Belle B Physics results

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Slac Summer Institute/August 23, 2001

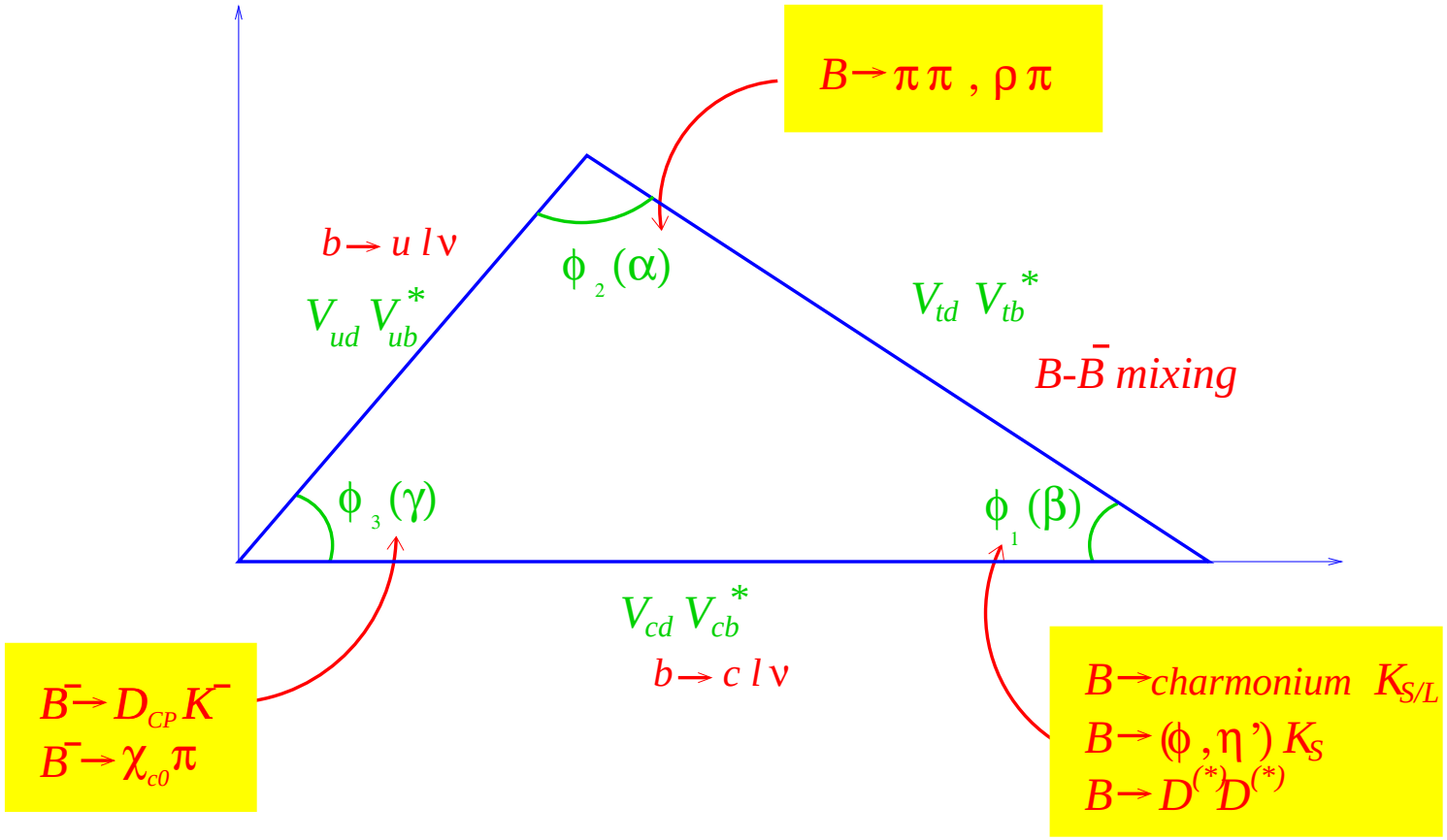
Outline

- **Belle detector and analysis techniques**
- **Physics results :**
  - $D^{(*)\pm}D^{*\mp}$
  - **CKM matrix elements V_{cb}, V_{ub}**
  - **Charmless hadronic decays**
  - $\chi_{c0}K$, ϕK, $D_{CP}K$
  - **Color-suppressed decays**
  - **Penguin decays**
- **Summary/Perspectives**

Physics goals

> 30 contributions papers for summer conferences !

Unitary triangle for B



KEK asymmetric e^+e^- collider

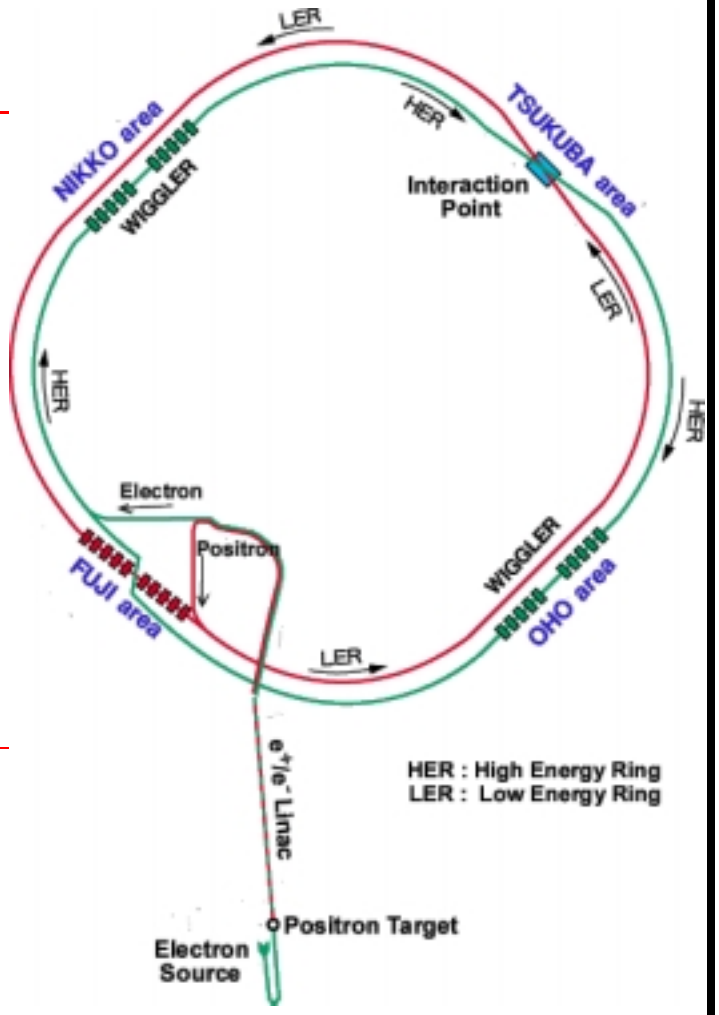
2 separate rings : $e^+(\text{LER}) = 3.5$ GeV
$e^-(\text{HER}) = 8.0$ GeV

$\sqrt{s} = 10.58$ GeV at $\Upsilon(4S)$

± 11 mrad crossing angle (boost $= 0.42$)

Luminosity :
achieved $\sim 4.5 \times 10^{33} cm^{-2} s^{-1}$
target $\sim 10^{34} cm^{-2} s^{-1}$

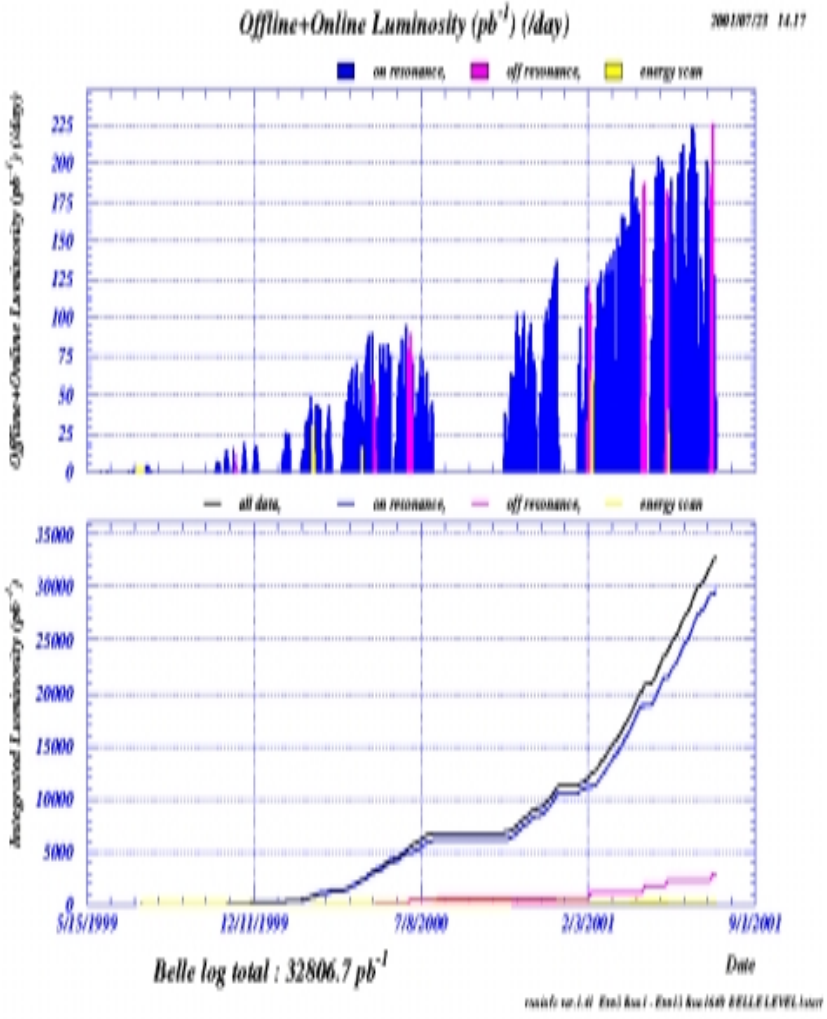
beam sizes : $\sigma_x \sim 100 \mu m$, $\sigma_y \sim 3 \mu m$



