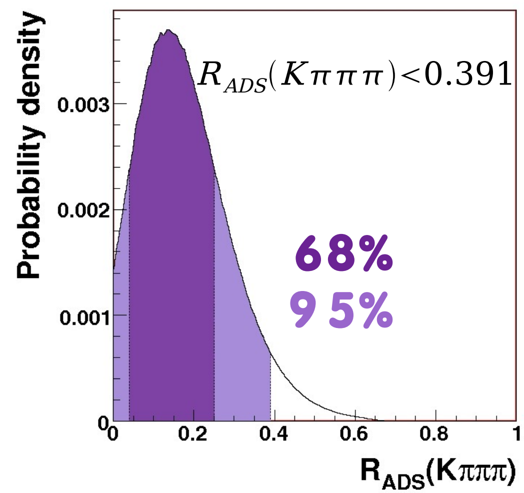
signal enhanced m_{ES} projections of the likelihood on data

$B^0 \to D^0 K^{*0}[K^+\pi^-]$ ADS analysis
$(D^0 \to K^\mp\pi^\pm, K^\mp\pi^\pm\pi^0, K^\mp\pi^\pm\pi^\mp\pi^\pm)$

- likelihood scan for the three R_{ADS} ratios and 95% probability bayesian limits





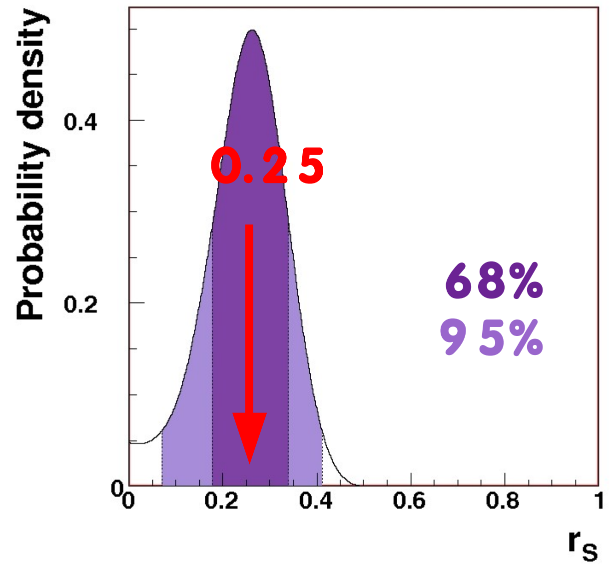


Ignoring differences in r_D and strong phases within the three channels.. $<R_{ADS}> = 0.078^{+0.037}_{-0.035}$

Combining the three modes and using external inputs (r_D ratios from the PDG and CLEO-c likelihood for k_D and δ_D):

$r_S \in [0.18, 0.34]$ at 68% prob.

$r_S \in [0.07, 0.41]$ at 95% prob.



$B^0 \to D^0[K_S\pi^+\pi^-]K^{*0}[K^+\pi^-]$ Dalitz analysis

A.Giri, Y.Grossman, A.Soffer and J.Zupan, Phys.Rev.D 68 (2003) 054081

$$A(B^0) \sim f(s_{12}, s_{13}) + r_S e^{i(\delta+\gamma)} f(s_{13}, s_{12})$$

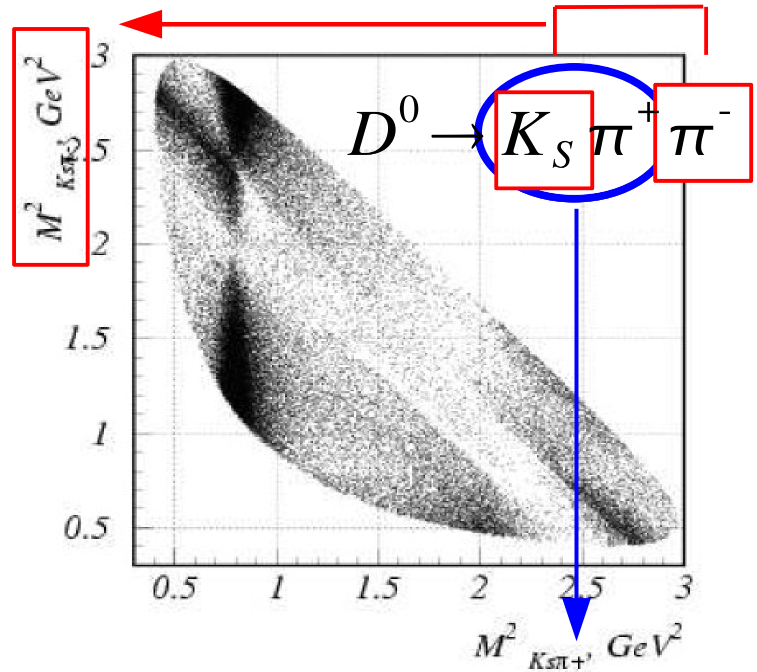
$$A(\bar{B}^0) \sim f(s_{13}, s_{12}) + r_S e^{i(\delta-\gamma)} f(s_{12}, s_{13})$$

