SLAC–PUB–10703
September 2004
hep-ex/0409022

Flavour Changing Neutral Current B Decays at BaBar*

Fabio Bellini
Università degli Studi di Roma "La Sapienza"
Piazzale A. MOro 5 Rome, 00185 Italy

and

Stanford Linear Accelerator Center
Stanford University
Stanford, CA 94309 USA

On behalf of BaBar Collaboration

Submitted to the 24th International Conference On Physics In Collision (PIC 2004)
27-29 Jun 2004, Boston, Massachusetts

*Work supported by Department of Energy contract DE-AC02-76SF00515.

XXIV Physics in Collision - Boston, June 27-29, 2004

FLAVOUR CHANGING NEUTRAL CURRENT B DECAYS AT BABAR

Fabio Bellini
Università degli Studi di Roma "La Sapienza", Piazzale A. Moro 5 Rome, 00185

ABSTRACT

Recent BaBar results on rare B decays involving flavour-changing neutral currents are presented. New measurements of the CP asymmetries in $b \to s\gamma$ decays are reported as well as $b \to sl^+l^-$ branching ratio measurements[1].

1 Introduction

Since the first measurement of the exclusive $B \to K^*\gamma$ decay rate by CLEO [1], rare B decays involving flavour changing neutral current have been a unique probe to search for new physics. In the Standard Model (SM), the lowest order diagram for the $b \to s\gamma$ decay is a loop (radiative penguin) diagram of top quark and W boson. In principle, new particles such as charged Higgs or SUSY partners can form the same loop diagram and may modify the SM amplitude. A comparison between the measured rate and the SM prediction has provided a stringent constraint on such new particles. The inclusive decay is to date accurately calculated up to the next-to-leading order QCD corrections [2] and several measurements have already been performed. On the contrary, exclusive measurements, do not give a further constraint to new physics because of the large uncertainties in the form factors

[1]Charge conjugate modes will be assumed throughout this text

Table 1: *A_{CP} measurements in $b \to s\gamma$. Errors are statistics and systematics respectively.*

	$B \to K^*\gamma$	$B \to X_s\gamma$
Direct CP asymmetry A_{CP}	(-1.3 ±3 ±1)%	(2.5 ±5.0 ±1.5)%

computation. Other observables, such as the partial rate asymmetry (A_{CP}) between charge conjugate modes, could be more useful to constrain new physics. For example, the SM predicts very small asymmetry (≈1%)[3], while there are several extensions of the SM predicting much larger A_{CP}. Electroweak processes, like $b \to sl^+l^-$, are also useful probes for new physics searches. Expected rates are two order of magnitude smaller than for $b \to s\gamma$. At the lowest order, the decay is described by an electroweak (Z) penguin diagram and a W-box diagram in addition to the radiative penguin. If new particles with large weak bosons couplings exist, one can expect some additional contributions to $b \to sl^+l^-$ that are not visible in $b \to s\gamma$.

2 Measurements of CP Asymmetries in $b \to s\gamma$

The exclusive $B \to K^*\gamma$ analysis is detailed in [4]. The K^* is reconstructed in the four modes $K^{*0} \to K^+\pi^-, K^0_S\pi^0$ and $K^{*+} \to K^+\pi^0, K^0_S\pi^+$ and combined with a high energy isolated photon to form a B meson candidate. The background, mostly from continuum production, is suppressed by means of event topology variables. To reject events in which the photon comes from a $\pi^0(\eta)$ decay, a veto on $m_{\gamma\gamma}$ invariant mass is applied. The discriminating variables are the beam energy-substituted mass $m_{ES} = \sqrt{(E^*_{beam})^2 - (\vec{p}^*_B)^2}$ and the energy difference $\Delta E^* = E^*_B - E^*_{beam}$, where $\vec{p}_B$, E^*_B and E^*_{beam} denote the B-momentum, B-energy and beam energy in the center-of-mass (CM) frame, respectively. The signal yields are extracted from a likelihood fit to m_{ES} and ΔE. A "semi-inclusive" method, which measures a sum of exclusive $B \to X_s\gamma$ decays, is also used in BaBar [5]. The hadronic system X_s is reconstructed in 12 final states including a K^0_S or a K^+ and up to three pions (at most one π^0). The signal yields are extracted from a likelihood fit to m_{ES}. The results for the direct CP asymmetry, based on $81.9 fb^{-1}$, are reported in Table 1. These are consistent with zero and statistics limited.

3 Measurements of Branching Fractions in $b \to sl^+l^-$

The exclusive $b \to sl^+l^-$ measurement is described in [7]. Eight final states are reconstructed where a K^+, K^0_S, K^{*0} or K^{*+} recoils against a $\mu^+\mu^-$ or e^+e^- pair,

Table 2: *Branching Fractions (BF) Predictions and Measurements in $b \to sl^+l^-$ decays. Errors are statistics and systematics respectively.*

	$B \to Kl^+l^-$	$B \to K^*l^+l^-$	$B \to X_sl^+l^-$
BF Predictions ($\times 10^7$)	3.5 ± 1.2	11.9 ± 3.9	42 ± 7
Measured BF ($\times 10^7$)	$6.5^{+1.4}_{-1.3} \pm 0.4$	$8.8^{+3.3}_{-2.9} \pm 1.0$	$56 \pm 15 \pm 12$

using an integrated luminosity of 113.1 fb^{-1}. Specific selection criteria are used to suppress individual backgrounds. Event shape variables are used to eliminate the continuum background. To reject events from $B \to J/\psi(\psi(2S))K^{(*)}$ decays with $J/\psi(\psi(2S)) \to l^+l^-$, a veto on m_{ll} is applied. In each of the four $K^{(*)}l^+l^-$ final states, a signal is extracted from a fit to the $m_{ES}, \Delta E, (m_{k\pi})$ distributions. In the "semi-inclusive" approach [8], the reconstructed hadronic system X_s consists of one K^0_S or K^+ and up to two pions (at most one π^0). Background rejection is similar to the exclusive analysis. The signal yield is extracted from a likelihood fit to m_{ES} and the analysis is performed with an integrated luminosity of 81.9 fb^{-1}. The measured branching ratios are reported in Table 2 togheter with the theoretical predictions [6]. These results are in agreement with the SM predictions within the current level of accuracy and have errors comparable to the theoretical prediction precision. With larger data samples at the *B-factories*, it will be possible to make precise tests of the theoretical predictions for the differential distributions in these decays.

References

1. R. Ammar *et al.* [CLEO Collaboration], Phys. Rev. Lett. **71**, 674 (1993).
2. P. Gambino, M. Misiak, Nucl. Phys. B **611**. 338 (2001).
3. T. Hurth, E. Lunghi, W. Porod, arXiv:hep-ph/0310282. International Europhysics Conference on High-Energy Physics, Aachen, Germany
4. B. Aubert *et al.* [BABAR Collaboration], arXiv:hep-ex/0407003. Submitted to Phys. Rev. Lett.
5. B. Aubert *et al.* [BABAR Collaboration], Phys. Rev. Lett. **93**, 021804 (2004)
6. A. Ali, E. Lunghi, C. Greub and G. Hiller, Phys. Rev. D **66**, 034002 (2002)
7. B. Aubert *et al.* [BABAR Collaboration], Phys. Rev. Lett. **91**, 221802 (2003)
8. B. Aubert *et al.* [BABAR Collaboration], Phys. Rev. Lett. **93**, 081802 (2004)