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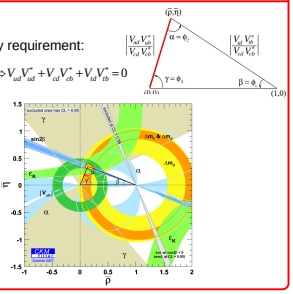
Study of B→πℓν and B→ρℓν at BaBar

Jochen Dingfelder, Michael Kelsey,
Vera Lüth, Wells Wulsin

CP Violation

Unitarity requirement:

$$V_{CKM}^{*} V_{CKM} = 1 \Rightarrow V_{ud}V_{ub}^{*} + V_{cd}V_{cb}^{*} + V_{td}V_{tb}^{*} = 0$$



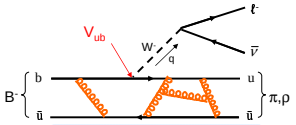
Motivation

$$B \to \pi \ell \nu: \quad \frac{d\Gamma}{dq^2} = |V_{ub}|^2 \frac{G_F^2 |\vec{p}_\pi|^3}{24\pi^3} |f_+(q^2)|^2$$

$$B \to \rho \ell \nu: \quad \frac{d\Gamma}{dq^2} = |V_{ub}|^2 \frac{G_F^2 |\vec{p}_\rho| q^2 m_B^2}{96\pi^3} \times \left(|H_0|^2 + |H_+|^2 + |H_-|^2 \right)$$

Physics Goals
- Measure $|V_{ub}|$
- Test models of hadronic current form factors

Measure $\mathcal{B}(q^2)$ for:
- $B^0 \to \pi^- \ell^+ \nu$
- $B^0 \to \rho^- \ell^+ \nu$
- $B^+ \to \pi^0 \ell^+ \nu$
- $B^+ \to \rho^0 \ell^+ \nu$



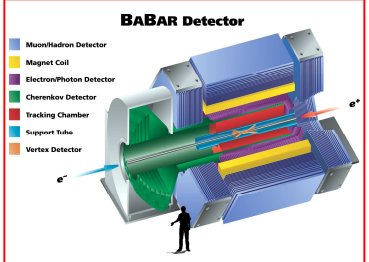
Update of previous analysis (83 million $B\bar{B}$)
- $\mathcal{B}(B^0 \to \pi^- \ell^+ \nu) = (1.38 \pm 0.10_{stat} \pm 0.16_{syst} \pm 0.08_{theo}) \times 10^{-4}$ (15% error)
- $\mathcal{B}(B^0 \to \rho^- \ell^+ \nu) = (2.14 \pm 0.21_{stat} \pm 0.48_{syst} \pm 0.28_{theo}) \times 10^{-4}$ (28% error)

PRD 72, 051102 (2005)

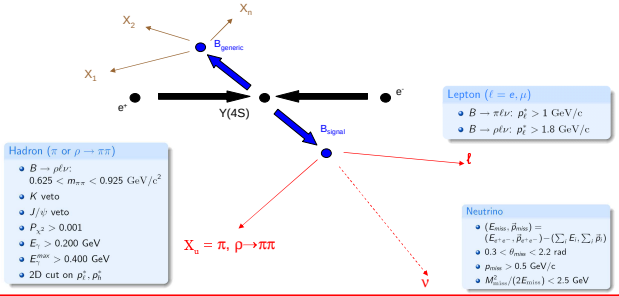
This analysis: 383 million $B\bar{B}$ pairs.

