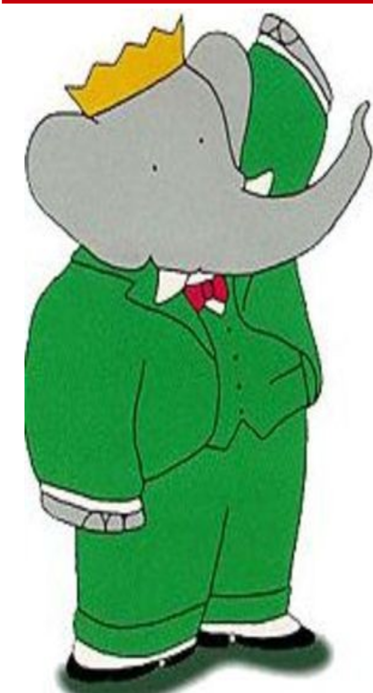
Semileptonic and Leptonic decays in the BaBar experiment



Joao Firmino da Costa
(now at DESY)
for the BaBar Collaboration

LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE

DISCRETE 2010 - Rome

Outline

Semileptonic decays

Charm

- $D^+ \to K^- \pi^+ e^+ \nu$

preliminary,arXiv:1012.1810, to be submitted to Phys. Rev. D

Bottom

- $B \to \pi/\rho\, l\, \nu$ $(l=e,\mu)$

arXiv:1005.3288, accepted by Phys. Rev. D

- $B \to \pi/\eta^{(\prime)}\, l\, \nu$ $(l=e,\mu)$

preliminary, arXiv:1010.0987v2, submitted to Phys. Rev. D

- $B \to X_u\, e\, \nu$ with had. tags

preliminary, shown at ICHEP2010

- $B^- \to D_s^{(*)+} K^- l^- \nu$

submitted to Phys. Rev. Lett.

Leptonic decays

Charm

- $D_s^+ \to l^+ \nu$

arXiv:1008.4080, accepted by Phys. Rev. D

Bottom

- $B^+ \to \tau^+ \nu$ with had. tags

arXiv:1008.0104, submitted to Phys. Rev. Lett.

● = not covered here

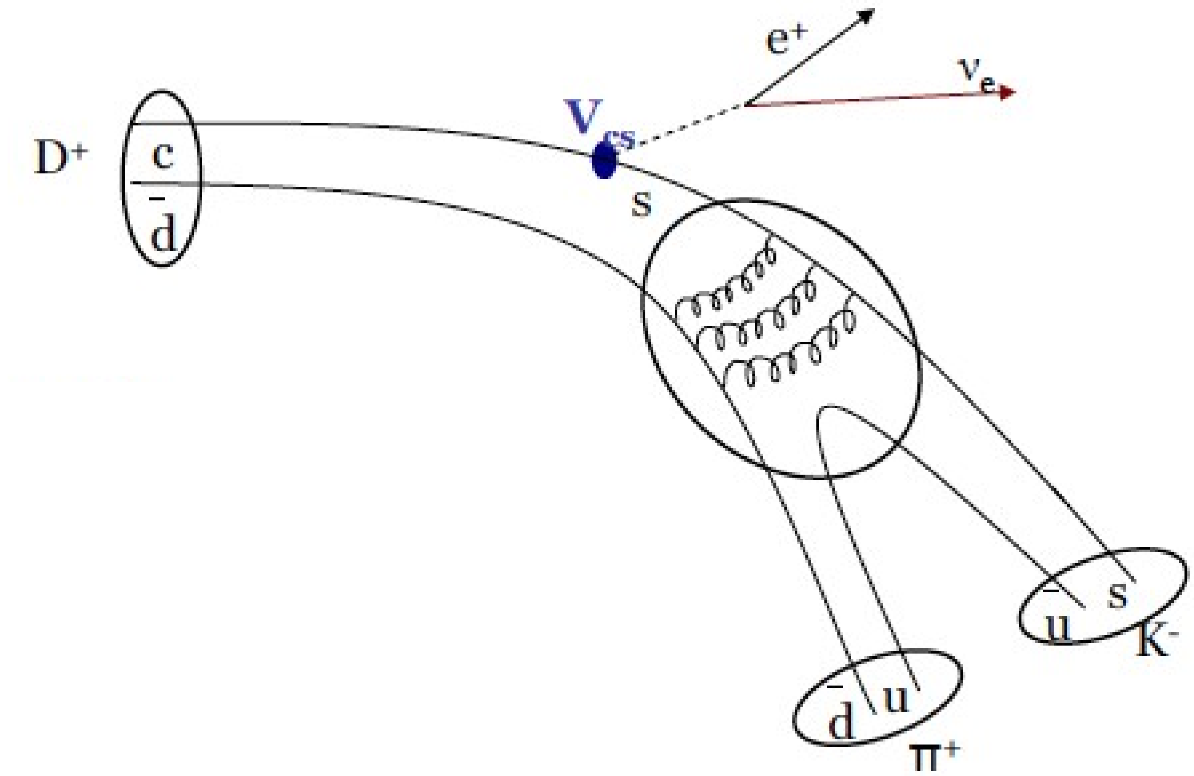
$D^+ \rightarrow K^- \pi^+ e^+ \nu$ - Motivation

S-wave

P-wave

D-wave

resonance X	J^P
$K_0^*(800)$ (?)	0^+
$K^*(892)$	1^-
$K_1(1270)$	1^+
$K_1(1400)$	1^+
$K^*(1410)$	1^-
$K_0^*(1430)$	0^+
$K_2^*(1430)$	2^+
$K^*(1680)$	1^-

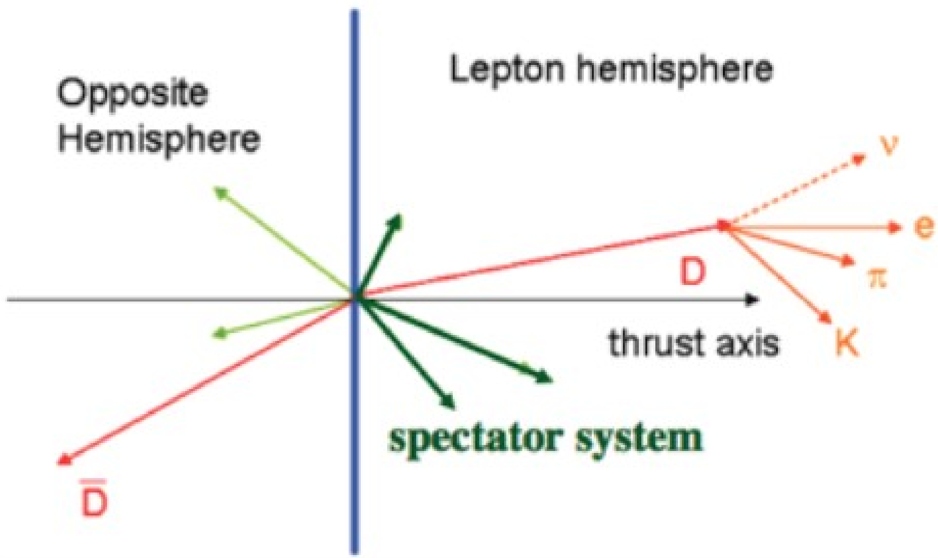


S-wave : phase variation with Kπ mass

P-wave : $K^*(892)$ resonance parameters, $D \rightarrow K^* e \nu$ form factors

Study Kπ composition and contribution from higher-mass states

$D^+ \rightarrow K^- \pi^+ e^+ \nu$ - Reconstruction and Strategy



- define two hemispheres.
  impose K^-, π^+, e^+ in the same hemisphere.
- compute the D^+ direction ($-\vec{p}_{\text{all tracks} \neq K,\pi,e}$).
- compute the missing energy in the lepton hemisphere.
- mass constraint fit $\vec{p}_{D^+} = \vec{p}_{K^+} + \vec{p}_{\pi^-} + \vec{p}_{e^+} + \vec{p}_{\nu}$.
- compute kinematical variables ($m_{K\pi}$, q^2, $\cos\theta_e$, $\cos\theta_K$, χ).

