Measurements of Semileptonic B Decays with BaBar

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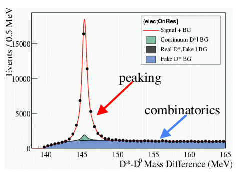
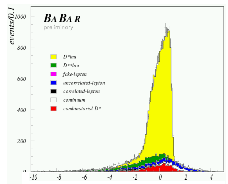
$|V_{cb}|$ with Exclusive $B^0 \to D^* l\nu$ Decays





$$\cos\theta_{B^0,D^*l} = \frac{-(m_{B^0}^2 + m_{D^*l}^2 - 2E_{B^0}E_{D^*l}) + m_{X\nu}^2}{2|\vec{p}_{B^0}||\vec{p}_{D^*l}|}$$

Pure sample of $B^0 \to D^* l\nu$:

- $D^* \to D^0\pi$, $D^0 \to K\pi, K3\pi, K\pi\pi^0$
- combinatorial background subtracted by using $\Delta M = M(D^*) - M(D^0)$
- D^{**} components estimated by fitting the cosine of the angle between B^0 and D^*l system

Differential measurement of $\mathcal{B}(B^0 \to D^* l\nu)$ allows for the extraction of $|V_{cb}|$:

$$\frac{d\Gamma}{dw} \propto |V_{cb}|^2 A_1^2(w)\left\{2\frac{1-2wr+r^2}{(1-r)^2}\left[1+\frac{w-1}{w+1}R_1(w)^2\right]+\left[1+\frac{w-1}{1-r}(1-R_2(w))\right]^2\right\};$$

$$A_1(w) = A_1(1)\left[1-8\rho_{A_1}^2 z + (53\rho_{A_1}^2-15)z^2 - (231\rho_{A_1}^2-91)z^3\right];$$

where $w = \frac{m_B^2 + m_{D^*}^2 - q^2}{2m_B m_{D^*}}$ and $z = \frac{\sqrt{w+1}-\sqrt{2}}{\sqrt{w+1}+\sqrt{2}}$

from Lattice QCD

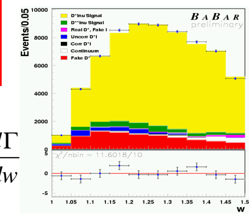
$A(1) = 0.913^{+0.030}_{-0.035}$

Preliminary results (89M $B\bar{B}$):

$\mathcal{B}(B^o \to D^* l\nu) = (4.68 \pm 0.03_{stat.} \pm 0.29_{syst})\%$; $\rho_{A_1} = 1.23 \pm 0.02 \pm 0.28$

$|V_{cb}| = (37.27 \pm 0.26_{stat} \pm 1.43_{syst.} {}^{+1.48}_{-1.22}{}_{th.}) \cdot 10^{-3}$

$\frac{d\Gamma}{dw}$



Semileptonic B Decays

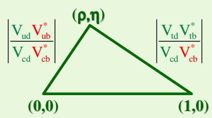
Semileptonic B decays provide measurements for:

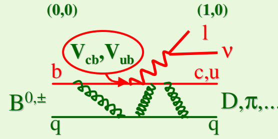
- V_{ub} and V_{cb}
- b quark mass
- non perturbative QCD parameters

Theoretical frameworks:

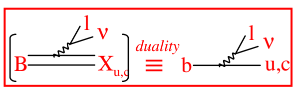
- ➢OPE/HQE for inclusive decays
- ➢HQET for exclusive decays

$\mathcal{B}(B \to X_c l\nu) \approx 50 \cdot \mathcal{B}(B \to X_u l\nu)$

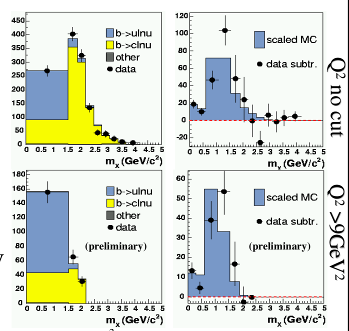




$|V_{ub}|$ with Inclusive Semileptonic B Decays



- **Extraction based on hadronic mass** of the X_u system in $B \to X_u l\nu$
- Large acceptance: no cut on multiplicity and phase space, except for $p_l^* > 1 GeV$
- High purity (S/B~2)
- 170 signal events with m_X<1.55GeV
- **Submitted to PRL (hep-ex/0307062)**

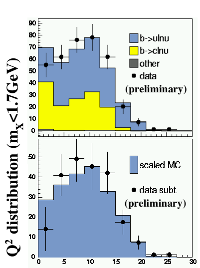


$$\mathcal{B}(\bar{B} \to X_u l\bar{\nu}) = (2.24 \pm 0.27_{stat.} \pm 0.26_{syst.} \pm 0.39_{th.syst.m_X}) \cdot 10^{-3}$$