KEK-B Performances

World record luminosity :
peak : $4.5 \times 10^{33} cm^{-2} s^{-1}$
229 pb^{-1}/day
$\sim 5 \times 10^6 B\bar{B}$ pairs/month

Integrated lum. : 32.8 fb^{-1}
(on resonance : $\sim 30 fb^{-1}$)



BELLE Detector performances

Tracking part :

Central Drift Chamber(CDC)
(50 layers)

Silicon Vertex Detector(SVD)
(3 silicon layers/double-sided)

Particle identification

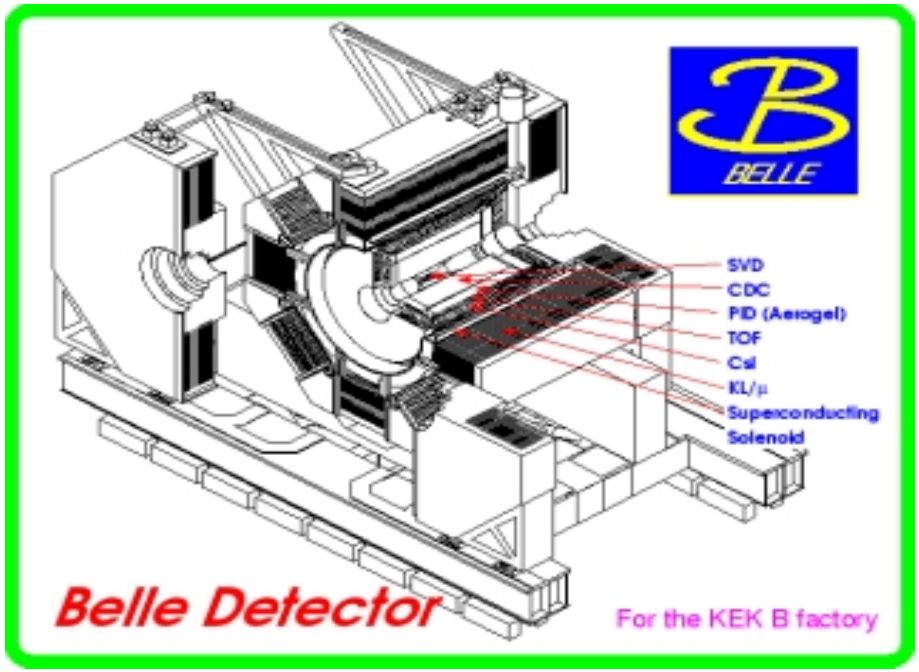
Aerogel Cerenkov Counter

Time of Flight (TOF)

CDC (dE/dx)

Electromagnetic Calorimeter

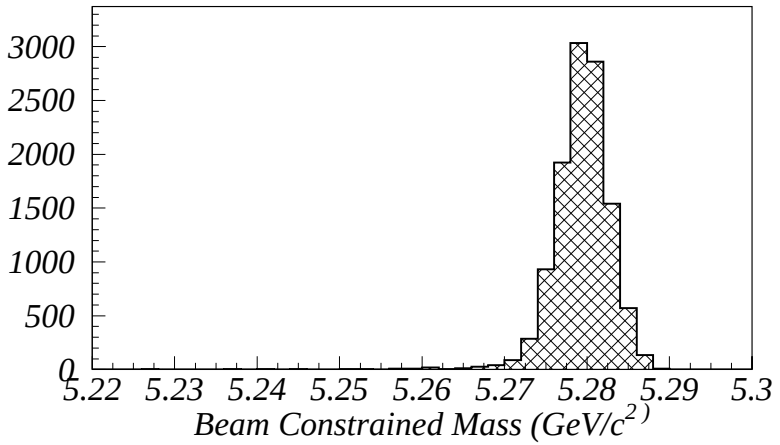
K_L and Muon detector (KLM)



these informations are combined to get one variable
for kaon-pion separation (0<p<4 GeV)

Analysis techniques

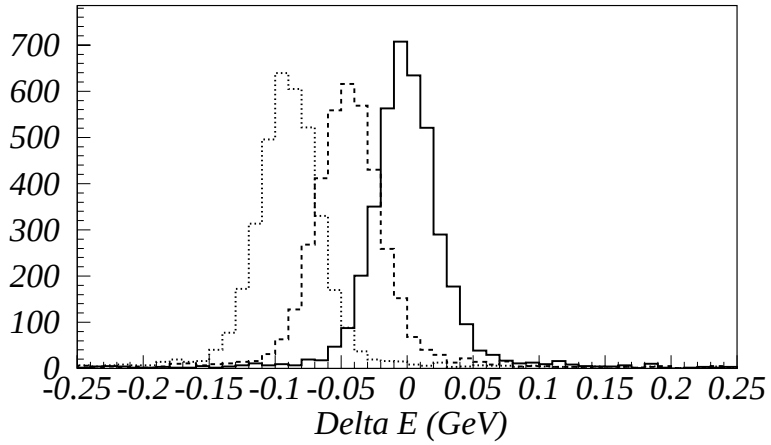
Kinematic variables to isolate B candidates :



Beam energy constrained mass :

$$m_{bc} = \sqrt{E_{beam}^2 - p_B^2}$$

- Resolution determined by E_{beam}.



Energy difference:

$$\Delta E = E_{beam} - E_B$$

- Kinematic separation of K and π.

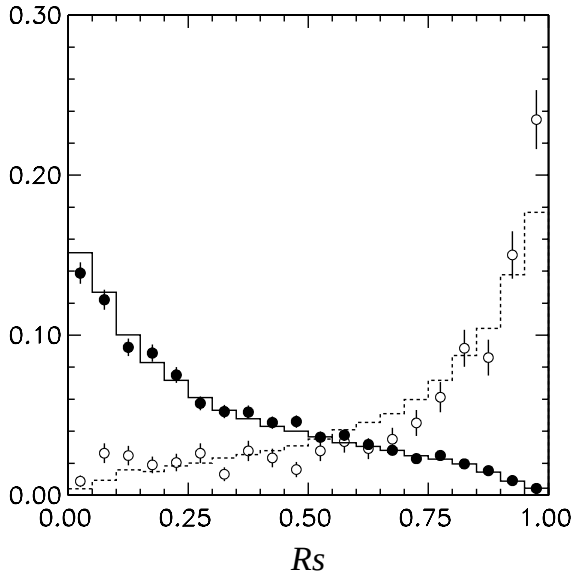
Analysis techniques

Event shape variables $\rightarrow$ reduce the $q\bar{q}$ background

$B\bar{B}$ = spherical
$q\bar{q}$ = jetty
$\Rightarrow$ Super Fox-Wolfram (SFW)
thrust angle
Fisher discriminant

+ other variables (B flight direction, helicity for PV mode ...)
$\Rightarrow$ Form a likelihood ratio of signal versus background

signal efficiency $\sim$ 50%
for a 97% $q\bar{q}$ reduction



- Most of the analysis results are based on $21.3 fb^{-1}$ data sample
- they are preliminary results

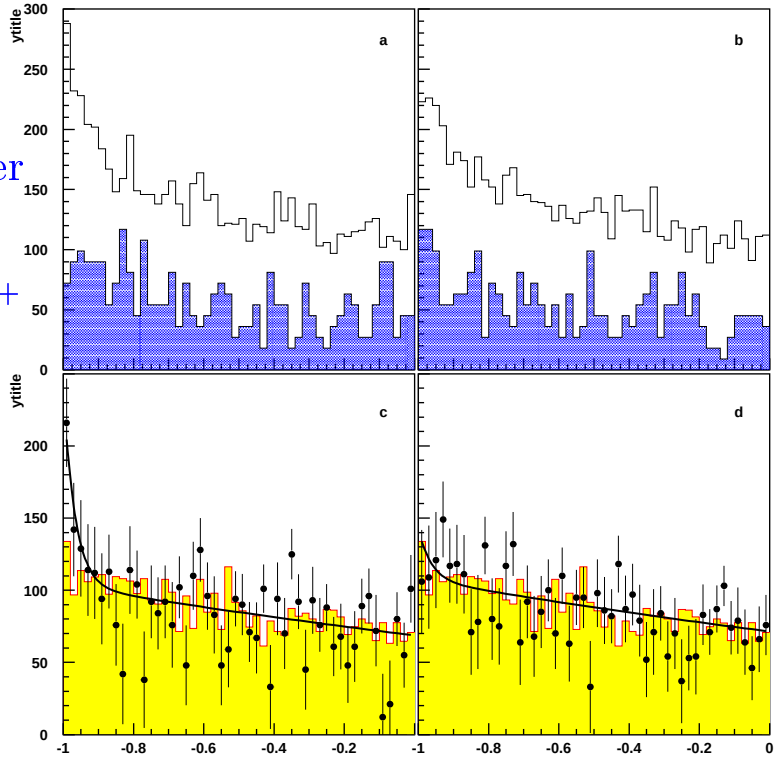
$B \to D^{\pm} D^{*\mp}$ *with* $D^{*\mp}$ *partial reconstruction*

for $\sin 2\phi_1$ measurement (CLEO upper limit 1.26×10^{-3} @ 90% C.L.) :
Method used for $B^0 \to D^{*-} D_s^{(*)+}$, $B^0 \to D^{*-} l^+ \nu$... by ARGUS, CLEO...