V_{cb} amplitude

V_{ub} amplitude
($V_{ub} = |V_{ub}|e^{-i\gamma}$)

Same final state $B^0 \to D^0K^{*0}$:

sensitivity to δ-γ in the interference



D^0 Dalitz plane distribution $f(s_{12},s_{13})$ parametrized as sum of Breit-Wigner :

same as in charged B Dalitz analysis! $f_- = f(s_{13}, s_{12})$ $f_+ = f(s_{12}, s_{13})$

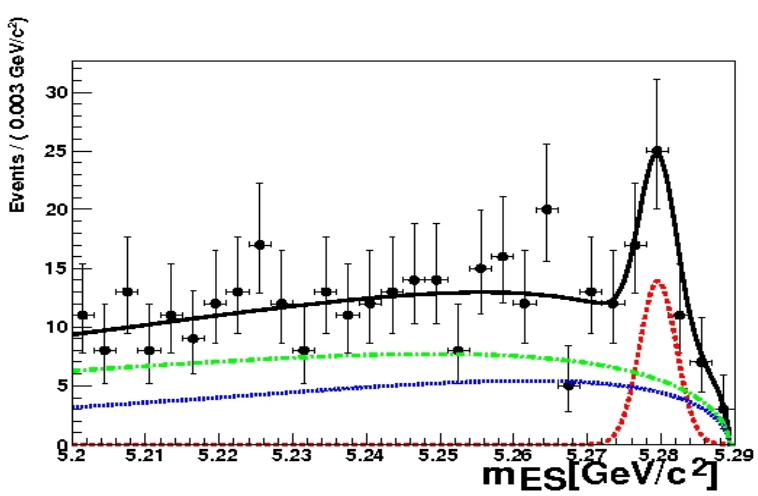
$$P_{Sig}(B^0/\bar{B}^0) = |f_{\mp.}|^2 + r_S^2|f_{\pm.}|^2$$
$$+ 2kr_S(\Re\{f_{\mp.} f^*_{\pm.}\}\cos(\delta_S \mp \gamma) - \Im\{f_{\mp.} f^*_{\pm.}\}\sin(\delta_S \mp \gamma))$$

V_{cb} term is the one from $\bar{D}^0$ for the B^0, the one from D^0 for the $\bar{B}^0$.

$B^0 \to D^0 K^{*0}[K^+\pi^-]$ Dalitz analysis

Preliminary, to be submitted to Phys.Rev.D

- Analysis of $B^0 \to D^0 K^{*0}$, with $D^0 \to K_S \pi^+ \pi^-$ and $K^{*0} \to K^- \pi^+$
- same cuts on $B \to DK\pi$ Dalitz plot (K^* mass and helicity) as ADS analysis
- first analysis extracting directly γ from neutral $B^0 \to D^0 K^{*0}$ decays.
- m_{ES} and shape variables used in a maximum likelihood fit to discriminate between signal and background
- all peaking contribution found negligible



Analysis performed on **371M** of BB pairs.

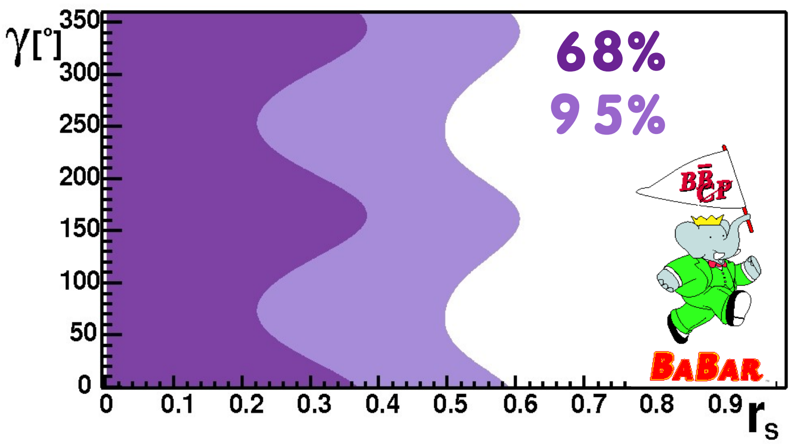
Number of signal events N=39±9

signal enhanced m_{ES} projections of the likelihood on data

$B^0 \to D^0 K^{*0} [K^+ \pi^-]$ Dalitz analysis

Preliminary, to be submitted to Phys.Rev.D

- D^0 Dalitz distribution used as an input in the fit
- CP fit for extraction of a 3-dimensional likelihood for γ, r_S, δ