>4x increase in statistics

The detector



Candidate selection



Hadron (π or $\rho \to \pi\pi$)
- $B \to \rho\ell\nu$: $0.625 < m_{\pi\pi} < 0.925$ GeV/c^2
- K veto
- J/ψ veto
- $P_{\chi^2} > 0.001$
- $E_\gamma > 0.200$ GeV
- $E_\gamma^{max} > 0.400$ GeV
- 2D cut on p_γ^*, p_h^*

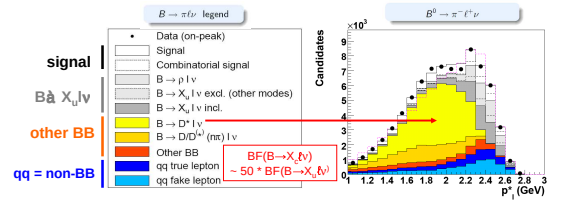
Lepton ($\ell = e, \mu$)
- $B \to \pi\ell\nu$: $p_\ell^* > 1$ GeV/c
- $B \to \rho\ell\nu$: $p_\ell^* > 1.8$ GeV/c

Neutrino
- $(E_{miss}, \vec{p}_{miss}) = (E_{e^+e^-}, \vec{p}_{e^+e^-}) - (\sum_i E_i, \sum_i \vec{p}_i)$
- $0.3 < \theta_{miss} < 2.2$ rad
- $p_{miss} > 0.5$ GeV/c
- $M^2_{miss}/(2E_{miss}) < 2.5$ GeV

Background sources

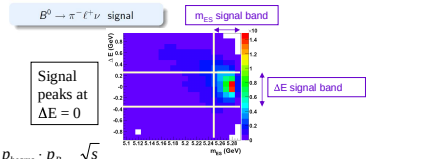
Backgrounds classified by the origin of the lepton

Neural net classifiers used to reduce $q\bar{q}$, $X_u\ell\nu$, and $X_c\ell\nu$ backgrounds.



Fit in m_{ES} & ΔE in q^2

Binned maximum-likelihood fit
- 47 bins in m_{ES} and ΔE
- 15 free parameters
  - 9 signal yields:
    - $B \to \pi\ell\nu$ in 6 q^2 bins
    - $B \to \rho\ell\nu$ in 3 q^2 bins
  - 6 background yields:
    - $B \to X_u\ell\nu$ in 2 q^2 bins
    - $B \to D^{*}\ell\nu$ (for both $\pi\ell\nu$, $\rho\ell\nu$)
    - other $B\bar{B}$
    - $q\bar{q}$
- Simultaneous fit of 4 modes



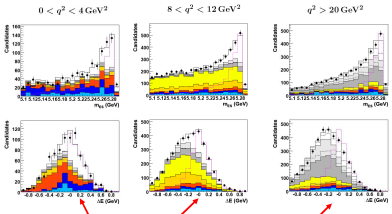
$$\Delta E = \frac{p_{beams} \cdot p_B}{\sqrt{s}} - \frac{\sqrt{s}}{2}$$

Signal peaks at $m_{ES} \approx m_B = 5.28$ GeV/c^2

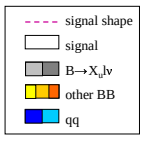
$$m_{ES} = \sqrt{\left(\frac{s/2 + \vec{p}_{beams} \cdot \vec{p}_B}{E_{beams}} \right)^2 - \vec{p}_B^{\,2}}$$

Yields

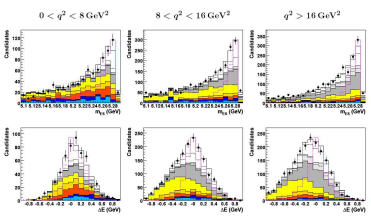
Fitted B^0à $\pi\ell^+\nu$ yields



q^2 bin:	1	2	3	4	5	6	all
S	763	1914	1664	1230	772	742	7085
B	2594	10489	17362	18971	7853	14416	71685
S/B	0.29	0.18	0.096	0.065	0.098	0.051	0.099



Fitted B^0à $\rho\ell^+\nu$ yields



q^2 bin:	1	2	3	all
S	245	493	212	950
B	2052	6636	6382	15070
S/B	0.12	0.074	0.033	0.063

Outlook

	B(Bà $\pi\ell\nu$)	B(Bà $\rho\ell\nu$)
Previous analysis (83x10^6 BB's)	15%	28%
This analysis (estimate)	6%	16%
HFAG most precise result	7%	13%