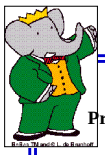
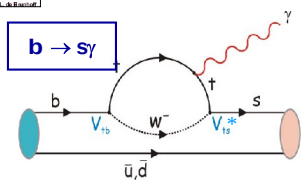
Flavour Changing Neutral Current B decays @ BaBar



Physics Interest

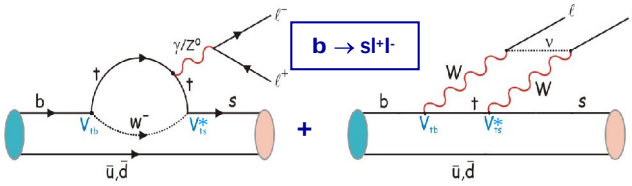
Processes involving Flavour Changing Neutral Currents are forbidden at tree level in the Standard Model: *they are generated at leading order by penguin diagrams*

b → sγ



Sensitivity to New Physics:
new heavy particles entering the loop could change Br and A_{CP} with respect to the SM

b → sl⁺l⁻



Theoretical predictions are more precise for inclusive modes than exclusive, due to hadronic uncertainties in the latter, however they are more challenging experimentally

b → sγ

SM direct CP asymmetry prediction: A_{CP} <1%

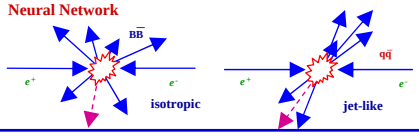
➢Photon selection:
High energetic isolated cluster in the Calorimeter
Shape consistent with photon hypothesis
π^0 and η veto

➢B Reconstruction
B-candidates are peaked strongly in 2 kinematic variables:

$m_{ES} = \sqrt{(E_{beam}^2 - P_B^2)}$ $\quad \Delta E = E_B^* - E_{beam}^*$

where E_{beam} is the beam energy in the CMS frame, E_b and P_b are the energy and momentum of the *B*-candidate's daughters

➢Continuum rejection: topological variables combined in Neural Network

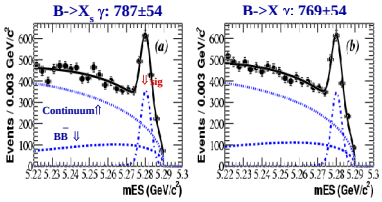


B→X_sγ: direct CP asymmetry

81.9 fb⁻¹

➢Reconstruct X_s as K^+ or $K_s(K_s \to \pi^+\pi^-)$ +1-3 π(up to 1 π^0): 0.6 GeV < M_{Xs} < 2.3 GeV

➢Signal yield extracted from an m_{ES} fit

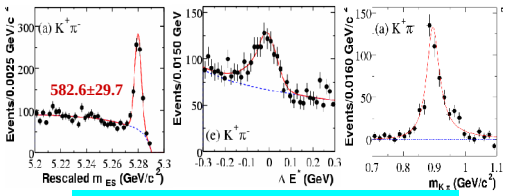


$A_{CP} = 0.025 \pm 0.050(stat) \pm 0.015(syst)$

B→K*γ: direct CP asymmetry

➢Reconstruct: $K_s \to \pi^+\pi^-$, $K^{*+} \to K^+\pi^0$, $K_S\pi^+$, $K^{*0} \to K^+\pi^-$, $K_S\pi^0$ (non self-tagging mode: used only for Isospin & Br measurement)

➢Signal extracted from a multi-dimensional fit to ΔE & m_{ES}



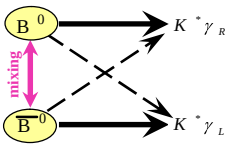
$A_{CP} = -0.013 \pm 0.036(stat) \pm 0.010(syst)$

B→K*γ(K*⁰→$K_S\pi^0$): time- dependent CP asymmetry

113.1 fb⁻¹

➢Final state $K_S\pi^0\gamma$ accessible to both B and B̄

➢In the limit of massless s quarks, photons are completely polarized with opposite helicities for B and B̄



Helicity Flip Suppressed by ~ m_s/m_b

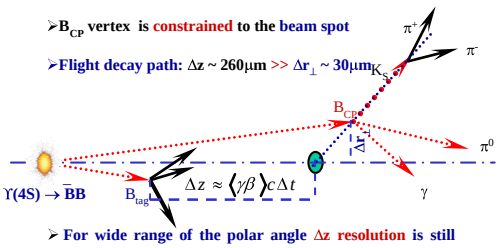
$$A_{CP}(t) = \frac{\Gamma(\overline{B}(t) \to K_S\pi^0\gamma) - \Gamma(B(t) \to K_S\pi^0\gamma)}{\Gamma(\overline{B}(t) \to K_S\pi^0\gamma) + \Gamma(B(t) \to K_S\pi^0\gamma)} = S\sin(\Delta mt) - C\cos(\Delta mt)$$