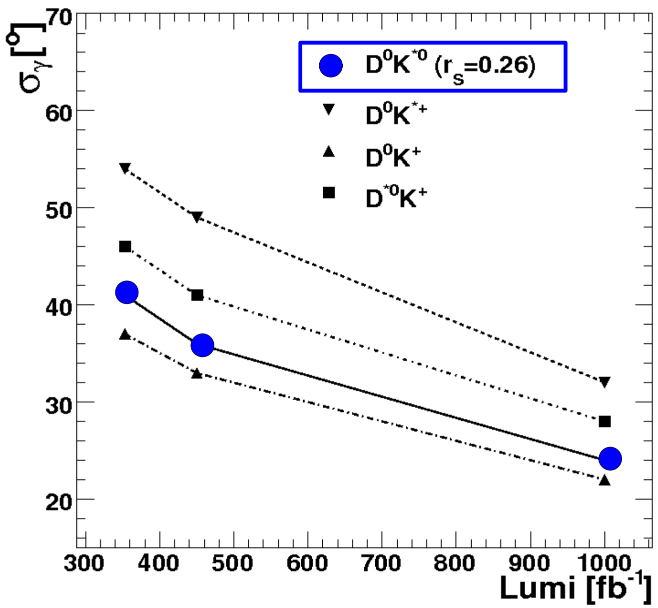


Combined with the likelihood for r_S from B.Aubert et al (Babar coll.) Phys.Rev. D74, 031101 (2006)

$$\gamma = (162 \pm 56)^o (mod.180^o)$$

- main error statistical (55°)
- average error on toy-MC, for r_S=0.3, is $(45 \pm 14)^o$
- main source of systematics from Dalitz model (evaluated on data), assumed Gaussian and convoluted with the 3-dimensional likelihood

From toy-MC studies: this channel sensitivity is comparable with the one of a single channel for the charged B Dalitz analysis



Viola Sordini, CKM 2008 - Roma

conclusions

- $B \to D^{(*)\mp}\pi^{\pm}(\rho^{\pm})$ channels confirmed to have low sensitivity to γ ($r_D \sim 2\%$)
- Angle γ known mainly from charged $B \to DK$, small values of the r_B ratios (~0.1)
- Neutral $B \to DK$ decays can give access to γ as well

- Using a time dependent Dalitz analysis of $B \to D^{\mp}K^0\pi^{\pm}$ decays, Babar finds
$2\beta+\gamma=(83\pm53\pm20)^{\circ}$ (with a 180° ambiguity)

- $r_S=|A(b\to u)|/|A(b\to c)|$ for $B^0 \to D^0K^{*0}$ decays found to be $r_S \sim 0.25$, which makes this channel very promising for γ determinations (preliminary)

- first attempt of exploiting this channel for the extraction of γ using a Dalitz analysis of $B^0 \to D^0K^{*0}$ decays gives $\gamma=(162\pm56)^{\circ}$ (with a 180° ambiguity) (preliminary)

- With higher statistics, these analyses could give an important contribution to the determination of the angle γ

Backup slides

CPV in the SM

Field theory that describes strong, weak and electromagnetic interactions in terms of gauge group theories, starting from the elementary particles.

gauge group

strong interactions

$$SU(3) \times SU(2) \times U(1)$$

electroweak interactions

color symmetry (strong interactions)

isospin symmetry (weak)

hypercharge svmmetrv

6 leptons (antipleptons), in three families $\begin{pmatrix} \nu_e \\ e \end{pmatrix}, \begin{pmatrix} \nu_\mu \\ \mu \end{pmatrix}, \begin{pmatrix} \nu_\tau \\ \tau \end{pmatrix}$

6 quarks (antiquarks), in three families $\begin{pmatrix} u \\ d \end{pmatrix}, \begin{pmatrix} c \\ s \end{pmatrix}, \begin{pmatrix} t \\ b \end{pmatrix}$

Parity :

$$P(t, \vec{x}) = (t, -\vec{x})$$

Charge conjugation: particle → antiparticle

CP violation discovered in 1964 in the K rare decays and then confirmed by the B-factories results

The CKM matrix and the Unitarity Triangle

weak interaction eigenstates

$$\begin{pmatrix} d' \\ s' \\ b' \end{pmatrix} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \begin{pmatrix} d \\ s \\ b \end{pmatrix}$$

mass eigenstates

Cabibbo
Kobayashi
Maskawa

V_{CKM} Unitary matrix

UNITARITY CONDITION:

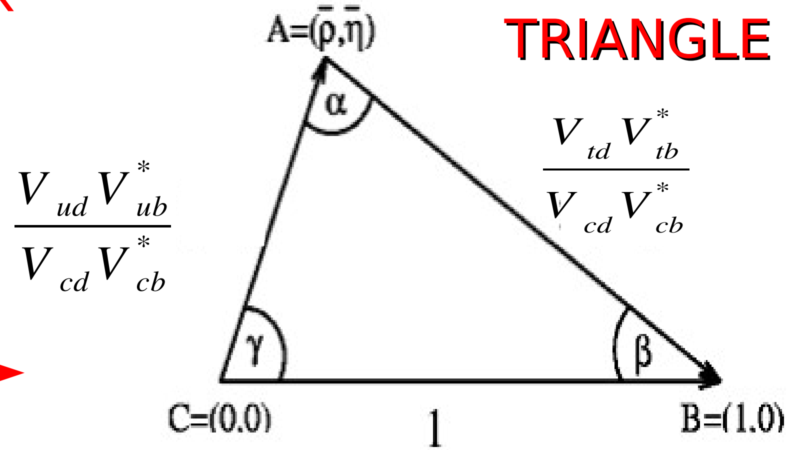
$$V_{CKM} V^{+}_{CKM} = V^{+}_{CKM} V_{CKM} = 1$$

six independent relations,

within them we choose:

$$V^{*}_{ub} V_{ud} + V^{*}_{cb} V_{cd} + V^{*}_{tb} V_{td} = 0$$

UNITARITY TRIANGLE



B physics

In a complex plane $(\bar{\rho}, \bar{\eta})$

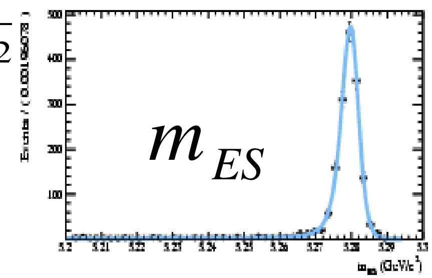
Experimental measurement techniques

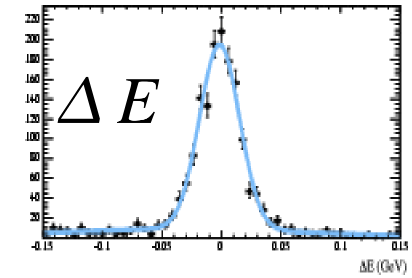
Exclusive reconstruction of B decays. Two sources of background: from $B\bar{B}$ events and from **continuum events** ($e^+e^-\to q\bar{q}$, with q=u,d,s,c).

Two almost-independent kinematic variables to characterize the B mesons:

$$m_{ES}(M_{bc}) = \sqrt{(s/2 + \vec{p}_B\,\vec{p}_{ee})^2 / E_{ee}{}^2 - \vec{p}_B{}^2}$$

$$\Delta E = E_B^* - \sqrt{s}/2$$

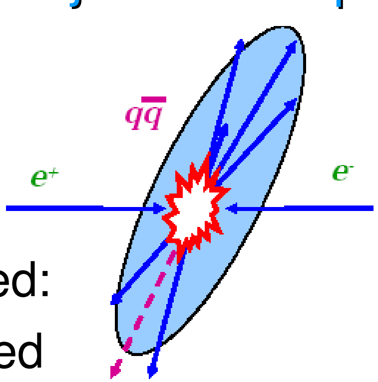




($E_{B(ee)}$,$p_{B(ee)}$) = 4-momentum of the reconstructed B or of the e^+e^- initial state in the laboratory frame. The * denotes the e^+e^- center of mass (CM) frame

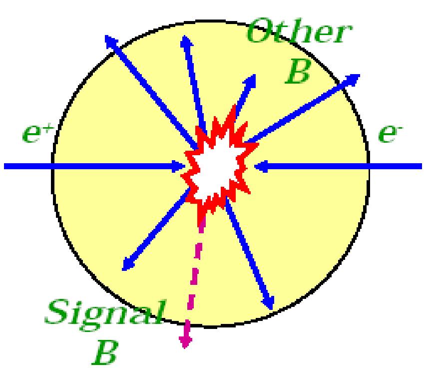
Typically, in all these analyses, dominant source of background: **continuum events** ($e^+e^-\to q\bar{q}$, with q=u,d,s,c). Different spatial distribution is exploited: several topological variables (combined in a Fisher discriminant)