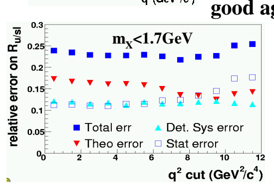
$$\frac{\mathcal{B}(\bar{B}^0 \to X_u l\bar{\nu})}{\mathcal{B}(\bar{B}^0 \to Xl\bar{\nu})}\frac{\mathcal{B}(B^- \to Xl\bar{\nu})}{\mathcal{B}(B^- \to X_u l\bar{\nu})} = (0.72 \pm 0.18_{stat.} \pm 0.19_{syst.})$$

$$|V_{ub}| = (4.62 \pm 0.28_{stat.} \pm 0.27_{syst.} \pm 0.40_{th.syst.m_X} \pm 0.26_{th.syst.\mathcal{B}\to V_{ub}}) \cdot 10^{-3}$$

Further studies



- Studied improvements to decrease theoretical uncertainties
- A combination of cuts in m_X and Q^2 should exclude regions of phase space with singularities and decrease extrapolation error
- **Q^2 spectra obtained after background subtraction show good agreement with expectation**



- Studied two options: m_X<1.5GeV and m_X<1.7GeV
- proper combination of resonant and non-resonant components as model
- for **m_X<1.7GeV + Q^2 >9GeV²** **improvement in theo. error by 35%**

Recoil Technique (89M $B\bar{B}$):

Advantages

- *Subtraction of the continuum*
- *B^0-B^+ separation*
- *B meson momentum*
- *Kinematic constraints*
- *Direct measurement of m_X (sum charged tracks and neutrals)*

Reconstructed modes:

$B^{(0,\pm)} \to D^{0,\pm(*)} X^{\pm}$,

$X^{\pm} \to n\pi^{\pm} m\pi^0 sK^{\pm} pK_s$

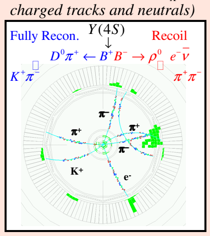
where n+s ≤ 5, p ≤ 2, n ≤ 2

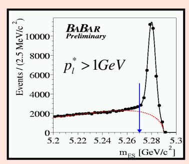
Efficiencies:

$\varepsilon(B^0) = 0.15\%$

$\varepsilon(B^{\pm}) = 0.25\%$

Purity ~25%

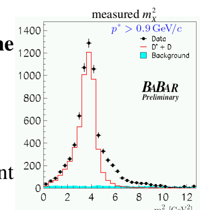




Hadronic Mass Moments in Semileptonic B Decays

Goal is to measure the $\langle m_X^2 \rangle$ for different cuts on the momentum of the lepton and then extract (λ_1, $\bar{\Lambda}$)

- Direct measurement of the hadronic mass using the recoil of fully reconstructed B mesons
- Kinematic fit to improve the resolution on **$\langle m_X^2 \rangle$**
- Measured mass corrected by using a model indipendent calibration curve from MonteCarlo



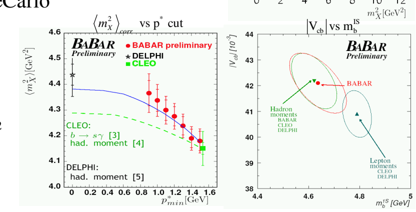
Fitting the mass moments:

(hep-ex/0307046)

(preliminary)

$$\bar{\Lambda}^{\overline{MS}} = (0.53 \pm 0.09_{exp})GeV$$

$$\lambda_1^{\overline{MS}} = (-0.36 \pm 0.09_{exp})GeV^2$$



and using $\Gamma_{sl} = (4.37 \pm 0.18) \cdot 10^{-11} MeV$ **yields:**

(preliminary)

$$m_b^{IS} = (4.64 \pm 0.09_{exp} \pm 0.06_{pert.} \pm 0.07_{1/m_B^3})GeV$$

$$\lambda_1^{IS} = (-0.26 \pm 0.06_{exp} \pm 0.04_{pert.} \pm 0.04_{1/m_B^3})GeV^2$$

$$|V_{cb}| = (42.10 \pm 1.04_{exp} \pm 0.52_{pert.} \pm 0.50_{1/m_B^3}) \cdot 10^{-3}$$

Excl. Charmless Semil. B Decays

- **Same technique as in inclusive V_{ub} analysis**
- It allows for high purity but small amount of events
- Fitted hadronic mass and charged tracks multiplicity is used to separate resonances

(preliminary)

$$\mathcal{B}(B^+ \to \pi^0 l^+\nu) = (0.78 \pm 0.32_{stat} \pm 0.13_{syst}) \cdot 10^{-4}$$

$$\mathcal{B}(B^+ \to "\rho^0" l^+\nu) = (0.99 \pm 0.37_{stat} \pm 0.19_{syst}) \cdot 10^{-4}$$

$$\mathcal{B}(B^+ \to \omega l^+\nu) = (2.20 \pm 0.92_{stat} \pm 0.57_{syst}) \cdot 10^{-4}$$

"ρ^0" is defined as $\pi^+\pi^-$ in the mass window $0.65 < m_{\pi+\pi-} < 0.95$ GeV

Projection of the results on the m_X variable