- fully reconstructed $D^+ \to K^- \pi^+ \pi^+$
- only the slow pion from the $D^{*+} \to \bar{D}^0 \pi^-$ (increase the number of B mesons by a factor of ten)
- Angle α between slow pion and D^+ meson used as signature

$\Rightarrow$ large background ($c\bar{c}$)

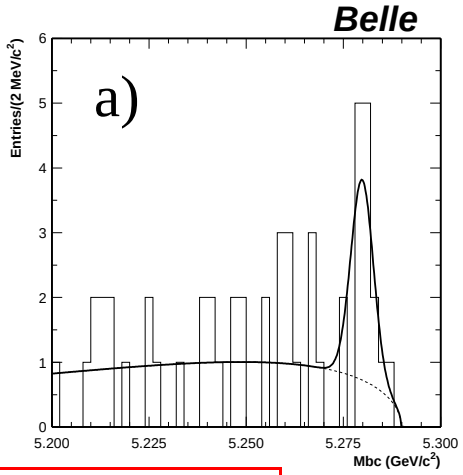
- high mom lepton tag : 35.8 ± 11.3 events
- No high mom lepton tag : 244 ± 87 events



$$\mathcal{B}(B^0 \to D^{\pm} D^{*\mp}) = (1.84 \pm 0.43^{+0.68}_{-0.60}) \times 10^{-3}$$

$B \to D^{(*)} D^{(*)}$ *full reconstruction*

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



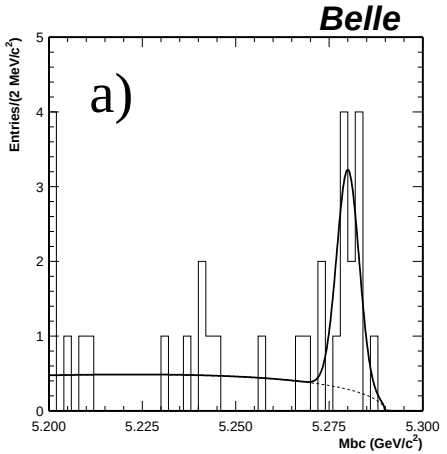
Fit M_{bc} by Gaussian(signal)+ARGUS function :

11.2 ± 4.0 events $(S = 4.1\sigma)$

$(\Delta E$: Gaussian+linear : 10.5 ± 3.7 evts$)$

$$\mathcal{B}(B^0 \to D^{\pm} D^{*\mp}) = (1.04 \pm 0.38 \pm 0.22) \times 10^{-3}$$

- Add $D^0 \to K_S \pi^+ \pi^-$



11.0 ± 3.7 events $(S = 5.0\sigma)$

$(\Delta E : 12.7 \pm 3.9$ evts$)$

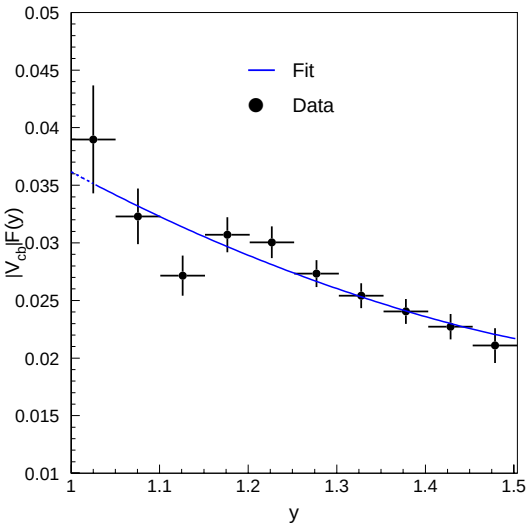
$$\mathcal{B}(B^0 \to D^{*+} D^{*-}) = (1.21 \pm 0.41 \pm 0.27) \times 10^{-3}$$

CKM Matrix elements : $|V_{cb}|$

Precisely measure the values of the CKM matrix elements :

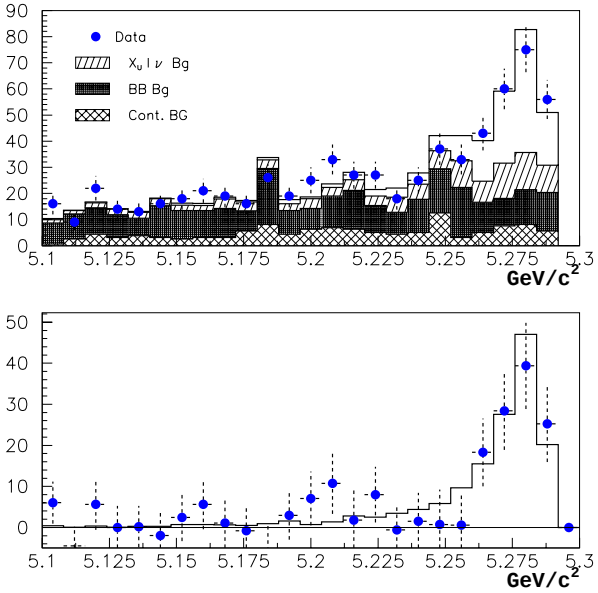
Using exclusive semi-leptonic decay in $\sim 10\ fb^{-1}$, extract $|V_{cb}|$ using HQET, fitting the differential decay rate distribution :

$$\frac{d\Gamma(B \to D^{(*)+} l^- \bar{\nu})}{dy} = \frac{G_F^2}{48\pi^3} M_{D^{(*)+}}^3 (M_B - M_{D^{(*)+}})^2 g(y) |V_{cb}|^2 \mathcal{F}(y)^2$$



- $\mathcal{B}(\bar{B}^0 \to D^{*+} l^- \bar{\nu}) = (4.77 \pm 0.38 \pm 0.40) \times 10^{-2}$
  $\Rightarrow |V_{cb}|\ \mathcal{F}(1) = (3.62 \pm 0.15 \pm 0.18) \times 10^{-2}$
- $\mathcal{B}(\bar{B}^0 \to D^{+} l^- \bar{\nu}) = (2.09 \pm 0.11 \pm 0.31) \times 10^{-2}$
  $\Rightarrow |V_{cb}|\ \mathcal{F}(1) = (3.98 \pm 0.45 \pm 0.45) \times 10^{-2}$

CKM Matrix elements : toward $|V_{ub}|$



$\underline{B^0 \to \pi^- l^+ \nu :}$

$b \to c l \nu$ background :

$|\vec{P}_l| > 1.2$ GeV/c

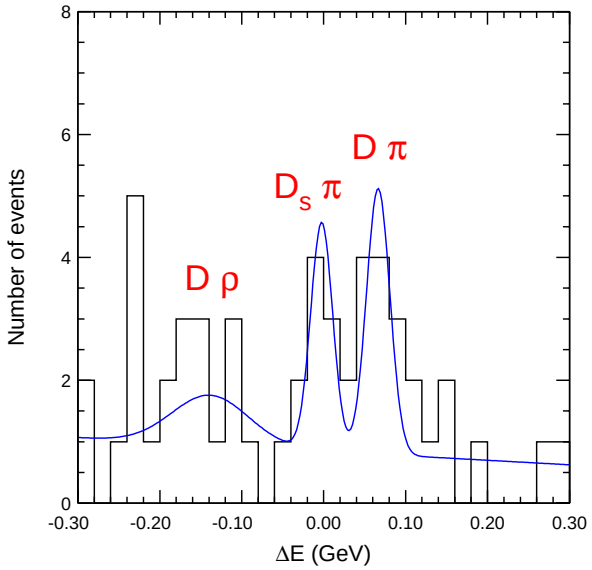
$|\vec{P}_l| + |\vec{P}_\pi| > 1.2$ GeV/c

- extracted signal yield : 107 ± 16 events
- $\mathcal{B}(B^0 \to \pi^- l^+ \nu) = (1.28 \pm 0.20 \pm 0.26) \times 10^{-4}$

$\underline{B^0 \to D_s^+ \pi^- :}$

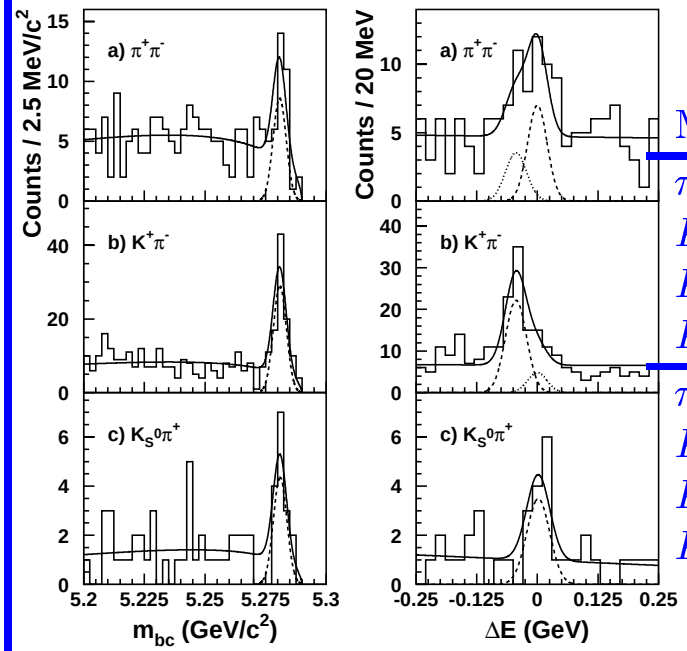
Until now, just a limit 7.5×10^{-5} @ 90% C.L.(CLEO)