$$q^2 = (P_D - P_{K\pi})^2 = (P_e + P_\nu)^2$$

$$d^5\Gamma = \frac{G_F^2 \, ||V_{cs}||^2}{(4\pi)^6 \, m_D^3} X \beta \mathcal{I}(m^2, q^2, \theta_K, \theta_e, \chi) \, dm^2 dq^2 d\cos(\theta_K) d\cos(\theta_e) d\chi.$$

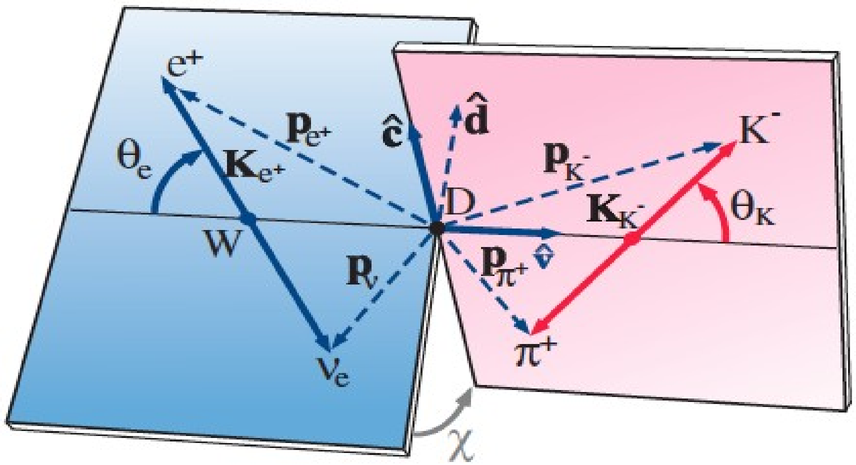
→

Function of form factors
(e.g. 3 for P-wave : ($V(q^2)$, $A_1(q^2)$, $A_2(q^2)$))
Expanded in partial waves

Fit of decay rate in full 5D phase space
(make use of all angular correlations)

→ Separation of S,P,D contributions

$347\ fb^{-1}$, 554×10^6 $c\bar{c}$

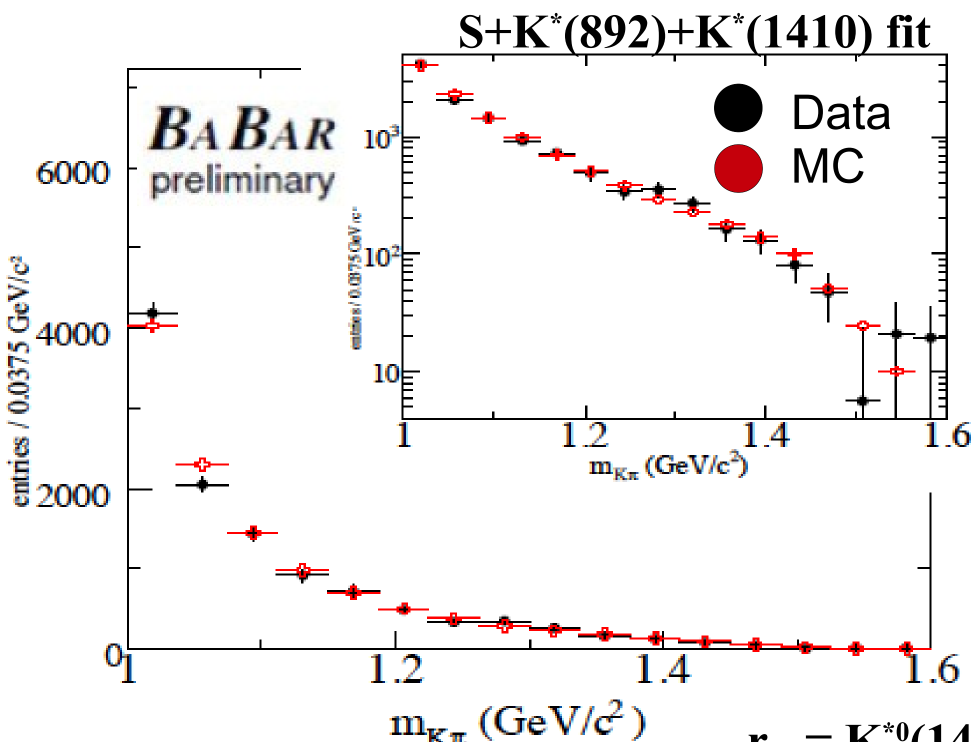


$D^+ \to K^- \pi^+ e^+ \nu$ – Results

Measured quantity	This analysis	PDG
$\mathcal{B}(D^+ \to K^-\pi^+e^+\nu_e)(\%)$	$4.04 \pm 0.03 \pm 0.04 \pm 0.09$	4.1 ± 0.6
$\mathcal{B}(D^+ \to K^-\pi^+e^+\nu_e)_{\overline{K}^{*0}}(\%)$	$3.80 \pm 0.04 \pm 0.05 \pm 0.09$	3.66 ± 0.21
$\mathcal{B}(D^+ \to K^-\pi^+e^+\nu_e)_{S-wave}(\%)$	$0.234 \pm 0.007 \pm 0.007 \pm 0.005$	0.21 ± 0.05
$\mathcal{B}(D^+ \to \overline{K}^*(1410)^0e^+\nu_e)(\%)$	$0.30 \pm 0.12 \pm 0.18 \pm 0.06$ (< 0.6 at 90% C.L.)	
$\mathcal{B}(D^+ \to \overline{K}^*_2(1430)^0e^+\nu_e)(\%)$	$0.023 \pm 0.011 \pm 0.011 \pm 0.001$ (< 0.05 at 90% C.L.)	

Very low limit

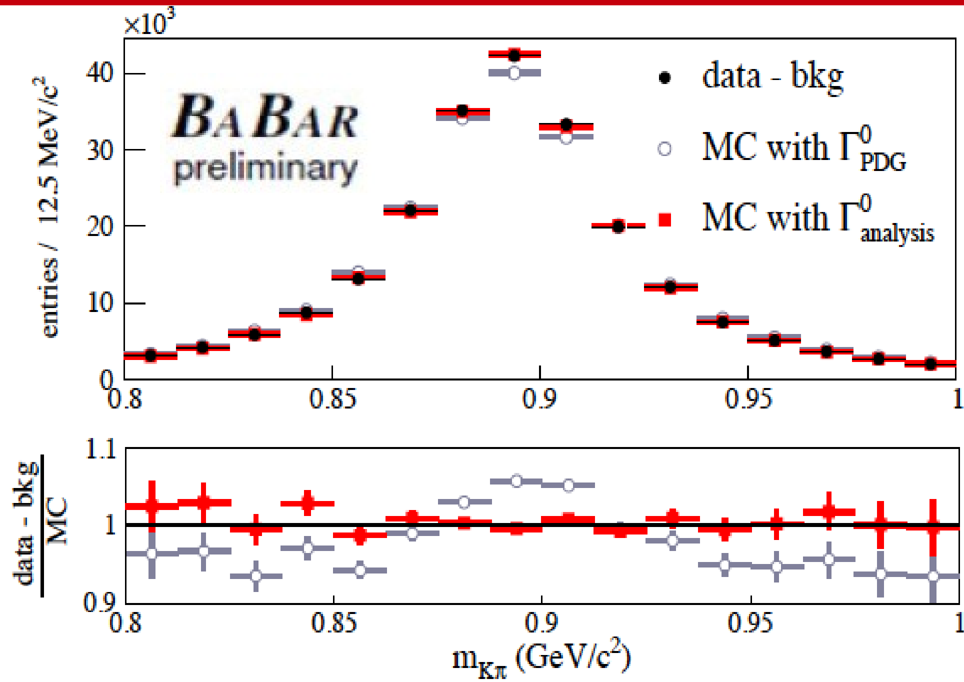
S-wave = low mass component + $K^*_0(1430)$



