1 The D** background

The decay $B^{\pm} \to D^{**0}\ell^{\pm}\nu$ followed by the dominating decay $D^{**0} \to D^{*\mp}\pi^{\pm}$ presents a background to the TagMix analysis, and there are variations of this background scenario in the shape of broader D^{**} resonances and non-resonant $B^{\pm} \to D^{*\mp}\pi^{\pm}\ell^{\pm}\nu$. However, $B^0 \to D^{**\mp}\ell^{\pm}\nu$ with $D^{**\mp} \to D^{*\mp}\pi^0$ will be considered signal, as the tagging efficiency is expected to be the same. Thus, the three types of D^{**} backgrounds are non-resonant $D^*\pi$, narrow D^{**}, $D(2460)^{**}_{\Gamma=20\ MeV}$, and broad D^{**}, $D(2660)^{**}_{\Gamma=200\ MeV}$, where the mass and width of the broad D^{**} are chosen for the sake of illustration.

For the reduction and also determination of these backgrounds, which we shall commonly term D^{**} background, we consider the variable $\cos(\theta_{B,D^*\ell})$. With a toy Monte Carlo we have determined the distribution of this variable for D^* and D^{**} events. The toy MC consists of a generator of kinematically allowed decays with a flat q^2 distribution, onto which the $D^*\ell\nu$ matrix element [1, page 85, pages 128-133] (heavy quark limit assumed, which is compatible with existing data) is imposed, both for the D^* and D^{**} decays. The tracks are then smeared with Gaussian distributions, using $\sigma_{p_t}/p_t = 0.5\%$ and $\sigma_{\theta,phi} = 2\ mrad$. Finally the detector acceptance ($-0.88 < \cos(\theta_{lab}) < 0.94$, $|\vec{p}| > 75\ MeV$) and the analysis cuts ($|\vec{p_\ell}|^{[\Upsilon(4S)]} > 1.2\,GeV$, $\cos(\theta_{D^*,\ell}) < 0$) are taken into account. The final acceptance including the $\cos(\theta_{B,D^{*(*)}})$ cut is 22% for D^*, and 6.4%, 7.8% and 7.0% for the three types of D^{**} background. The $\cos(\theta_{B,D^{*(*)}})$ cut is almost 100% efficient for the signal, whereas it leaves only 52%, 50% and 42% of the D^{**} backgrounds respectively.

The toy MC reproduces the shape of $\cos(\theta_{B,D^*\ell})$ nicely for $D^*\ell\nu$ events, which can be seen in figure 1.

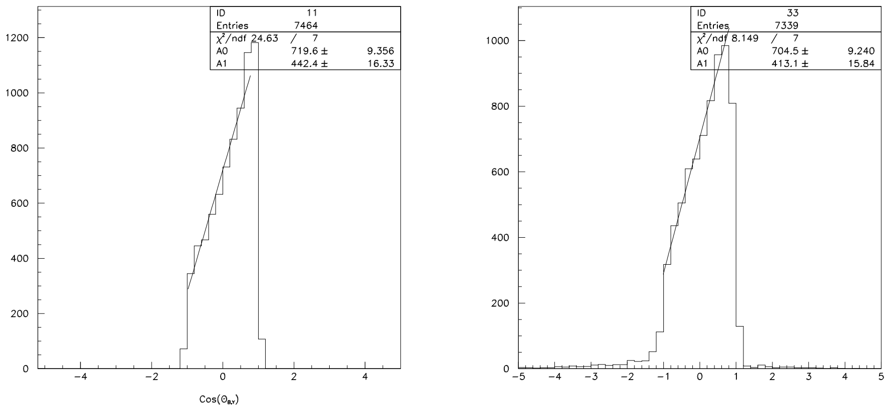

Figure 1: *The distribution of* $\cos(\theta_{B,D^{*(*)}})$ *for toy MC and BaBar MC, along with a linear fit.*

For the D^{**} backgrounds the distribution of $\cos(\theta_{B,D^*\ell})$ has a long tail in the negative direction, due to the missing pion. The shape of the three distributions are very similar (see figure 1), and it turns out that they can all be fairly well fitted with the following function:

$$f_{fit}(x) = N\ \frac{c\ b^{\frac{a+1}{c}}}{\Gamma(\frac{a+1}{c})}\ x^a\ e^{-b(1-x)^c} \tag{1}$$

This has been done for each type of D^{**} background, and the results can be seen in figure 1 below. A more reslistic scenario is an even mixture of the three [2, page 10], which is equally well fitted by the function $f_{fit}(x)$, and the resulting values of parameters for the three seperate D^{**} along with the mixture is quoted in table 1.