SM predictions: $S_{K^*\gamma} \approx 2\frac{m_s}{m_b}\sin(2\beta) \approx 0.05$ $\quad |C|<1\%$

Vertex Reconstruction

➢B_{CP} vertex is constrained to the beam spot

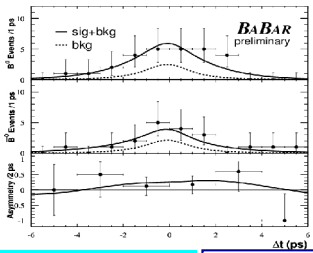
➢Flight decay path: Δz ~ 260μm >> $\Delta r_\perp$ ~ 30μm



➢ For wide range of the polar angle Δz resolution is still dominated by the uncertainty on the B_{tag} decay vertex position σ(z_{tag})~180mm.

113.1 fb⁻¹

➢Signal extracted from a multi-dimensional fit to m_{ES}, ΔE, K* mass, Fisher, flavour tag & time structure variables



$S_{K^*\gamma} = 0.25 \pm 0.63 \pm 0.14$
$C_{K^*\gamma} = -0.56 \pm 0.32 \pm 0.09$

First time dependent CP measurement in b→sγ

b → sl⁺l⁻

B→K(*)l⁺l⁻

113.1 fb⁻¹

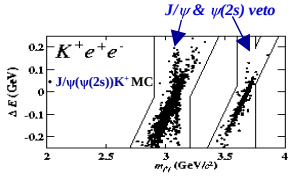
➢The branching fraction for B→Kl⁺l⁻ (B→K*l⁺l⁻) is predicted to be around 0.5×10^{-6} (1.5×10^{-6}) with an accuracy of 35%

➢Reconstruct K^+, $K_s \to \pi^+\pi^-$, $K^{*0} \to K^+\pi^-$, $K^{*+} \to K_s\pi^+$, l=e,μ

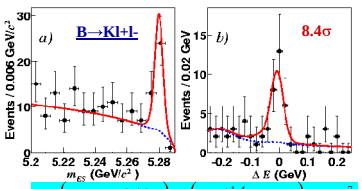
Background

- Non-peaking background arises from random combinations of particles from *BB* and *qq* events
- Peaking background in m_{ES} and Δ*E* arises from:

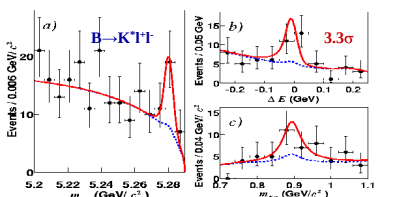
1)B→J/ψ(ψ(2s))K(*)
2)B→K*γ followed by photon conversion
3)Hadronic *B*-decays in which a $\pi^+\pi^-$ pair is identified as a $\mu^+\mu^-$ pair



➢Signal yield extracted from an unbinned maximum likelihood fit to m_{ES} and ΔE (m_{ES}, ΔE and m_{K^*}) for B→Kl⁺l⁻ (B→K*l⁺l⁻)



$Br(B \to Kl^+l^-) = (6.5^{+1.4}_{-1.3} \pm 0.4) \times 10^{-7}$



$Br(B \to K^*l^+l^-) = (8.8^{+3.3}_{-2.9} \pm 1.0) \times 10^{-7}$

B→X_Sl⁺l⁻

81.9 fb⁻¹

➢The inclusive branching fraction for B→X_sl⁺l⁻, where *l* is either an *e* or μ, is predicted to be $(4.2\pm0.7)\times10^{-6}$ for m_{ll}>0.2 GeV/c^2

➢Background similar to B → K(*)l⁺l⁻ but more severe

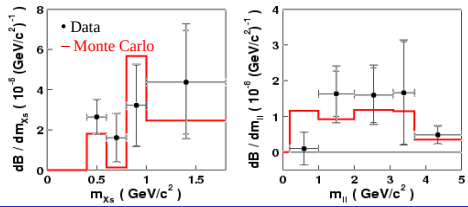
➢Reconstruct X_S as (K^+,K_S) +0-2 π (up to 1 π^0): 70% of total rate

➢Yield from m_{ES} fit: 40±10(stat)±2(syst) events for M_{ll}>0.2GeV/c^2

$Br(B \to X_s l^+l^-) = (5.6 \pm 1.5(stat) \pm 0.6(\exp syst) \pm 1.1(\mathrm{mod}\, syst)) \times 10^{-6}$

➢Dominant systematic uncertainties from theoretical exclusive *Br* predictions and Fermi motion model used for the *b*-quark in the meson

➢Differential distributions very sensitive to New Physics: no discrepancy observed but more statistics needed



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