- $D_s^+ \to \phi\pi^+, \bar{K}^{*0} K^+, K_S K^+$
- 6.3 ± 3.0 events
- $\mathcal{B}(B^0 \to D_s^+ \pi^-) < 1.1 \times 10^{-4}$



Charmless decays : hh

Charmless hadronic B decays $B \to \pi\pi, K\pi$ and KK :
First step towards CP violation studies ($\pi\pi \to \phi_2$, $K\pi \to \phi_3$)
$\Rightarrow$ measurements of B.F. with $10.4 fb^{-1}$



$b \to c$ background is negligible, mainly $q\bar{q}$

Mode	N_S	S(σ)	$\mathcal{B}(10^{-5})$
$\pi^+\pi^-$	$17.7^{+7.1+0.3}_{-6.4-1.1}$	3.1	$0.56^{+0.23}_{-0.20} \pm 0.04$
$K^+\pi^-$	$60.3^{+10.6+2.7}_{-9.9\ -1.1}$	7.8	$1.93^{+0.34+0.15}_{-0.32-0.06}$
K^+K^-	$0.2^{+3.8}_{-0.2}$		< 0.27
$K^0\pi^0$	$8.4^{+3.8+0.4}_{-3.1-0.6}$	3.9	$1.60^{+0.72+0.25}_{-0.59-0.27}$
$\pi^+\pi^0$	$10.4^{+5.1+1.2}_{-4.3-1.6}$	2.7	< 1.34
$K^+\pi^0$	$34.9^{+7.6+0.6}_{-7.0-2.0}$	7.2	$1.63^{+0.35+0.16}_{-0.33-0.18}$
$K^0\pi^+$	$10.3^{+4.3+0.4}_{-3.6-0.1}$	3.5	$1.37^{+0.57+0.19}_{-0.48-0.18}$
$K^+\bar{K}^0$	$0.0^{+0.9}_{-0.0}$		< 0.50

$\Rightarrow$ Confirm than $\mathcal{B}(B \to K^+\pi^-)$ is larger than $\mathcal{B}(B \to \pi^+\pi^-)$
Other interesting ratios : to extract ϕ_2 ($\mathcal{B}(B^+ \to \pi^+\pi^0/\mathcal{B}(B^0 \to \pi^+\pi^-)$,
to determine the electro-weak penguins contributions
($\mathcal{B}(B^+ \to K^+\pi^0/\mathcal{B}(B^0 \to K^+\pi^-)$...

Charmless hadronic decays : $K\pi$

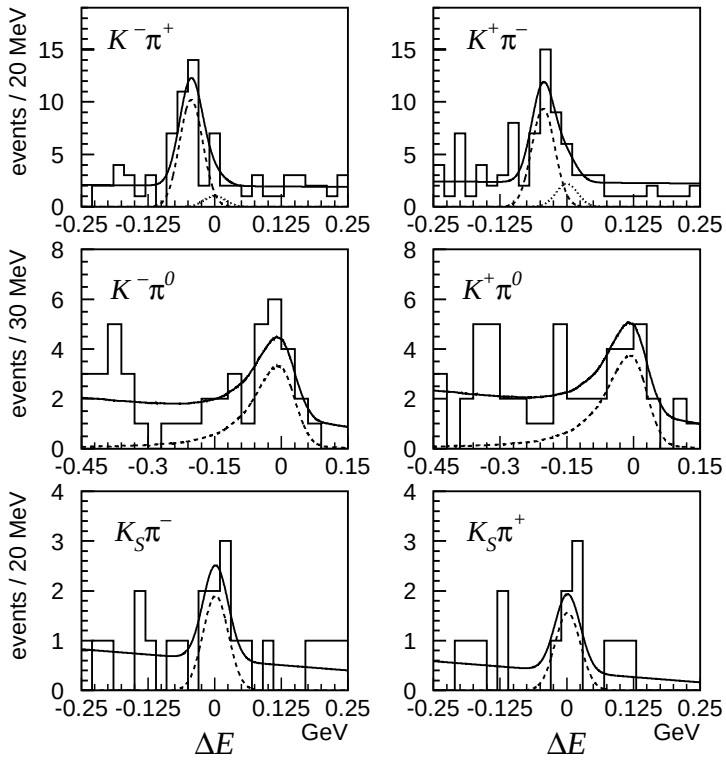
Direct CP violation in $B \to K\pi$

$$\mathcal{A}_{CP} = \frac{N(\bar{B}\to\bar{f}) - N(B\to f)}{N(\bar{B}\to\bar{f}) + N(B\to f)}$$

prediction : $\mathcal{A}_{CP} \sim -0.2$

$\mathcal{A}_{CP}(K^{\pm}\pi^{\mp}) \sim \mathcal{A}_{CP}(K^{\pm}\pi^{0})$
$\to$ increase the statistics

data sample : $10.4 fb^{-1}$



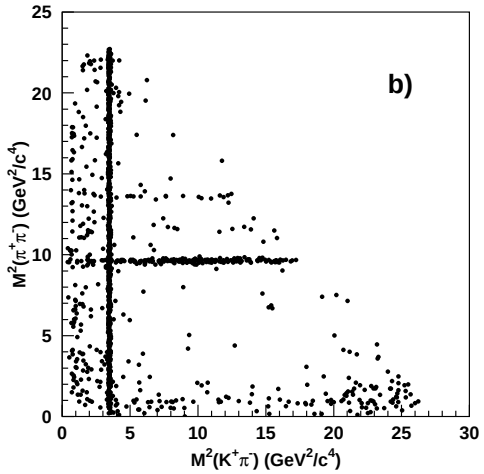
Mode	$N_{\bar{B}}$	N_B	$\mathcal{A}_{CP}$
$K^{\pm}\pi^{\mp}$	$27.7^{+6.8}_{-6.1}$	$25.4^{+7.0}_{-6.3}$	$0.044^{+0.186+0.018}_{-0.167-0.021}$
$K^{\pm}\pi^{0}$	$16.5^{+5.3}_{-4.7}$	$18.6^{+5.7}_{-5.0}$	$-0.059^{+0.222+0.055}_{-0.196-0.017}$
$K^{\pm}(\pi^{\mp}\pi^{0})$			$0.003^{+0.142+0.017}_{-0.126-0.014}$

$$-0.22 < \mathcal{A}_{CP}(K^{\pm}(\pi^{\mp}\pi^{0})) < 0.25 \ @\ 90\%\ \text{C.L.}$$

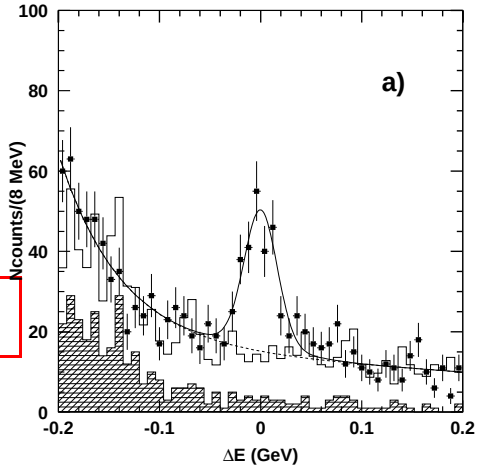
Three-body charmless B decays $K\pi\pi$

$K\pi\pi$ (no assumption on the intermediate mechanisms) :

- Large combinatoric backgrounds
- Large contributions from $B^+ \to \bar{D}^0\pi^+$ ($\bar{D}^0 \to K^+\pi^-$) and $B^+ \to J/\Psi(\Psi')K^+$ (muon-pion misentification)
  (Dalitz plot from the B signal region)
  $\Rightarrow$ veto on invariant masses of two intermediate particles



- Extracted from ΔE fit : (177±20) events

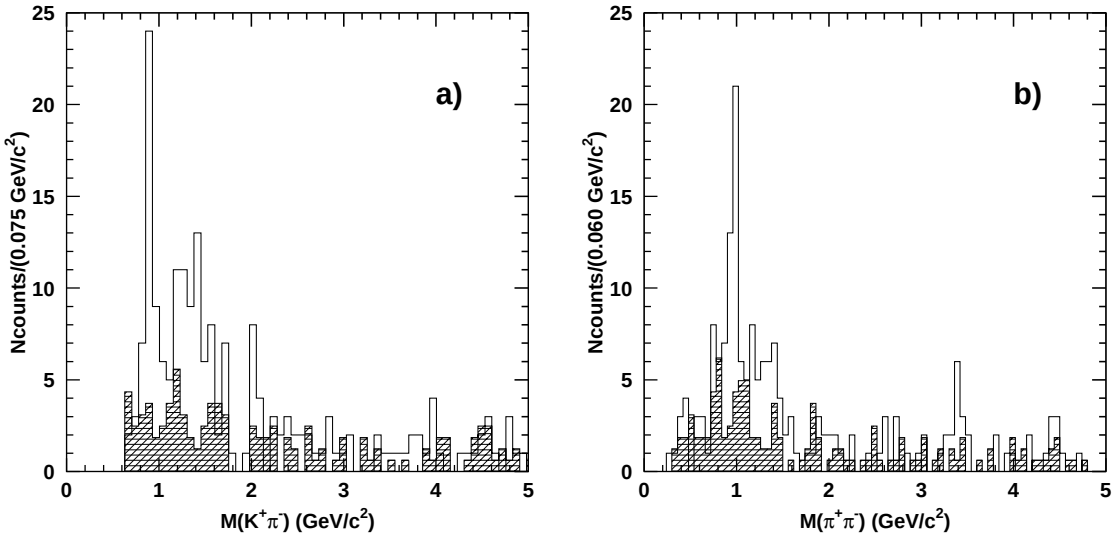


First measurement :

$$\mathcal{B}(B \to K^+\pi^-\pi^+) = (58.5 \pm 7.1 \pm 8.8) \times 10^{-6}$$

Three-body charmless B decays : $K\pi\pi$

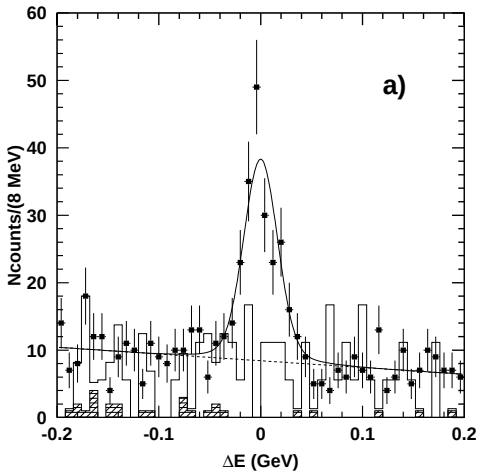
(a) $K^+\pi^-$ (narrow peak around 0.9 GeV/c^2 = $K^{*0}(892)$)
(b) $\pi^+\pi^-$ (slightly below 1 GeV/c^2 = $f_0(980)$)