$r_{P'} = 0.074 \pm 0.016_{(stat.)}$

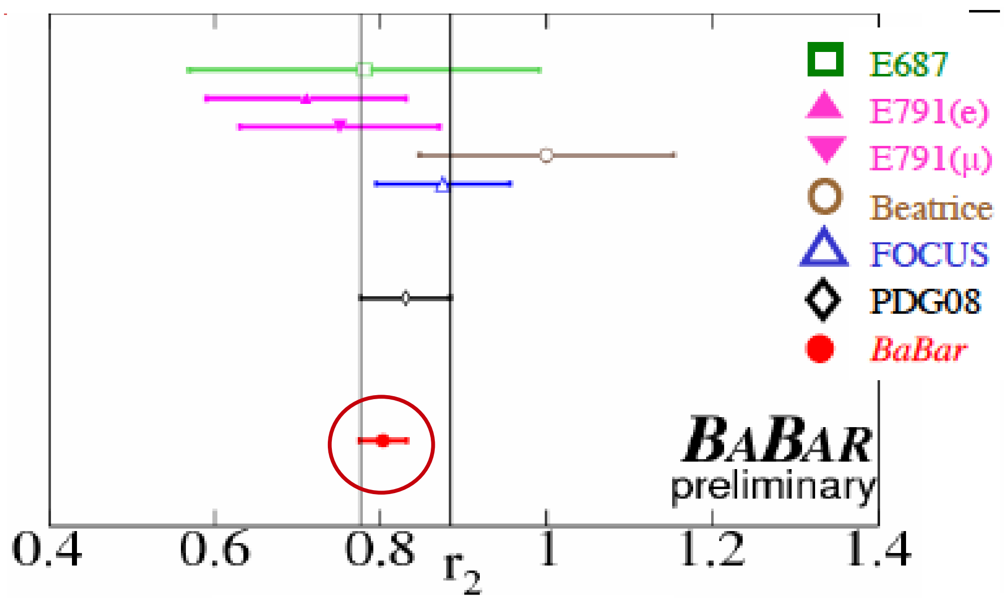
$r_{P'}$ = $K^{*0}(1410)$ relative amplitude

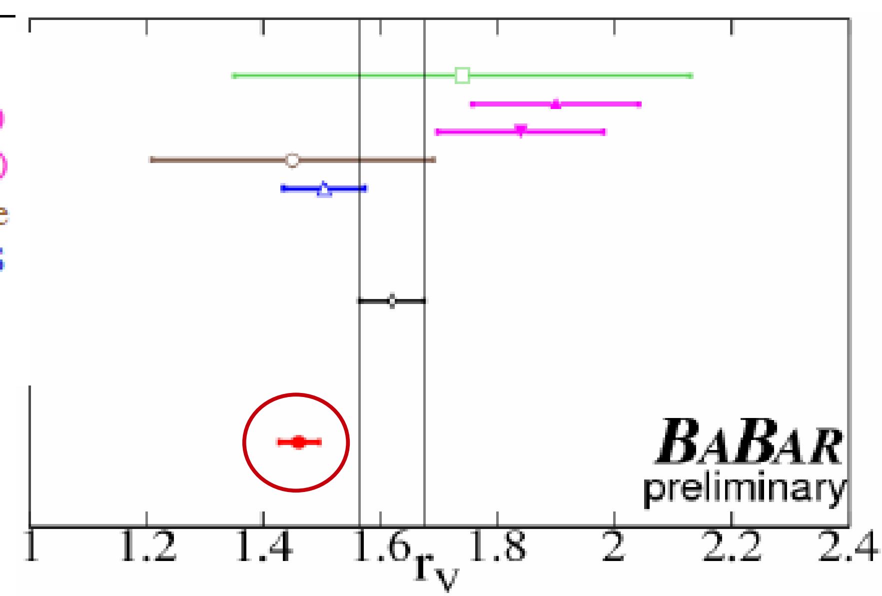
$D^+ \rightarrow K^- \pi^+ e^+ \nu$ – Results



$m_{K^*(892)^0}\,(\mathrm{MeV}/c^2)$	$895.4 \pm 0.2 \pm 0.2$
$\Gamma^0_{K^*(892)^0}\,(\mathrm{MeV}/c^2)$	$46.5 \pm 0.3 \pm 0.2$
$r_{BW}\,(\mathrm{GeV}/c)^{-1}$	$2.1 \pm 0.5 \pm 0.5$

$\Gamma^0_{K^*(892)}$(PDG) (MeV/c²) = 50.3 ± 0.6



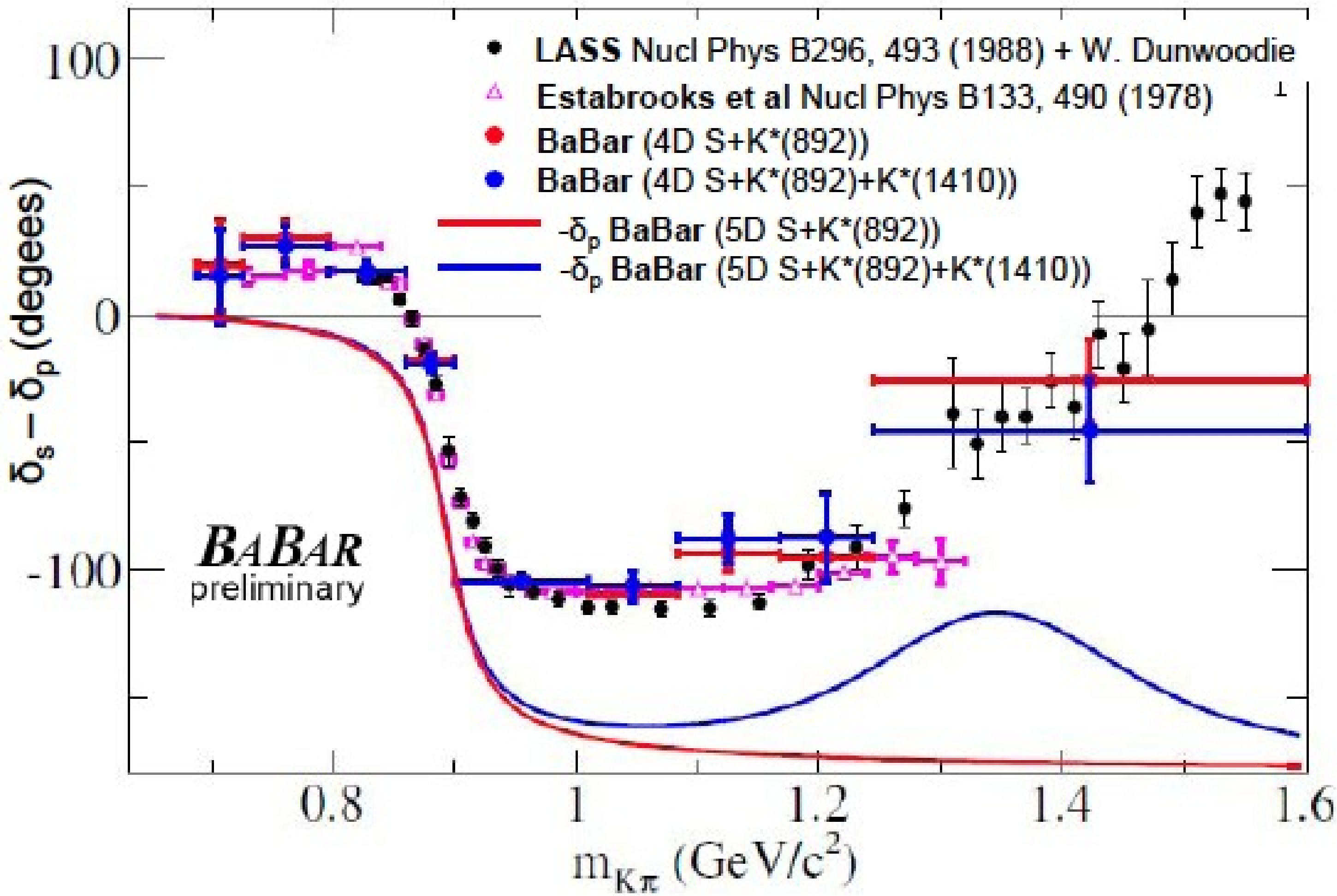


r_2=1.463±0.017±0.031

r_v=0.801±0.020±0.020

$D^+ \to K^- \pi^+ e^+ \nu$ – Results

Fixing the $K^*(892)$ parameters, signal and background fitted previously, the S-wave is measured in bins of $m_{K\pi}$