jet-like shape



$$e^+e^-\to q\bar{q}$$

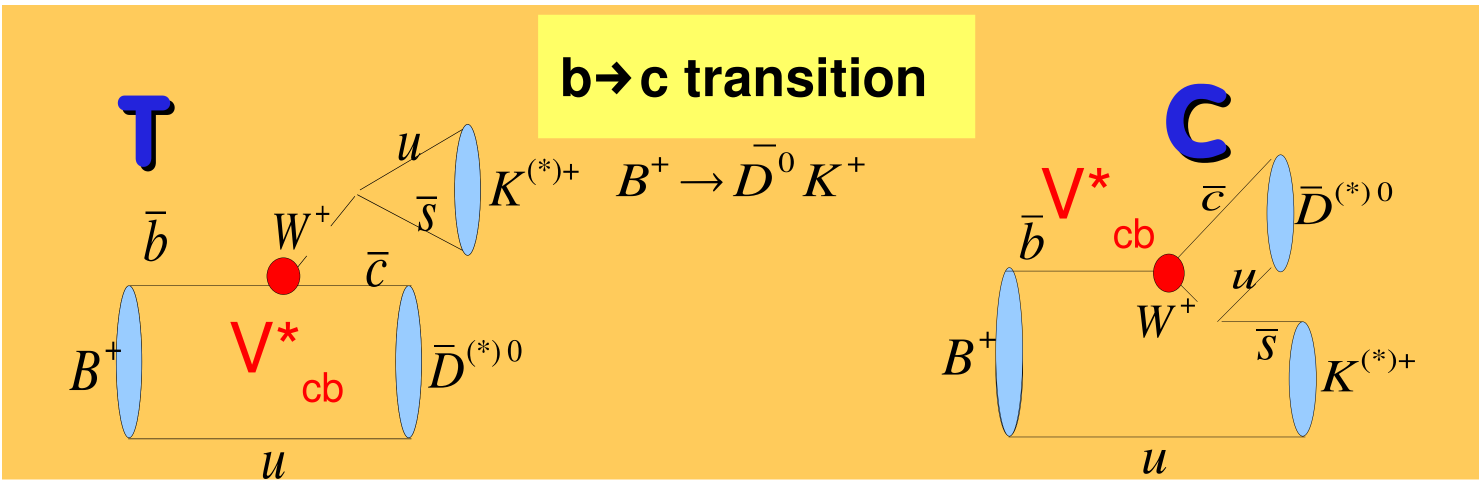
isotropic shape

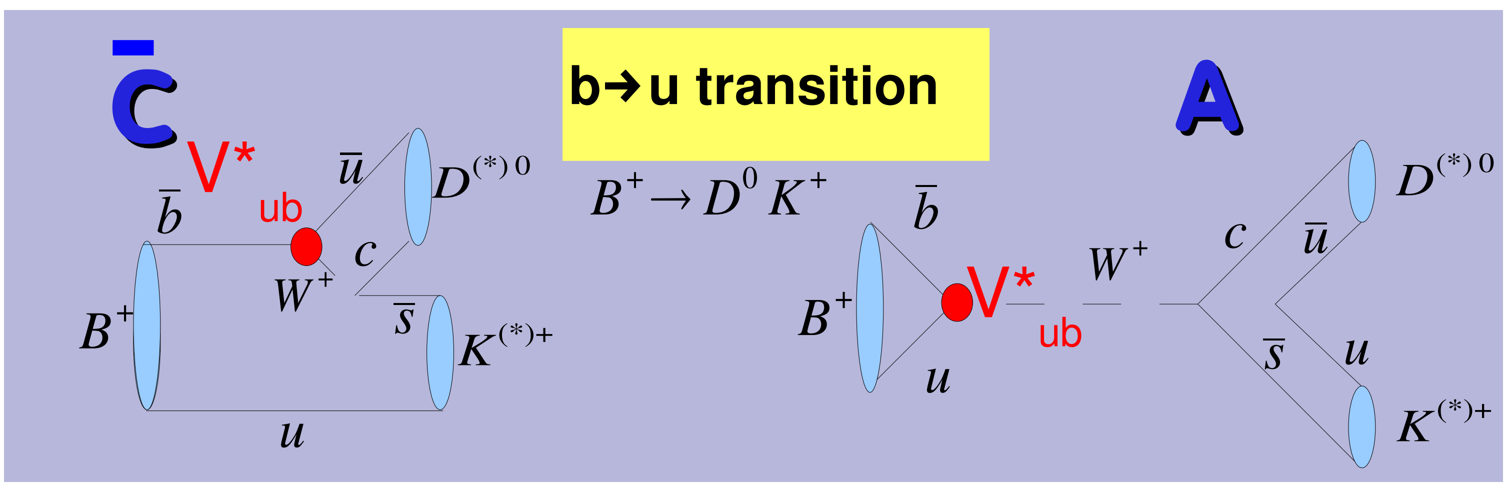


$$e^+e^-\to b\bar{b}$$

γ in charged B→DK decays

γ weak phase between b→c and b→u transition





T = tree

C = colour-suppressed

A = annihilation

|C|/|T| ~ 0.3
|A|/|C| ~ 0.2

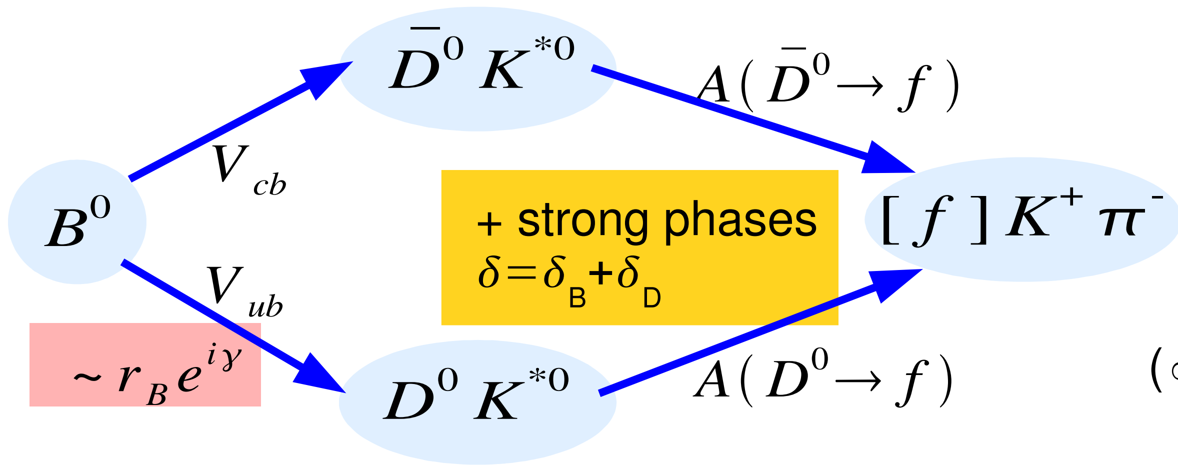
Viola Sordini, CKM 2008 - Roma

Interference scheme