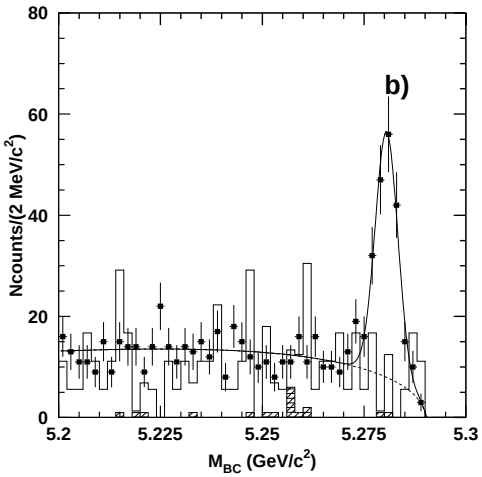


Mode	N_S	S(σ)	$\mathcal{B}(10^{-6})$
$K^*(892)^0\pi^+$	$38.5^{+8.5}_{-7.9}$	6.2	$11.1^{+2.5}_{-2.3} \pm 1.4^{+2.0}_{-3.9}$
$f_0(980)K^+$	$40.9^{+8.8}_{-9.6}$	6.0	$11.7^{+2.5}_{-2.7} \pm 1.5^{+4.1}_{-1.0}$

Similar analysis made for $B \to K\pi\pi^0$:
(105 ± 24) events $(S = 4.8\sigma)$

Three-body charmless B decays : KKK

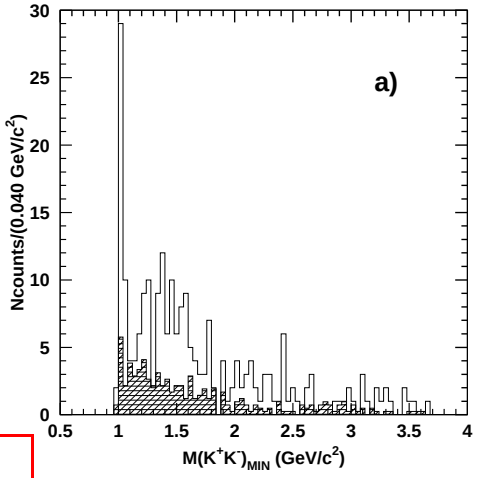




For KKK, similar analysis but looser cuts on PID to maintain high efficiency

Exclude : $B^+ \to \bar{D}^0 h^+ (\bar{D}^0 \to K^+\pi^-)$
$B^+ \to D_{CP} h^+ (D_{CP} \to K^+K^-)$

- Extracted from ΔE fit : (162±16) events
- narrow peak at 1.02 GeV/c^2 ($\phi(1020)$)

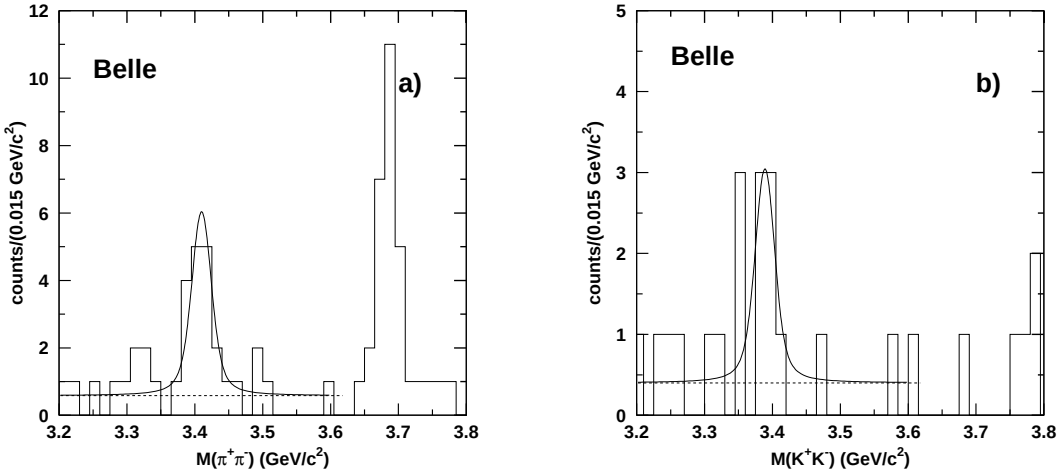


$$\mathcal{B}(B \to K^+K^-K^+) = (37.0 \pm 3.9 \pm 4.4) \times 10^{-6}$$

$\chi_{c0}K$

Until now, limits found for B.F. of $B^+ \to \chi_{c0}K^+$ (CLEO : $< 4.8 \times 10^{-4}$)
Require $M_{K^+\pi^-}$ ($M_{K^+K^-}$) > 2 GeV/c^2 : suppress $\bar{D}^0$, $K^{*0}(892)$ ($\phi(1020)$)

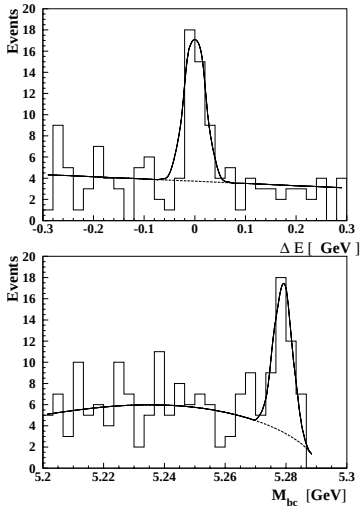
χ_{c0} submode	N_S	S(σ)
$\pi^+\pi^-$	$15.5^{+5.3}_{-4.6}$	4.8
$K+K^-$	$15.5^{+5.3}_{-4.6}$	3.2



First observation.
Gives B.F. with $\chi_{c0} \to \pi^+\pi^-$

$$\mathcal{B} = (8.0^{+2.7}_{-2.4} \pm 1.0 \pm 1.1) \times 10^{-4}$$

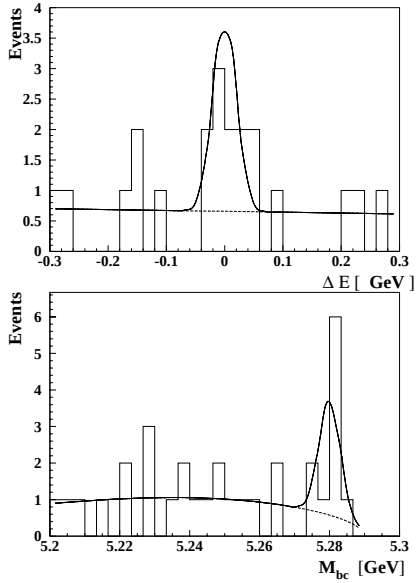
$B \to \phi K^{(*)}$



- $b \to s s \bar{s}$ (penguin and box diagrams)
- V_{ts}, non-SM particles
- direct CP violation

Mode	N_S	S(σ)	$\mathcal{B}(10^{-5})$
ϕK^+	$36.1^{+7.2}_{-6.5}$	8.5	$1.12^{+0.22}_{-0.20} \pm 0.14$
ϕK_S	$8.0^{+3.5}_{-2.8}$	4.2	$0.89^{+0.34}_{-0.27} \pm 0.10$
ϕK^{*0}	$7.5^{+3.7}_{-3.0}$	3.6	$1.30^{+0.64}_{-0.52} \pm 0.21$

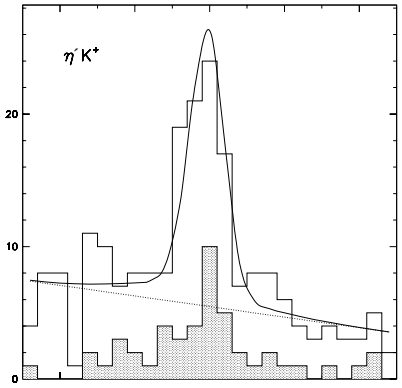
$\phi K_S \to$ measurement of $\sin\phi_1$ (presence of new CP violating phases)
No significant signal in ϕK^{*+}



$B \to \eta K^*, \eta' K$

Large B.F. reported by CLEO : $\mathcal{B}\ (B \to \eta' K^+) = (80 \pm 12) \times 10^{-6}$

- $B^+ \to \eta' K^+$ where $\eta' \to \eta\pi^+\pi^-,\ \rho^0\gamma$
- $79.9^{+12}_{-11} \pm 9$ events $(12\ \sigma)$ using $10.4 fb^{-1}$