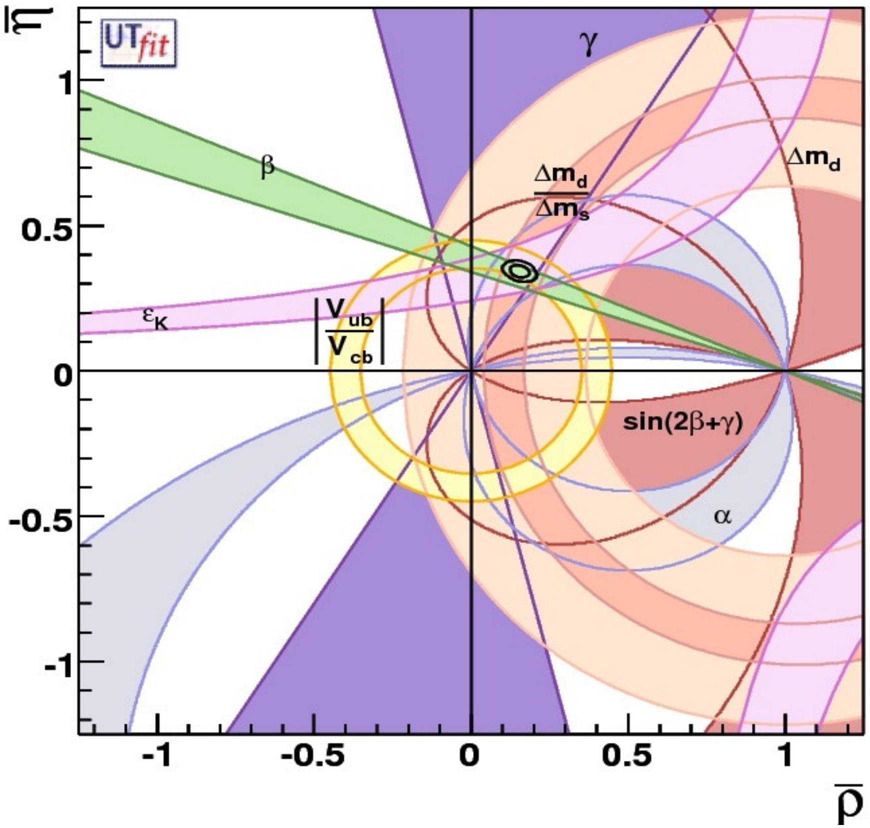
Watson's theorem:
Same phase variation (modulo π) with regards to Kπ scattering in the elastic regime

BaBar in agreement with LASS (Kπ scattering experiment) with a difference of π radians
This may help in the understanding the effect of the spectator pion in $D^+ \to K^- \pi^+ \pi^+_7$

V_{ub}

Important test of the SM picture
of CP-violation: consistency of UT

$$\frac{B(b \to u l \nu)}{B(b \to c l \nu)} \approx \frac{|V_{ub}|^2}{|V_{cb}|^2} \approx \frac{1}{50}$$

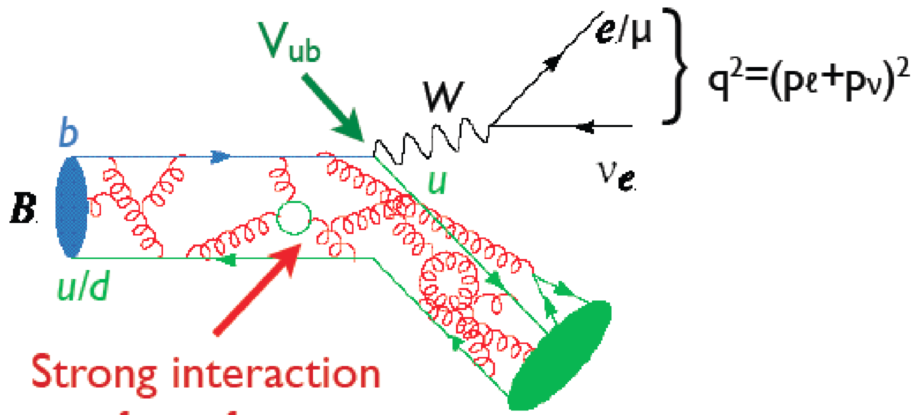


Precision achieved on V_{ub} depends both on experimental and theoretical FF errors

Two approaches to determine V_{ub} :

Exclusive : study of decays into specific final states ($B \to \pi/\eta/\rho/\eta'\ l\,\nu$)

Inclusive : study of decays into charmless final states ($B \to X_u\, e\, \nu$)



- Measure V_{ub}
- Test **QCD calculations of form factors**

$X_u = \pi^{\pm}, \pi^0, \rho^{\pm}, \rho^0, \eta^{(\prime)}$

$$\frac{d\Gamma}{dq^2}(B \to \pi l \nu) = \frac{G_F^2}{24\pi^3} p_\pi^3 |V_{ub}|^2 |f_+(q^2)|^2$$

- Selected signal sample is untagged, i.e. neutrino is identified as the missing massless particle in the whole event

- New BABAR result ($B \to \pi/\eta\, l\, \nu$) as well as BABAR analysis ($B \to \pi/\rho\, l\, \nu$) from earlier this year

In ($B \to \pi/\eta\, l\, \nu$) q^2 is determined as $(P_B - P_{meson})^2$ in three decay modes:

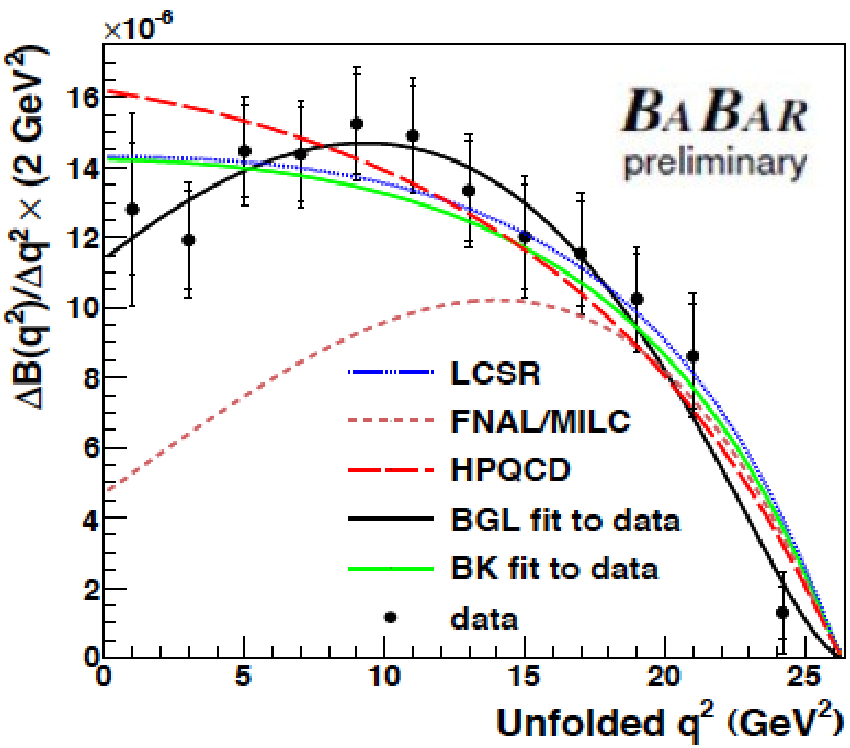
$\mathbf{B^0 \to \pi^- l^+ \upsilon\ ,\ B^+ \to \eta l^+ \upsilon\ ,\ B^+ \to \eta' l^+ \upsilon}$