CP violation detectable when there are two paths to reach the same final state.

Interference in the B→DK system allows the determination of γ

$$|A_1 + A_2 e^{i\phi}|^2 = A_1^2 + A_2^2 + 2A_1 A_2 \cos(\phi)$$



interference $\propto \cos(\delta+\gamma)$

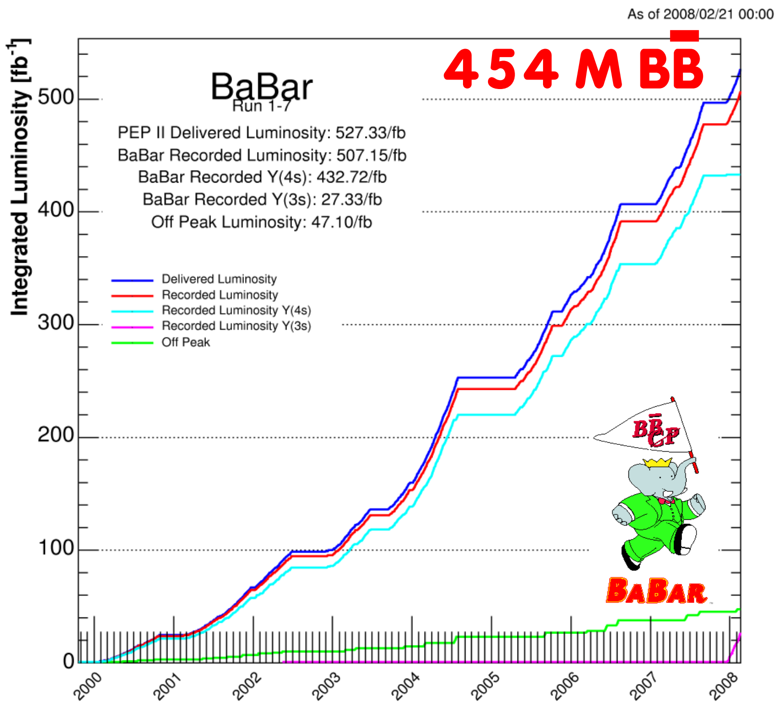
$(\propto \cos(\delta-\gamma)$ for $\bar{B}^0$)

Main characters: γ, r_B , δ

Sensitivity to γ is driven by the ratio $\mathbf{r_B = |A(b \to u)|/|A(b \to c)|}$ (channel-dependent).

