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SEMILEPTONIC DECAY OF $D^0 \to \pi l \nu$ AND FORM FACTORS FOR THE MEASUREMENT OF $|V_{ub}|$ AT KEKB

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1 Introduction

The quark mixing parameters of the standard model are fundamental parameters of the weak interaction. Semi-leptonic decays have provided most of the information on these matrix elements, and the simplest way to take into account effects of the strong interactions has been to do so in terms of form factors, but even so the dominant uncertainties can come from the uncertainties in the form factors [1]. So, the form factors in semileptonic D decay itself are of great interest.

When V_{ub} is measured via $B \to \pi l \nu$, one has to use a form factor $f_B(q^2)$. The form factors f_B and f_D have both been calculated in the quenched approximation of lattice QCD, with the unquenched result to come soon [2].Using

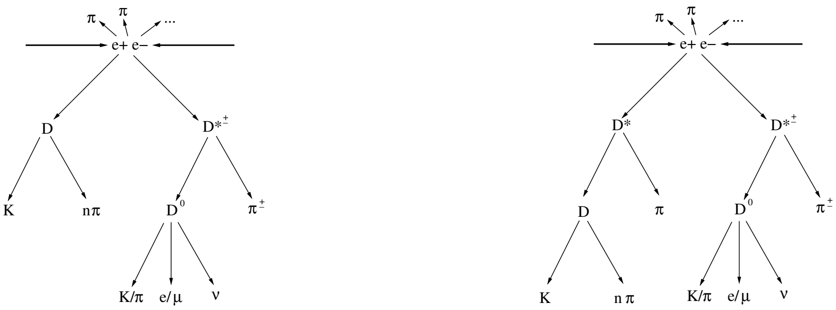

Figure 1: *Scheme of reconstructed event topology, DD^* events (left) and D^*D^* events (right).*

the ratio of these form factors cancels common theoretical errors and with good information available for the analogous form factor $f_D(q^2)$ from the decay $D \to \pi l \nu$, the values of V_{ub} determined in this way will be improved.

Using the same method of reconstruction described below also form factors for $D \to K l \nu$ can be evaluated. With some modification this method is also very powerful to study inclusive decays of D^0. All is preliminary.

2 Method of Reconstruction

The choice of the event topology used in this analysis is based on the observation of [3] that the cross sections for $e^+e^- \to D^*D^*$ and $e^+e^- \to DD^*$ are quite large. Instead of primary D^0 mesons, we use primary $D^{*\pm}$ mesons decaying to $D^0\pi^\pm$, a decay which has the very welcome property of a small phase space[1], resulting in a *slow pion* with well-defined momentum and a very good selection power for the D^0. This D^* is called *signal-side*; on the other *tag side*, both D and D^* are allowed to enhance statistics.

Since $c\bar{c}$ production threshold is well below the available energy at BELLE, the $D^{(*)}D^*$ pair is often accompanied by several π and/or K mesons. To achieve the best possible statistics, no restriction on this number of *additional mesons* is applied in the reconstruction.

[1]due to $m_{D^{*\pm}} - (m_{D^0} + m_{\pi^\pm}) = 5.8$ MeV

As indicated in Fig.1 reconstruction starts with the tag-side $D^{(*)}$, looking for the decay channels $D \to K^{\pm}n\pi$ with $n = 1, 2, 3$ (total $\approx 25\%$ BR) and subsequently $D^* \to D\pi, D\gamma$; if no D^* can be reconstructed, a DD^* event is assumed. A combined mass- and vertex fit is applied to the D (and the D^* if applicable) to improve resolution. After this full reconstruction of tag-side, and allowing for an arbitrary number of additional primary π or K, the known beam momentum is used to deduce the momentum of the signal-side $D^{*\pm}$ via momentum conservation (so-called *recoil method*). Appropriate mass- and vertex fits are then made also on the signal side, identifying events where $D^{*\pm} \to D^0\pi^{\pm}$ on the signal side. The neutrino in $D^0 \to \pi\ell\nu$ or $D^0 \to K\ell\nu$ is similarly reconstructed using the recoil-method. Finally, the neutrino candidates are selected by requiring a successful fit and $m_\nu^2 < 0.05$ GeV^2.

3 Detector and data sets

The data sample used came from $152 fb^{-1}$ of data collected by the BELLE experiment. The BELLE detector at KEKB is described in [4].

4 Analytical procedure and first preliminary results

Applying the method described in Section 2 on the data (Section 3) candidates for semileptonic decays of D^0 have been found, shown in Fig.2. The very good resolution $\sigma_{m_\nu^2} = 0.01\ GeV^2$ is achieved.