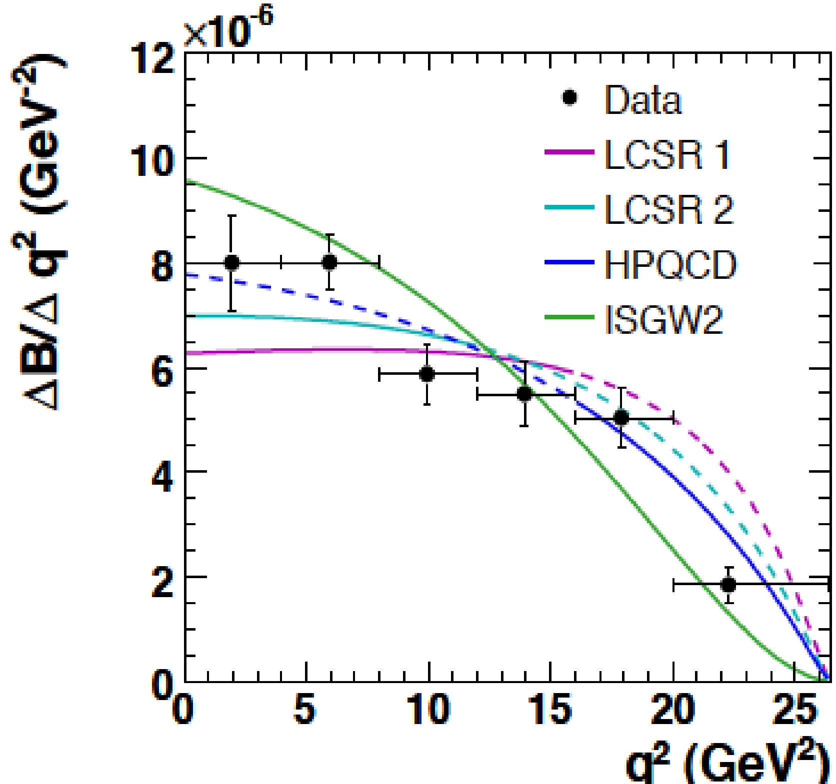
while in ($B \to \pi/\rho\, l\, \nu$) q^2 is determined as $(P_l + P_\upsilon)^2$ in four decay modes:

$\mathbf{B^{0/+} \to \pi^{-/0} l^+ \upsilon\ ,\ B^{0/+} \to \rho^{-/0} l^+ \upsilon}$

Exclusive V_{ub} - Results on q^2 spectra

	Loose neutrino reconstruction (π-η analysis)	Neutrino reconstruction (π-ρ analysis)
Lumi:	422.6 fb^{-1}	349 fb^{-1}
$\#B\bar{B}$pairs	$464 * 10^{6}$	$377 * 10^{6}$
q^2 bins	12	6
# modes	1 per fit	4 in same fit
B/S	11.5	6.3

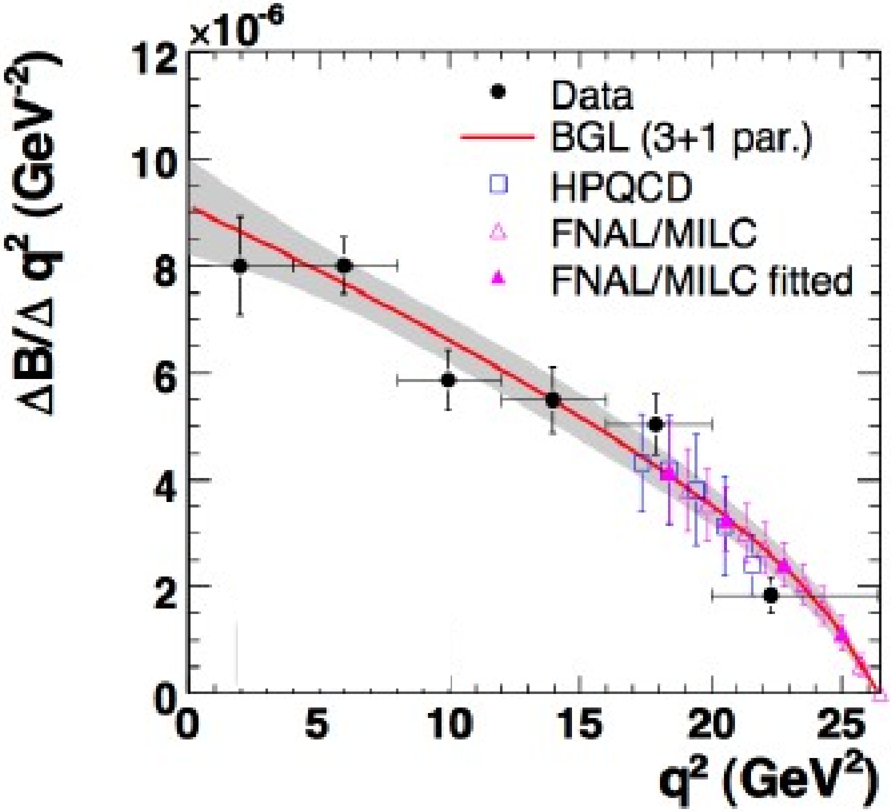




Best agreement with both B→ π l ν found with HPQCD

Theory extrapolations have large uncertainties

Exclusive V_{ub} - Results from combined fit to LQCD and BABAR data



Boyd, Grinstein, Lebed (BGL)

$$f_+(q^2) = \frac{1}{\mathcal{P}(q^2)\phi(q^2, q_0^2)} \sum_{k=0}^{k_{max}} a_k(q_0^2)[z(q^2, q_0^2)]^k$$

3 free parameters a_k: $\sum_k a_k^2 \leq 1$

Fit based on BGL (z-expansion) uses measured q^2 shape over the whole q^2 spectrum and shape + normalization from LQCD, highly correlated theory values!

Determination of q^2 shape dominated by BABAR data

Theory error on $|V_{ub}|$ reduced to 8.5% (traditional method: +17% - 11%)

$|V_{ub}|$ sensitive to data and theory in the specific q^2 range where they overlap

$|V_{ub}| = (2.95 \pm 0.31) * 10^{-3}$ FNAL/MILC (4 points)

Exclusive V_{ub} - Results on Br and V_{ub}

Branching ratios :

π-η analysis

$$\mathcal{B}(B^0 \to \pi^- \ell^+ \nu) = (1.42 \pm 0.05_{stat} \pm 0.08_{syst}) \times 10^{-4}$$
$$\mathcal{B}(B^+ \to \eta \ell^+ \nu) = (3.61 \pm 0.45_{stat} \pm 0.44_{syst}) \times 10^{-5}$$
$$\mathcal{B}(B^+ \to \eta' \ell^+ \nu) = (2.43 \pm 0.80_{stat} \pm 0.34_{syst}) \times 10^{-5}$$

π-ρ analysis

$$\mathcal{B}(B^0 \to \pi^- \ell^+ \nu) = (1.41 \pm 0.05 \pm 0.07) \times 10^{-4}$$
$$\mathcal{B}(B^0 \to \rho^- \ell^+ \nu) = (1.75 \pm 0.15 \pm 0.27) \times 10^{-4}$$