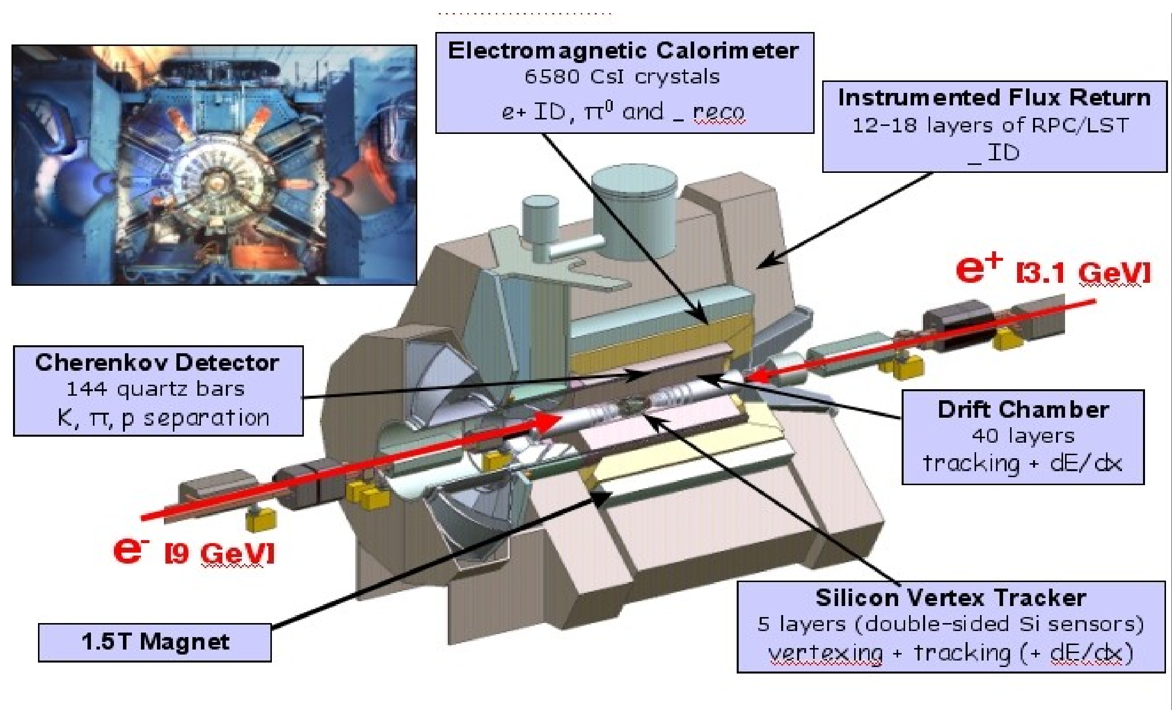
PEP II and BABAR

Viola Sordini, CKM 2008 - Roma



PEP II at SLAC (U.S.A.) e^+e^- collider with asymmetric beam energies @Y(4s) for B meson pairs production.

General purpose detector Babar



Different methods

Different methods proposed to study the $B \to D^0 K$ decays,

- **GLW method**:
  D^0 mesons reconstructed in two-body CP-eigenstate final states: K^+K^-, $\pi^+\pi^-$ (CP even) $K_s\pi^0$, $K_s\omega$ (CP odd)

- **ADS method**:
  D^0 mesons reconstructed in non CP-eigenstate final states: $K^-\pi^+$, $K^-\pi^+\pi^0$

more sensitive to r_B

- **GGSZ (Dalitz) method**:
  D^0 mesons reconstructed in three-body CP-eigenstate final states: $K_s\pi^+\pi^-$, $K_sK^+K^-$, $\pi^+\pi^-\pi^0$

the one that gives the best error on γ

All methods used by Babar and Belle.

Best determination from Dalitz analyses: error on $\gamma \sim 20^o$-25^o

Time dependent Dalitz plot analysis of $B \to D^{\mp} K^0 \pi^{\pm}$, resonance model

