BABAR

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1 Introduction

The BABAR experiment has been running at the PEP-II asymmetric $B$ factory of the SLAC National Laboratory (Stanford, USA) from 2001 to 2008, collecting a data sample corresponding to approximately $0.5 \text{ab}^{-1}$. The data were collected mostly at the CM energy corresponding to the $\Upsilon(4S)$ mass; large data sample were also obtained at the CM energy corresponding to the $\Upsilon(2S)$ and $\Upsilon(3S)$ resonances. The experiment has produced a wealth of important physics results, ranging from measurements of all three angles of the Unitarity triangle, to the discovery of the $D-\bar{D}$ mixing, the discovery of the $\eta_b$, the discovery of several interesting charm and charmonium states. The study of the ISR events, also pursued at BABAR has produced many important results in the energy range down hadron threshold production. To date the BABAR analysis effort has resulted in about 500 publications in Phys. Rev. Lett. or Phys. Rev. D. After the end of data taking the complete data set was reprocessed, and large amount of Monte Carlo events were generated and fully reconstructed. During 2011 the intense analysis period has not yet slowed down.

The preparation of a “Physics of the B-factories” book, in collaboration with the Belle group, to illustrate the analysis strategies and the physics results of the $B$-factories is near completion. The main activity of the LNF group in 2011 has been the analysis of $B \to D^{*\pm}D^{*\mp}$ selected with a partial reconstruction technique, described in the next section.

2 Measurement of $\sin^2\beta$ with partial reconstruction of $B$ mesons to the $D^{*\pm}D^{*\mp}$ decay

In 2011 this analysis has been finalized for publication. The parameters $S$, $C$ are extracted from the $CP$ and tag side vertices time difference $\Delta t$ distribution of events selected using event topology and kinematic cuts. In fig. 1 we show the recoil mass distribution of real data from RUN 1 through

Figure 1: Missing mass for $B \to D^{*\pm}\pi^\mp(X)$ for kaon (left) and lepton (right) tagged events. The curves represent the probability distribution functions (p.d.f.) for signal (red), continuum background (green), $BB$ background (blue) and their sum (black).
6 (black crosses), corresponding to $\approx 435 \text{ fb}^{-1}$ of integrated luminosity. The presence of an excess of events in the signal region is evident. We fit the data with a PDF (black curve), made of a signal component (red) plus a continuum (green) and $B\bar{B}$ (blue) combinatorial background component. We find a total of $3843 \pm 397$ ($1128 \pm 218$) events in the kaon (lepton) sample. We fit the time distribution in the data, whose result we show in fig. 2 where we plot the time difference distribution of all data events for the full collected sample, and the corresponding raw $CP$ asymmetry for the lepton and kaon tag samples.

Following the preliminary review stage, the analysis was allowed to be unblinded at the end of the year, and is now in the final stage of the process leading to publication. As the results are not official yet, we can only summarize here the statistical errors obtained from the fit. We find:

$$\delta C = \pm 0.11 \quad \text{kaon tags},$$
$$\delta S = \pm 0.16$$

$$\delta C = \pm 0.15 \quad \text{lepton tags},$$
$$\delta S = \pm 0.20.$$  

The combined statistical and systematic errors are:

$$\delta C = \pm 0.09 \pm 0.05$$  \hspace{1cm} (1)  
$$\delta S = \pm 0.12 \pm 0.09,$$  \hspace{1cm} (2)

This measurement reduces the error of the previous BaBar measurement performed with fully reconstructed $D^+D^-$ final states by $\approx 25\%$.

A full description of this analysis and its results has been included in the B-Factories legacy book.
Over the last decade BaBar and Belle have studied the physics of bottom and charm mesons, tau leptons, heavy quarkonium states, etc. that were produced at the PEP-II and KEKB e+e- storage rings. The two collaborations continuously developed more and more sophisticated techniques for extracting the maximum amount of information from data. A project is ongoing to document all these techniques in a book, named “Physics of the B-Factories”. The book will provide descriptions of all of the techniques developed by the experiments and a comprehensive overview of the measurements. The publication of the book is currently expected to happen in 2012. One member of our group is co-editor of the chapter on the measurement of the angle $\gamma$ of the Unitarity Triangle.

References