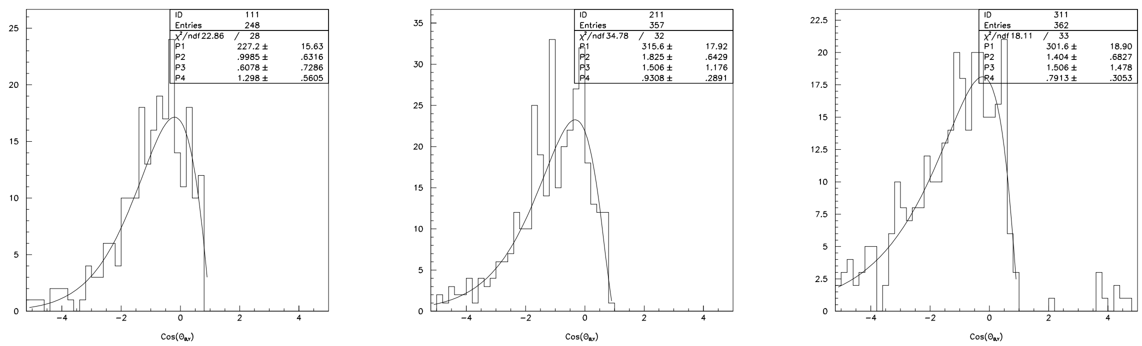

Figure 2: *Distribution of* $\cos(\theta_{B,D^*\ell})$ *for the three cases of* D^{**} *background — non-resonant* $D^*\pi$ *(a), narrow* D^{**} *(b), broad* D^{**} *(c). The fit is to the function* $f_{fit}(x) = N\ \frac{c\ b^{(a+1)/c}}{\Gamma(\frac{a+1}{c})}\ x^a\ e^{-b(1-x)^c}$, *which includes the essential features of the distributions.*

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In order to fit data, the D^* and the D^{**} MC distributions are fitted seperately, with a liniar fit and the function f_{fit} respectively. The shape of these fits are then fixed as well as the overall normalization of both D^* and D^{**}, and a global fit is carried out leaving only the relative fraction as free parameters.

$$f_{global}(r) = N_{events}(r f_{fit}(x) + (1-r)(1+0.63x)) \tag{2}$$

To check that this global fit works, it is performed on the MC distribution of $\cos(\theta_{B,D^*\ell})$ for both D^* and D^{**}, where the relative fraction is known. The result of this can be seen in table 2, where also the result of fitting the data is shown.

References

[1] J.D. Richman, P.R. Burchat. Leptonic and Semileptonic Decays of Charm and Bottom Hadrons. Rev. of Mod. Phys. August 1995 (hep-ph-9508250). 1995.

	a	b	c	$\chi^2/dof.$
$D^*\pi$ non-res.	1.0 ± 0.6	0.61 ± 0.73	1.3 ± 0.6	23/28
D^{**} narrow	1.8 ± 0.6	1.5 ± 1.2	0.93 ± 0.29	35/32
D^{**} broad	1.4 ± 0.7	1.5 ± 1.5	0.79 ± 0.31	18/33
Mixture	1.7 ± 0.3	1.6 ± 0.6	0.88 ± 0.14	53/37

Table 1: *The fitted parameters of the different* D^{**} *backgrounds.*

	N_{D^*}	$N_{D^{**}}$	$\chi^2/dof.$
Monte Carlo	1478	967	—
Fit to MC	1524 ± 38	920 ± 38	85/48
Fit to data	1897 ± 62	355 ± 62	48/28

Table 2: *The true and fitted normalizations for Monte Carlo events and the fit to data.*

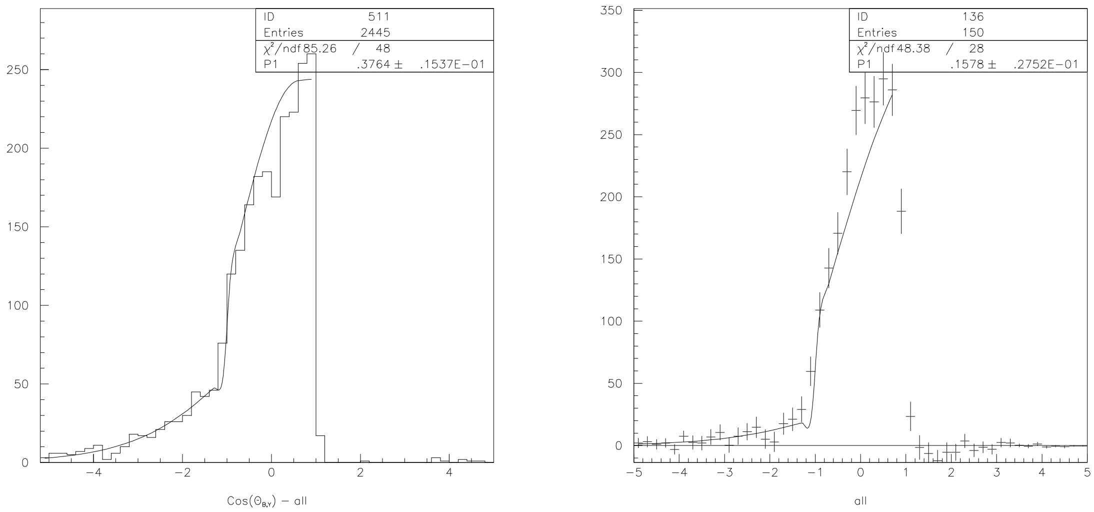

Figure 3: *The fitted normalizations for Monte Carlo and data.*

[2] ALEPH, CDF, DELPHI, L3, OPAL, SLC. Combined results on b-hadron production rates, lifetimes, oscillations and semileptonic decays. LEPHFS note 99-02 (draft 2). 10th March 2000.