V_{ub} extraction :

	q^2 (GeV^2)	π-η analysis: $\|V_{ub}\|$ (10^{-3})	π-ρ analysis
HPQCD	> 16	$3.24 \pm 0.13 \pm 0.16 \,^{+0.57}_{-0.37}$	$3.21 \pm 0.17^{+0.55}_{-0.36}$
FNAL	> 16	$3.14 \pm 0.12 \pm 0.16 \,^{+0.35}_{-0.29}$	
LCSR	< 12	$3.70 \pm 0.07 \pm 0.09 \,^{+0.54}_{-0.39}$	$3.78 \pm 0.13^{+0.55}_{-0.40}$

π-ρ analysis + LQCD

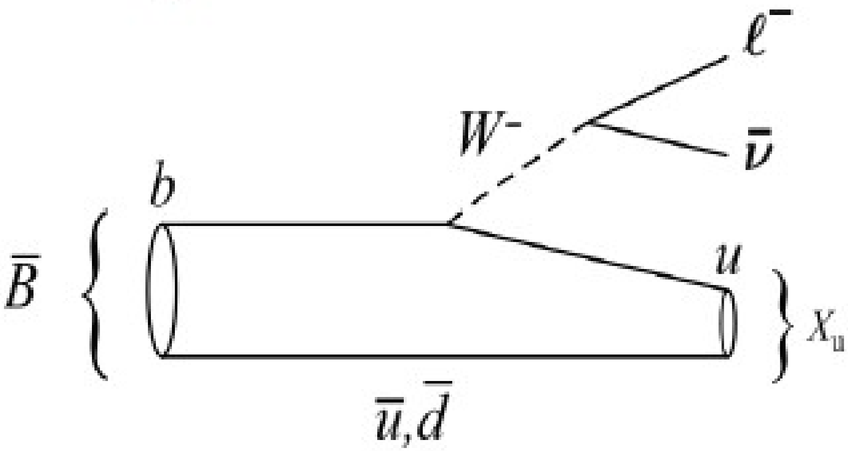
$|V_{ub}| = (2.95 \pm 0.31) * 10^{-3}$ FNAL/MILC (4 points)

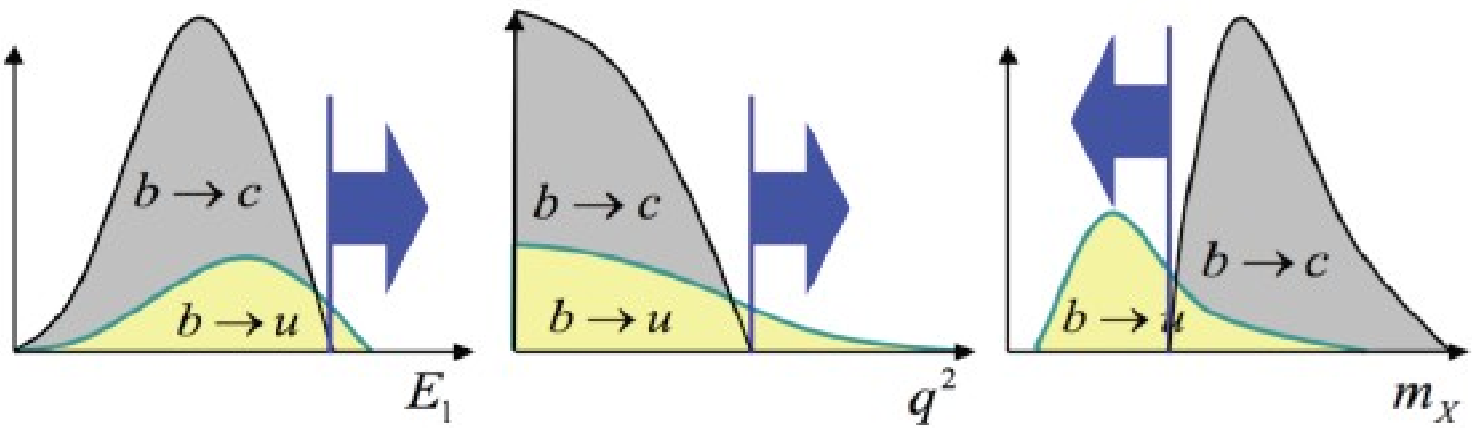
Much smaller theory errors !

To be compared with inclusive value of $V_{ub} = (4.27 \pm 0.38) * 10^{-3}$

Inclusive V_{ub} with hadronic tag - Overview

Huge background from $B \to X_c e \nu$ forces analysis
in restricted regions of phase space
$\to$ Determination of partial branching fractions



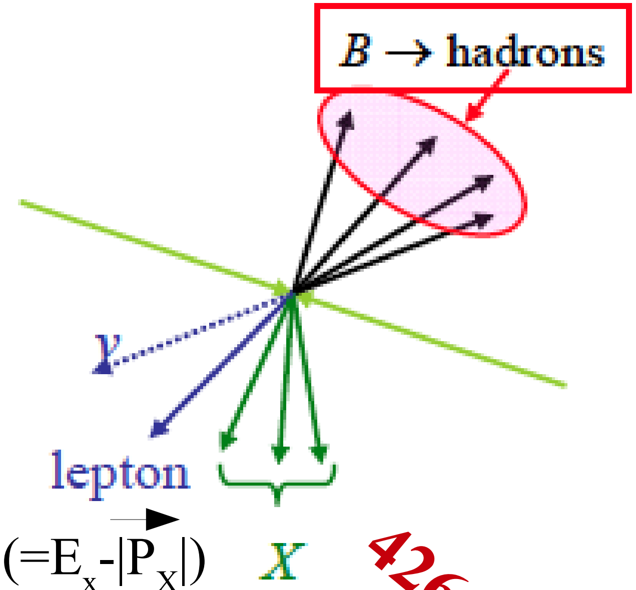


Induces dependence on theoretical models

Possibility to set limits on the size of weak annihilation decays (non-tree level effects) **(not covered here)**

Inclusive V_{ub} with hadronic tag - Reconstruction

$$B \rightarrow D^{(*)} Y$$
$$Y = n\pi + m\pi^0 + pK_S + qK$$



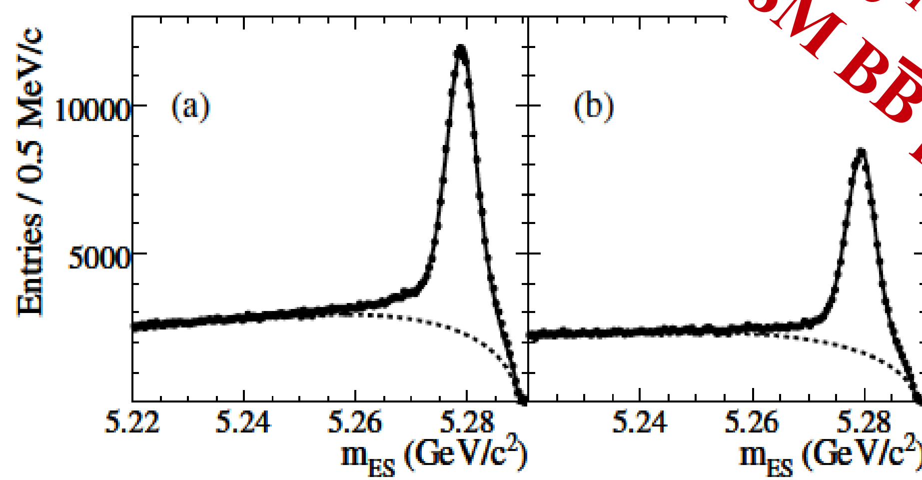
- Reconstruct a full decay chain in one of B (B_{reco})