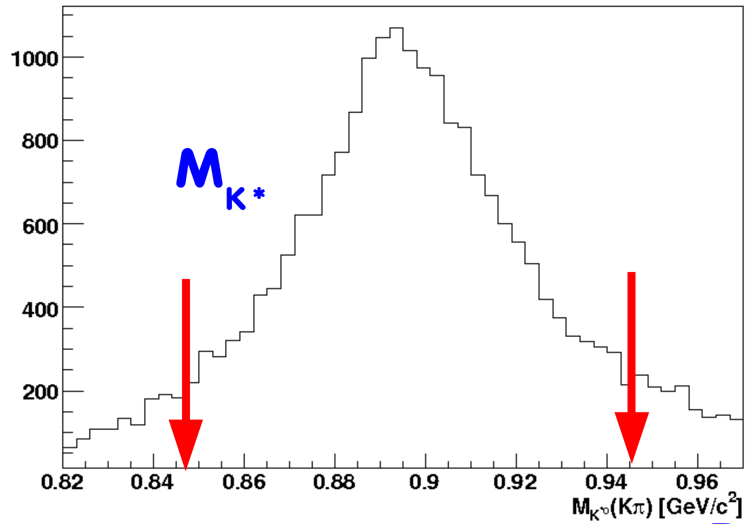
Isobar model

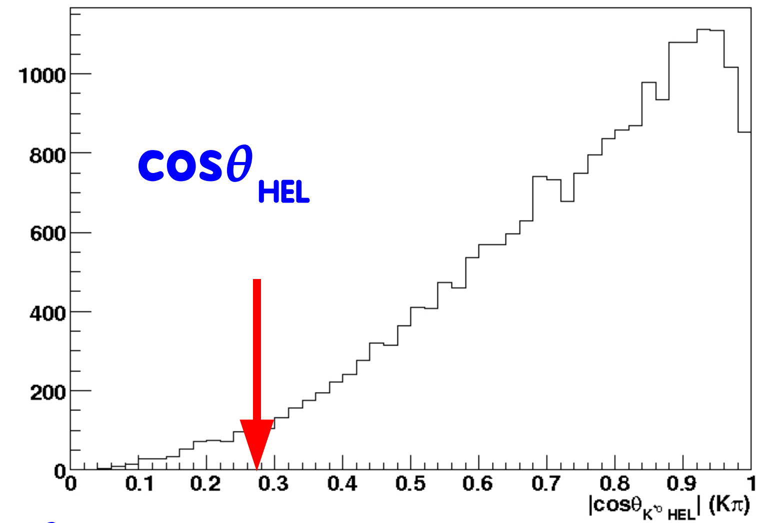
	Mass (GeV/c^2)	*Width* (Gev/c^2)	J^P	$a(V_{cb})$	$\phi(V_{cb})^o$	$a(V_{ub})$	$\phi(V_{ub})^o$
$D_{s2}(2573)^{\pm}$	2.572	0.015	2+	-	-	0.02	
$D_2^*(2460)^0$	2.461	0.046	2+	0.12	30	0.048	30
$D_0(2308)^0$	2.308	0.276	0+	0.12	70	0.048	90
$K^*(892)^{\pm}$	0.89166	0.0508	1-	1	0	-	-
$K_0^*(1430)^{\pm}$	1.412	0.294	0+	0.6	80	-	-
$K_2^*(1430)^{\pm}$	1.4256	0.0985	2+	0.2	0	-	-
$K^*(1680)^{\pm}$	1.717	0.322	1-	0.3	30	-	-
"Non Resonant"	-	-	-	0.07	0	0.028	30

$B^0 \to D^0 K^{*0}[K^+\pi^-]$: cuts on K^{*0}

The selection of the K* is common to the ADS and Dalitz analyses

Cuts optimized maximizing the statistical significance $S/\sqrt{(S+B)}$





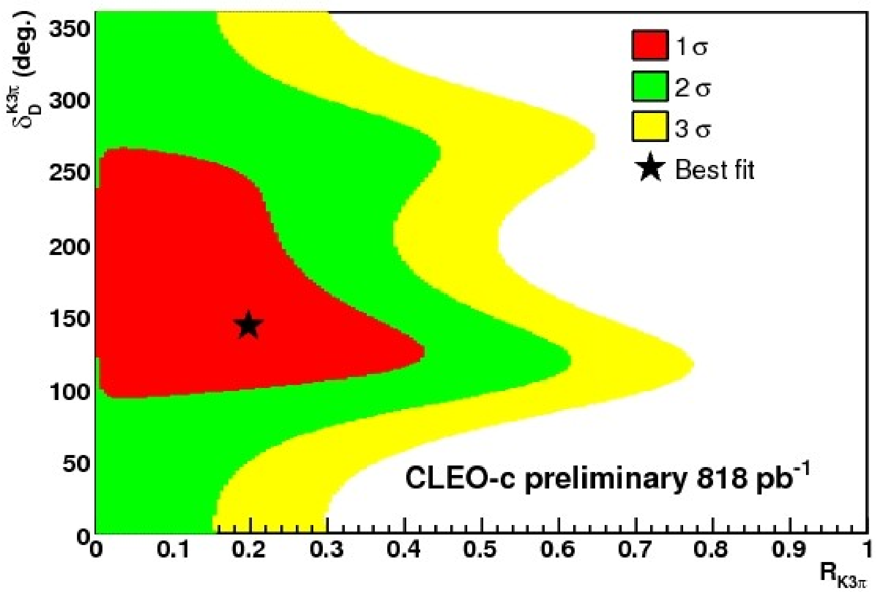
Distributions for signal

Inputs from CLEO-c

As shown in: arXiv:0805.1722 [hep-ex]

News from CLEO-c:

- strong phase measured for $K^+\pi^-$, $\delta = (22+14-16)^o$
- D Dalitz variables measured for $K^+\pi^-\pi^+\pi^-$
- analysis ongoing for $K^+\pi^-\pi^0$



The factor $R_{K3p} = k_D$ is significantly smaller than 1, as it is reasonable since we do not cut on Dalitz plane.