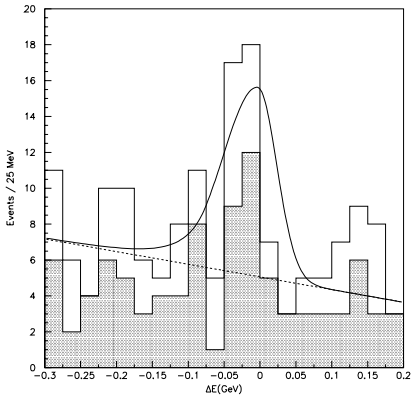


$\mathcal{B}(B^+ \to \eta' K^+) = (79^{+12}_{-11} \pm 9.0) \times 10^{-6}$

$$A_{CP} = +0.06 \pm 0.15 \pm 0.01 \to -0.20 < A_{CP} < 0.32 \ @\ 90\%\ \text{C.L.}$$

$(B \to \eta' K_S) = (55^{+19}_{-16} \pm 8) \times 10^{-6}$ (S $= 5.4\ \sigma$) $\to$ measurement of $\sin\phi_1$

- $B^0 \to \eta K^{*0}$ where $\eta \to \gamma\gamma$
- $13.9^{+5.6}_{-4.7}$ events (S $= 4.4\ \sigma$)



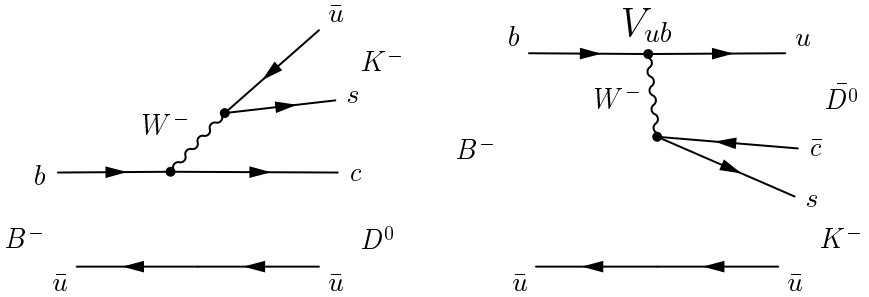
$\mathcal{B}(B^0 \to \eta K^{*0}) = (21.2^{+5.4}_{-4.7} \pm 2.0) \times 10^{-6}$

Direct CP violation in $B^- \to D_{CP} K^-$

Angle ϕ_3 can be determined from $B^- \to DK^-$ using the interference between $b \to c$ and $b \to u$ processes.

- B.F. $(D \to CP) \sim 1\%$
- CP violation through interference expected to be small

$\Rightarrow$ large number of B^- mesons are needed



Assuming $D^0 - \bar{D}^0$ mixing, observables for ϕ_3 extraction :

$$A_{1,2} = \frac{\mathcal{B}(B^- \to D_1 K^-) - \mathcal{B}(B^+ \to D_1 K^+)}{\mathcal{B}(B^- \to D_1 K^-) + \mathcal{B}(B^+ \to D_1 K^+)} = \frac{2r \sin\delta' \sin\phi_3}{1 + r^2 + 2r \cos\delta' \cos\phi_3}$$

D_1 is CP $= +$ eigenstate, $\delta' = \delta$ (D_2 is CP $=$ -1, $\delta' = \delta + \pi$)

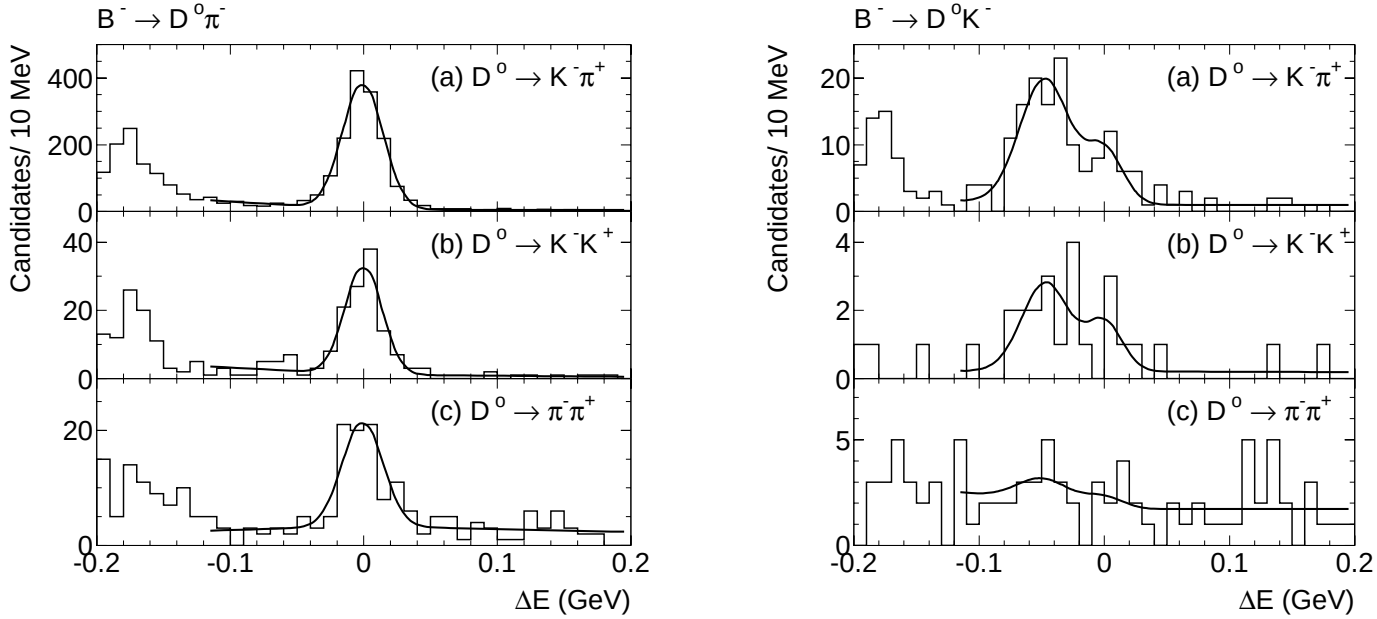
To reduce systematics from D, prompt hadron reconstruction :

$$R_{1,2} = \frac{\frac{\mathcal{B}(B^- \to D_1 K^-) + \mathcal{B}(B^+ \to D_1 K^+)}{\mathcal{B}(B^- \to D_1 \pi^-) + \mathcal{B}(B^+ \to D_1 \pi^+)}}{\frac{\mathcal{B}(B^- \to D^0 K^-) + \mathcal{B}(B^+ \to \bar{D}^0 K^+)}{\mathcal{B}(B^- \to D^0 \pi^-) + \mathcal{B}(B^+ \to \bar{D}^0 \pi^+)}} = \frac{R_{CP}}{R_{non-CP}} = 1 + r^2 + 2r \cos\delta' \cos\phi_3$$

Direct CP violation in $B^- \to D_{CP}K^-$

Search for $B^- \to DK^-$, with D^0 meson decays into the specific state, $K^-\pi^+$, or into CP $= +1$ eigenstate, K^-K^+, $\pi^-\pi^+$

$$R_{non-CP} = 0.077 \pm 0.009 \pm 0.006 \text{ (hep-ex/0104051)}$$



First observation of $B^- \to D^0(\to K^-K^+)K^-$: 12.3 ± 3.9 events (S=4.3σ) by combining $D \to K^+K^-$, $\pi^+\pi^-$ (~ 17 events) :

$$A_1 = 0.04^{+0.40}_{-0.35} \pm 0.15, \quad (-0.78 < A_1 < 0.94 \text{ @ } 90\% \text{ C.L.})$$

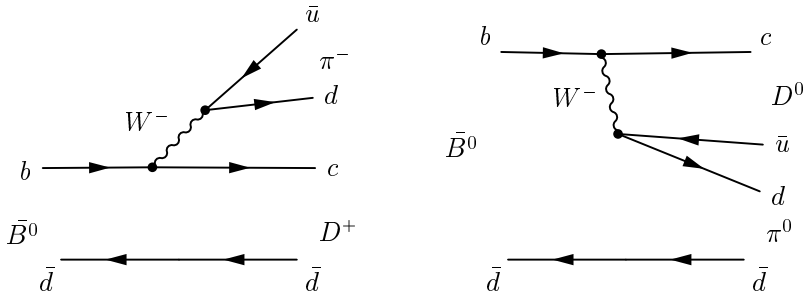
$$R_1 = 1.39 \pm 0.53 \pm 0.26$$

Color-Suppressed decays

$\bar{B}^0 \to D^{(*)0} X^0$ where X^0 is a light neutral meson : π^0, η, ω

proceeds via an internal spectator diagram :

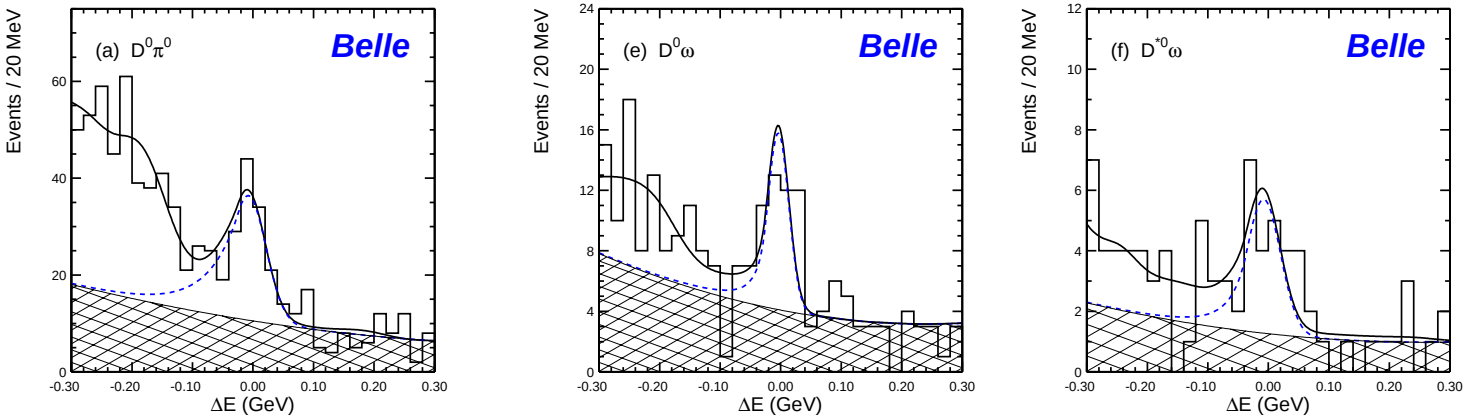
- test models of hadronic B meson decays
- provide information on final-state interaction



$\Rightarrow$ Theory predictions $\sim (0.5 - 1.7) \times 10^{-4}$ (Neubert, Stech)
$\Rightarrow$ previous results (CLEO) for these color-suppressed $\bar{B}^0 \to D^{(*)0} X^0$ decays provided upper limits.