- Study the recoiling B :
  - Decay products are properly assigned
  - Require a high-momentum lepton ($p^* > 1$ GeV/c) and missing mass consistent with neutrino
  - Kinematics completely determined, accessing to m_X, q^2, P_+ ($=E_x - |\vec{P}_X|$)
  - Low statistics (0.3-0.5 % efficiency)

426 fb^{-1}
468M $B\bar{B}$ pairs

- Subtract incorrectly reconstructed B_{reco} by fitting the m_{ES} distribution

$$m_{ES} = \sqrt{s/4 - \vec{p}_B^{\,2}}$$



Inclusive V_{ub} with hadronic tag – Strategy

Fit the distribution of different kinematic variables in several regions of phase space :

- $M_X < 1.55$ GeV/c^2
- $M_x < 1.70$ GeV/c^2
- $P_+ < 0.66$ GeV/c
- $M_X < 1.70$ GeV/c^2, $q^2 > 8$ GeV^2/c^4
- M_X, q^2 $p_l > 1$ GeV/c
- p_l, $p_l > 1.0 – 2.3$ GeV/c

- Signal yield extracted with a χ^2 shape fit

- We adjust ratio $N_{D^{**}}/(N_D+N_{D^*}+N_{D^{**}})$ based on signal-depleted sample, to correct for poorly known BF :
  - Fit quality improves;
  - $N_{D^{**}}/(N_D+N_{D^*}+N_{D^{**}})$ smaller in data than in MC

Normalized to semileptonic sample to reduce experimental systematic uncertainty

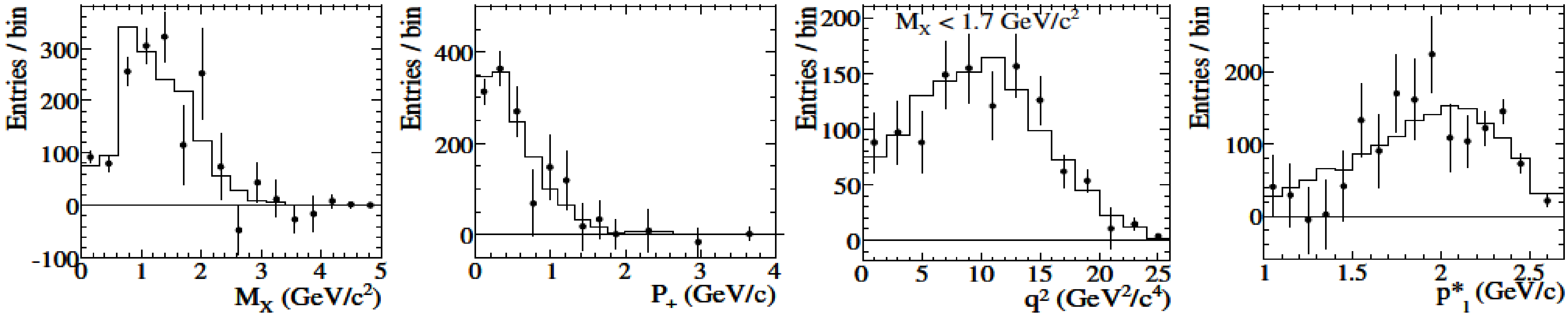
$$\Delta R_{u/sl} = \frac{(N_u^{fit})/(\epsilon_{sel}^u \epsilon_{kin}^u)}{N_{SL}^{meas} - BG_{sl}} \times \frac{\epsilon_l^{sl} \epsilon_t^{sl}}{\epsilon_l^u \epsilon_t^u}$$

$$\Delta R_{u/sl} \times (10.66 \pm 0.15)\%$$

$$\downarrow$$

$$\Delta B(\bar{B} \rightarrow X_u l \bar{\nu})$$

Inclusive V_{ub} with hadronic tag - Results



Belle analysis
PRL 104:021801 (2010)

	Signal yield	$\Delta\mathcal{B}(\bar{B} \to X_u \ell \bar{\nu})$ (10^{-3})	$\Delta\mathcal{B}(\bar{B} \to X_u \ell \bar{\nu})$ (10^{-3})
$M_X < 1.55$	$1033 \pm 73_{stat}$	$1.08 \pm 0.08_{stat} \pm 0.06_{sys}$	
$M_X < 1.70$	$1089 \pm 82_{stat}$	$1.15 \pm 0.10_{stat} \pm 0.08_{sys}$	
$P_+ < 0.66$	$902 \pm 80_{stat}$	$0.98 \pm 0.09_{stat} \pm 0.08_{sys}$	
$M_X < 1.70$ and $q^2 > 8$	$665 \pm 53_{stat}$	$0.68 \pm 0.06_{stat} \pm 0.04_{sys}$	
(M_X, q^2), $p^*_\ell > 1.0$	$1441 \pm 102_{stat}$	$1.80 \pm 0.13_{stat} \pm 0.15_{sys}$	
$p^*_\ell > 1.0$	$1462 \pm 137_{stat}$	$1.76 \pm 0.16_{stat} \pm 0.18_{sys}$	$1.963^* \pm 0.17_{stst} \pm 0.16_{syst}$
$p^*_\ell > 1.3$	$1326 \pm 118_{stat}$	$1.50 \pm 0.13_{stat} \pm 0.14_{sys}$	

reference

Signal model systematic dominates most inclusive analyses

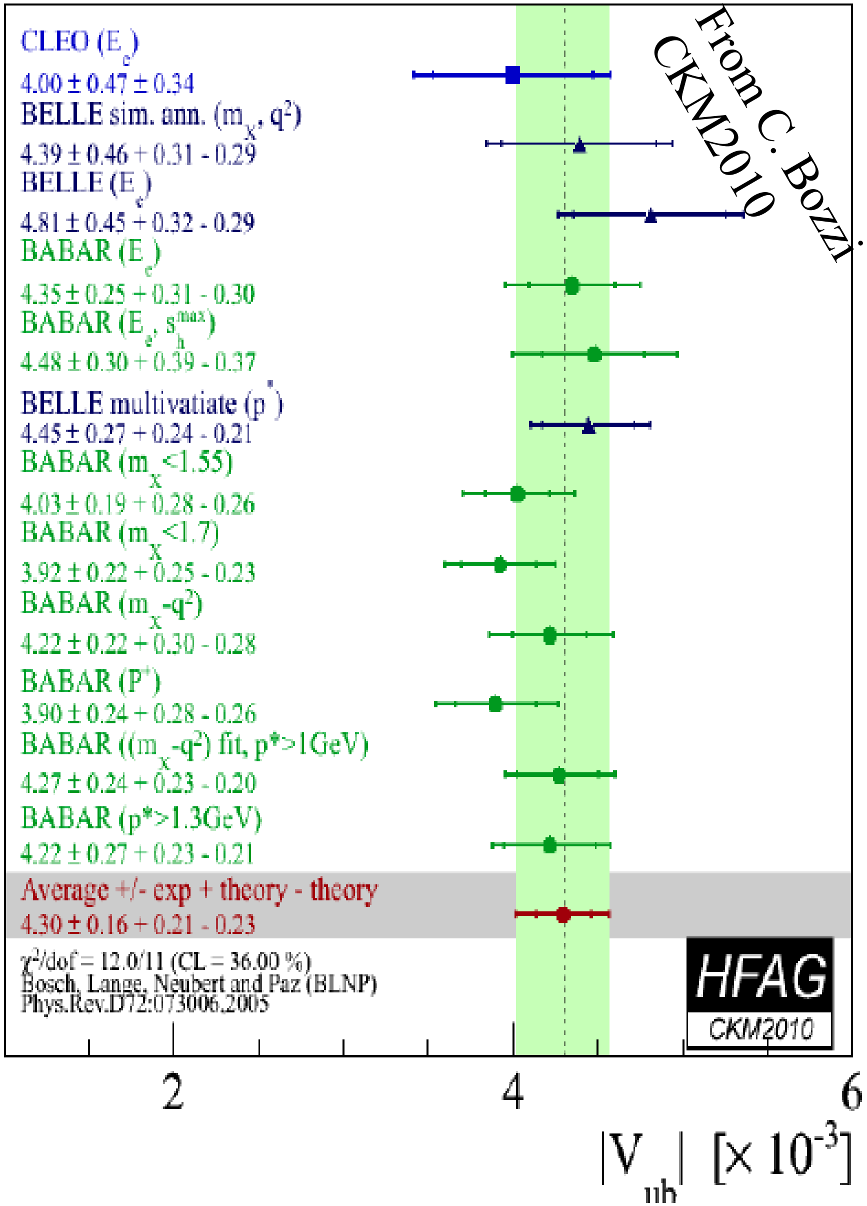
Inclusive V_{ub} with hadronic tag – Results - V_{ub}