Background can be subdivided into 3 main categories: Non D^0-events which fake a D^0 on the signal side: a side-band study yielded 0.7% for $D^0 \to K\ell\nu$ and 7% for $D^0 \to \pi\ell\nu$. Hadronic D^0-decays with fake lepton: a Monte Carlo study yielded 4.3% and 1.5%. Fake K/π in semileptonic decays: negligible and 10.6%

The preliminary numbers of events found for $D \to K/\pi\ell\nu$ *before* and *after* background subtraction are:

$D \to K/\pi\ell\nu - before$	K	π	$D \to K/\pi\ell\nu - after$	K	π
e	510	77	e	501	60.7
μ	529	62	μ	487	51.5
ℓ	1039	139	ℓ	988	112.2

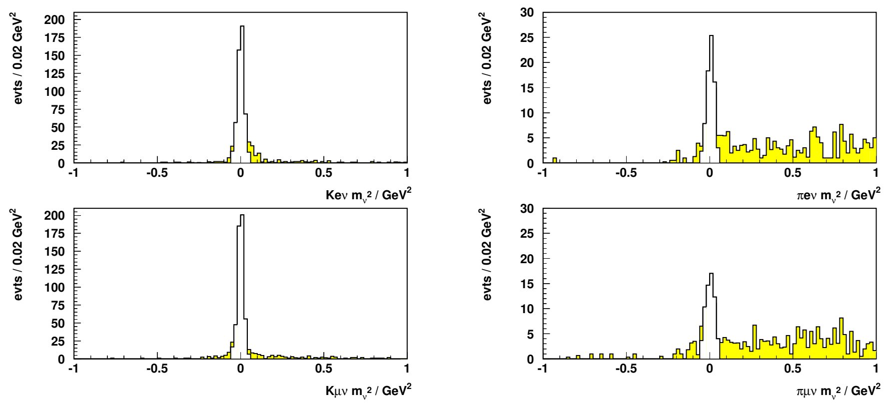

Figure 2: m_ν^2 *for four semileptonic modes (shaded: without neutrino cuts)*

For a first "taste" preliminary $f_+(q^2)$ distributions (the resolution for q^2 is very good, σ_{q^2} around $0.01GeV^2$) are given in Fig.3 (left). A pole fit parametrises very well the distributions. The aim of $\Delta(f_D)/f_D < 10\%$ for $D \to \pi\ell\nu$ is within reach even with the currently available data.

Also branching ratio of $D^0 \to K^{*0}(892)X$ was investigated. In Fig.3 right the peak at the $K^{*0}(892)$ mass corresponds to the inclusive cross section; that at the D^0 mass to the exclusive decay $D^0 \to K\pi$. The broad peak is a reflection of $D^0 \to K\pi^+\pi^0$.

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References

1. G. S. Huang et al. CLNS 04/1876, CLEO04-06.
2. A.El-Khadra et al, MILAB-PUB-00/346-T [hep-ph/0101023].
3. T. Uglov *et al* (Belle Collaboration), hep-ex/0401038.

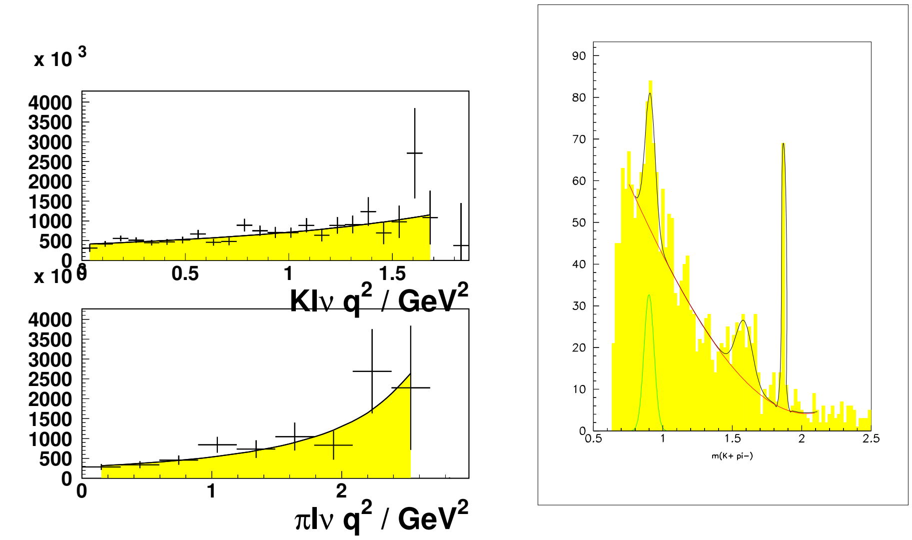

Figure 3: *$f_+(q^2)$ distributions for $Kl\nu$ and $\pi l\nu$ together with a pole fit (left), $K\pi$ mass distribution (in GeV-units) for particles constituting a D^0 (right)*

4. A. Abashian *et al.* (Belle Collab.), Nucl. Instr. and Meth. A **479**, 117 (2002).