Color-Suppressed decays

using $D0 \to K^-\pi^+, K^-\pi^+\pi^-, K^-\pi^+\pi^-\pi^+$, $D^{*0} \to D^0\pi^0$

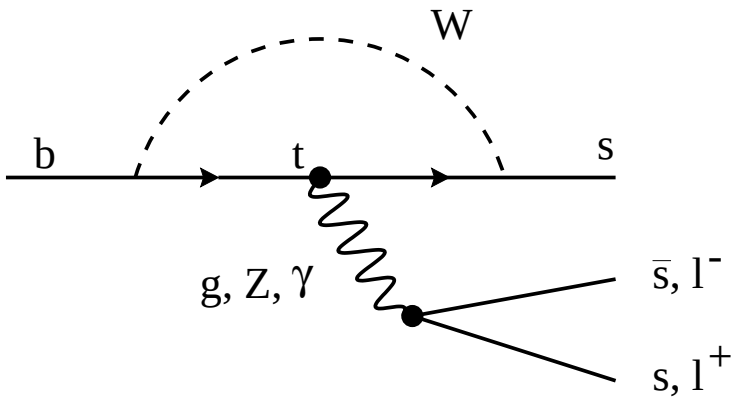


$\Rightarrow$ First observation for $\bar{B}^0 \to D^0\pi^0,\ D^0\omega,\ D^{*0}\omega$

- $\mathcal{B}(\bar{B}^0 \to D^0\pi^0) = (2.9^{+0.4}_{-0.3} \pm 0.6) \times 10^{-4}$: 128±18 events (S=7.9σ)
- $\mathcal{B}(\bar{B}^0 \to D^0\omega) = (1.7^{+0.5+0.3}_{-0.6-0.4}) \times 10^{-4}$: 30.2±8.6 events (S=4.7σ)
- $\mathcal{B}(\bar{B}^0 \to D^{*0}\omega) = (3.4^{+1.3}_{-1.1} \pm 0.8) \times 10^{-4}$: 17.7±6.5 events (S=4.3σ)

Evidence for other channels : $D^{*0}\pi^0(3.2\sigma),\ D^0\eta(3.8\sigma),\ D^{*0}\eta(3.6\sigma)$

Penguin decays

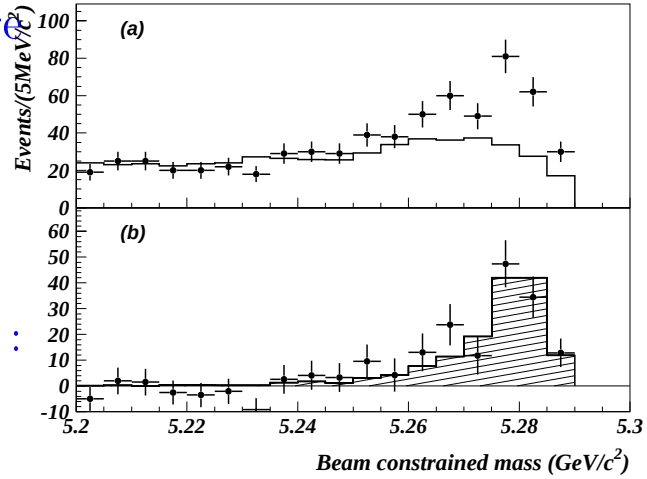


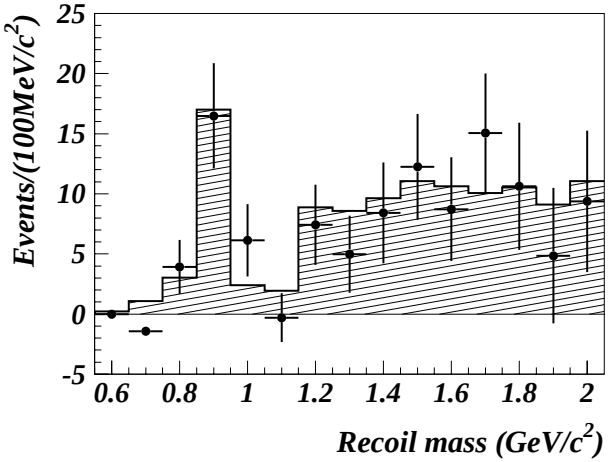
- possible contributions from the non-SM particles (Higgs, SUSY particles)
- ideal place to look for new physics

Inclusive $B \to X_S\gamma$:

- primary photon in barrel (veto π^0, η)
- X_S : a kaon (charged or K_S) and multiple pions (0-4 with a possible π^0)
- 5.8 fb^{-1} on resonance, 0.6 fb^{-1} off resonance (60 MeV below $\Upsilon(4S)$)

- $q\bar{q}$ continuum after topological cuts are applied :
  (0.7±0.2) events in signal region
- $b \to c$ decays ($B \to D^{(*)}\rho$) :
  (9.1 ± 1.8) events
- signal yield from the M_{bc} distribution :
  (106.5 ± 16.8) events





$\mathcal{B}(B \to X_S\gamma) =$
$(3.36 \pm 0.53 \pm 0.42\ ^{+0.50}_{-0.54}) \times 10^{-4}$
(SM prediction : $(3.28 \pm 0.33) \times 10^{-4}$)

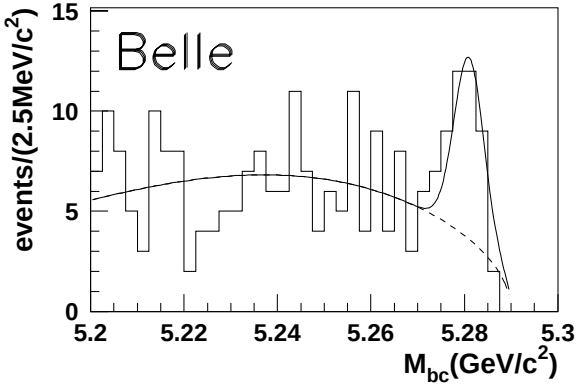
Exclusive : $\mathcal{B}(B \to K^{*0}\gamma) = (4.96 \pm 0.67 \pm 0.45) \times 10^{-5}$
$\mathcal{B}(B \to K^{*+}\gamma) = (3.89 \pm 0.93 \pm 0.41) \times 10^{-5}$ $\sim 15\%\ b \to s\gamma$

Exclusive $B \to K^{(*)}\gamma$

Look for higher kaonic resonances : X_S will be reconstructed in the two-body $K^+\pi^-$ and the three-body $K^+\pi^-\pi^+$ final state

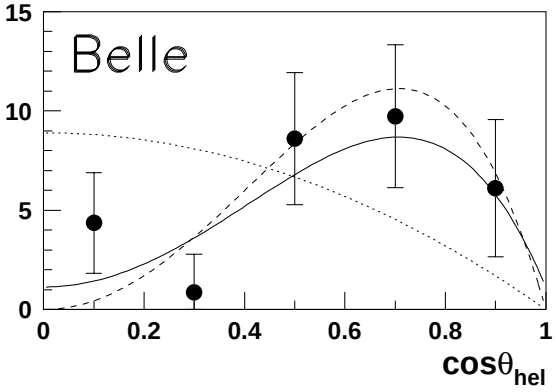
$B^0 \to K_2^*(1430)^0\gamma$, $K_2^*(1430)^0 \to K^+\pi^-$

- $29 \pm 6.7^{+2.4}_{-1.9}$ events
- consistent with the yield in ΔE



The helicity angle distribution ($\cos\theta_{hel}$) is then used to distinguish the signal ($\cos^2\theta_{hel} - \cos^4\theta_{hel}$) from $B \to K^*(1410)\gamma$ (1 - $\cos^2\theta_{hel}$) and non-resonant decays (uniform) :

- 20.1 ± 10.5 events
- $\mathcal{B}(B^0 \to K_2^*(1430)^0\gamma) =$ $(1.26 \pm 0.66 \pm 0.10) \times 10^{-5}$

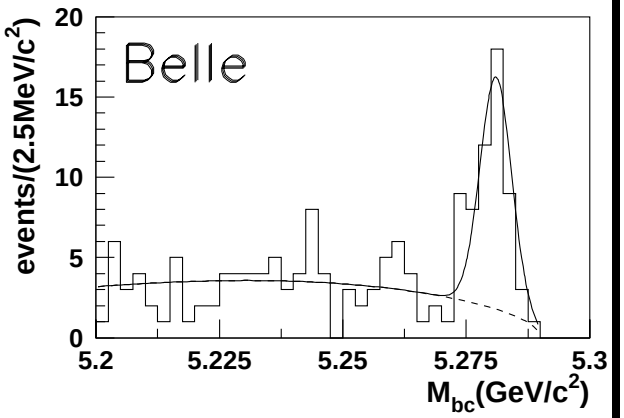


Exclusive $B \to K\pi\pi\gamma$

First observation for $B \to K^*\pi\gamma$ and $K\rho\gamma$ separately :

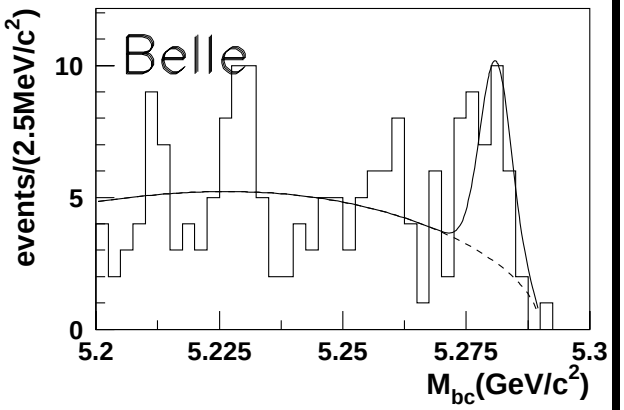
- $46.4 \pm 7.3^{+1.6}_{-2.7}$ events
- Substract the $B \to K\rho\gamma$ and $B \to K\pi\pi\gamma$ contributions $\to 40.7 \pm 7.6^{+1.8}_{-2.7}$

$$\mathcal{B}(B^+ \to K^*(892)^0\pi^+\gamma;\ M_{K^*\pi} < 2.0\ \mathrm{GeV/c^2}) = (5.6 \pm 1.1 \pm 0.9) \times 10^{-5}$$



- $24.5 \pm 6.4^{+1.2}_{-2.3}$ events

$$\mathcal{B}(B^+ \to K^+\rho^0\gamma;\ M_{K\rho} < 2.0\ \mathrm{GeV/c^2}) = (6.5 \pm 1.7^{+1.1}_{-1.2}) \times 10^{-5}$$



$\Rightarrow$ Sum of all exclusive modes $\sim$ half of $b \to s\gamma$

Search for $B \to X_S l^+ l^-$

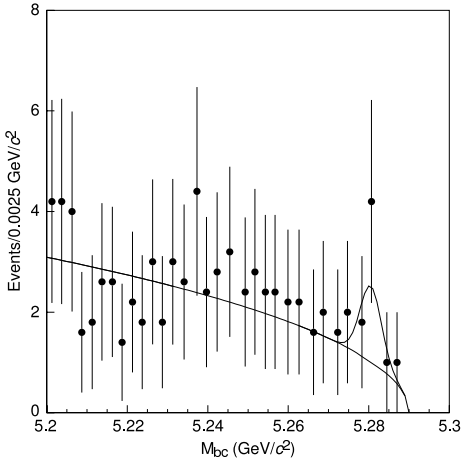
Inclusive decay :

- SM prediction (Ali *et al*) :
  $\mathcal{B}(X_S e^+ e^-) = (8.4 \pm 2.3) \times 10^{-6}$ $\mathcal{B}(X_S \mu^+ \mu^-) = (5.7 \pm 1.2) \times 10^{-6}$
- No evidence so far

Main differences in the analysis :

- the γ search is replaced by two leptons
- veto on J/Ψ and $\Psi^{'}$ for $l^+ l^-$
- signal yield fit to M_{bc} distribution

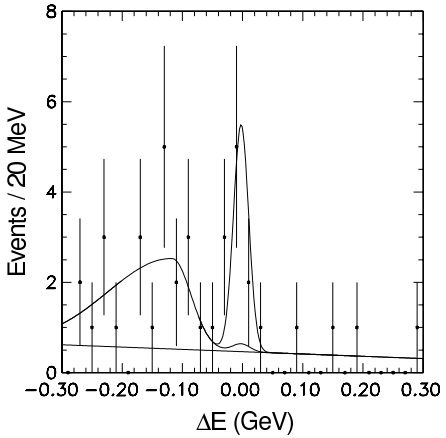
Mode	N_S	S(σ)	limit (10^{-6})
$X_S e^+ e^-$	$3.0^{+4.9}_{-4.3}$		10.1
$X_S \mu^+ \mu^-$	$11.4^{+5.1}_{-4.8}$	2.7	19.1

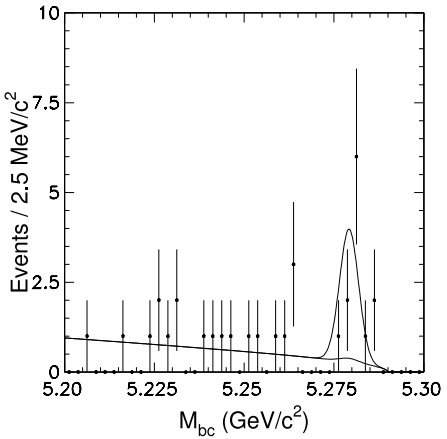


Exclusive $K^{(*)}l^+l^-$

For exclusive case, only upper limit were reported (Babar, Belle, CDF and CLEO)

- K candidates : K^+ and K_S,
  K^* : $K^+\pi^-$, $K_S\pi^0$, $K_S\pi^+$ or $K^+\pi^0$
- $B^0 \to K_S\mu^+\mu^-$: S=2.6 σ
- $B^+ \to K^+\mu^+\mu^-$: S=4.1 σ





combined result : $9.53^{+3.74}_{-3.06}$ events (4.8 σ)

$$\mathcal{B}\,(B \to K\mu^+\mu^-) = (0.99^{+0.39+0.13}_{-0.32-0.15}) \times 10^{-6}$$

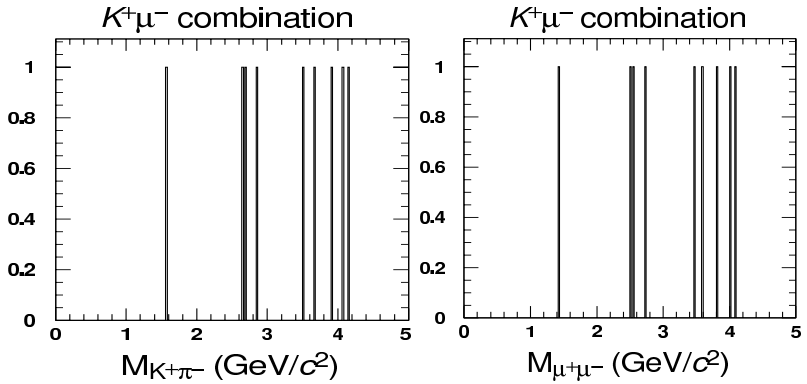
(ΔE fit yield gives a consistent $7.8^{+3.50}_{-2.84}$ events)

Further background studies for $K\mu^+\mu^-$

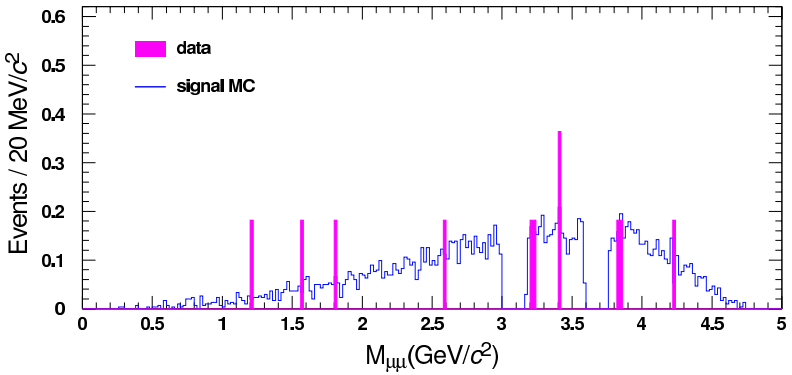
Potential source of backgrounds $B \to Kh^+h^-$ ($h^\pm$ refers to hadron) :

- $B^+ \to \bar{D}^0\pi^+$, $\bar{D}^0 \to K^+\pi^-$ (both pions misentified as muons) :
  $\Rightarrow$ 300 fb^{-1} MC sample : 0.2 events
  $\Rightarrow$ data (Kh^+h^- combinations weighted by the measured misidentification probability) : 0.3 events

$B^+ \to J/\Psi K^+$, $J/\Psi \to \mu^+\mu^-$
double misidentification ($K^+ \to \mu^+$, $\mu^+ \to K^+$)
no event in the D^0 or J/Ψ mass region



$B \to J/\Psi X \sim 0.1$ events (220 fb^{-1})



$\Rightarrow$ No indication of background peaking in M_{bc}

Conclusion

Summary :

- $\sin 2\phi_1$: $D^{*+}D^{(*)-}$, $\eta^{'}K_S$, ϕK_S...
- Hadronic charmless decays : observed in two and three-body decays
- Large B.F. for $\eta^{(')}K$
- Observation of $D_{CP}K^-$: first step toward ϕ_3 measurements
- New observations on color-suppressed modes
- Exclusive $b \to s\gamma$: $K^{*0}\pi^+\gamma$, $K^+\rho^0\gamma$
- Evidence for $K\mu^+\mu^-$

Perspectives :

- Higher luminosity : $4.5 \times 10^{33} cm^{-2}s^{-1} \to 10^{34} cm^{-2}s^{-1}$(expected)
  $\to$ more data
- Upgrade of silicon vertex detector (summer 2002) :
  4 layers and $r_{beampipe} = 2$ cm $\to 1.5$ cm