Use all possible theoretical calculations to extract V_{ub}:

BNLP, GGOU, DGE, ADFR

For **BNLP**$_{\text{(shown)}}$, **GGOU, DGE** one may use the following relation to extract V_{ub} :

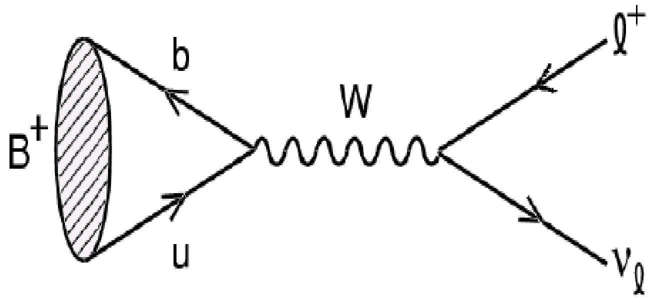
$$|V_{ub}| = \sqrt{\frac{\Delta\mathcal{B}(B \to X_u \ell \nu)}{\tau_B \cdot \Delta\Gamma_{theory}}}$$

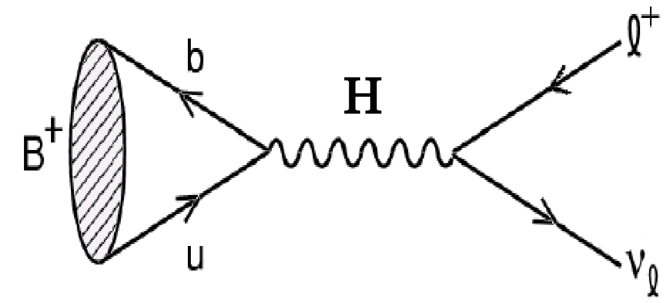


Agreement found between different calculations

Total uncertainties on the average for V_{ub} ~ 6.5 % (dominated by theory error)

$B^+ \to \tau^+ \nu$ - Overview





$$\mathcal{B}(B^+ \to \tau^+ \nu) = f_B^2 |V_{ub}|^2 \frac{G_F^2 m_B m_\tau^2}{8\pi} \left[1 - \frac{m_\tau^2}{m_B^2}\right]^2 \tau_{B^+} \quad \times \quad \left(1 - \frac{\tan^2\beta}{1+\epsilon_0 \tan\beta} \frac{m_B^2}{m_H^2}\right)^2$$

Can be used to measure V_{ub}, knowing the decay constant or vice-versa.

Can be used as probe for New Physics (NP) assuming external results for SM parameters

Helicity suppressed channel :

1st order prediction using PDG results for the SM $\to$ $Br = (1.2 \pm 0.2) * 10^{-4}$

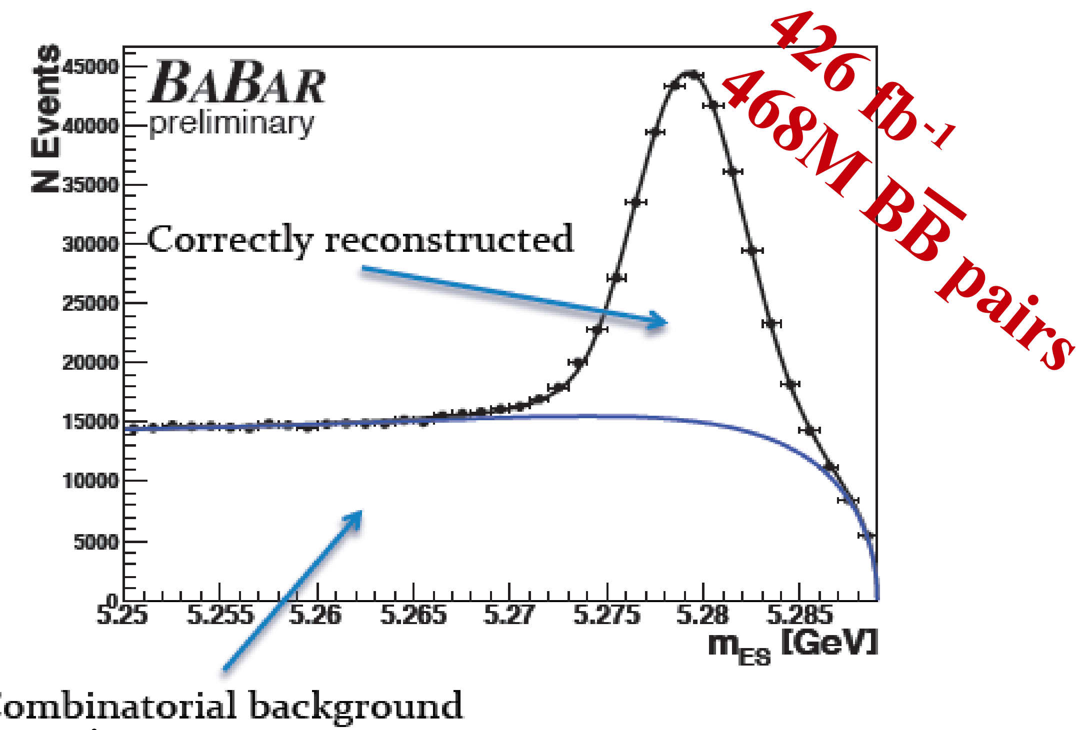
Previous results (e.g. BaBar with hadronic tags: $Br = (1.8^{+0.9}_{+0.8} \pm 0.4 \pm 0.2) * 10^{-4}$)

$B^+ \rightarrow \tau^+ \nu$ - Reconstruction and Strategy

$B \rightarrow D^{(*)} X$ and $B \rightarrow J/\psi X$
with single mode purity
$P > 10\ \%$ (optimized)

In case of multiple B candidates
select the one with smallest $|\Delta E$

Fit with standard distributions|



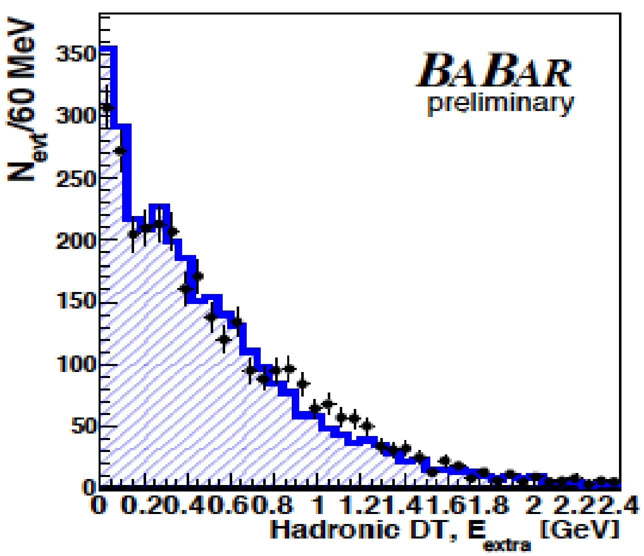
Most discriminating variable residual energy in the calorimeter (E_{extra})

- Defined as the total energy of clusters passing a minimum energy requirement of 60 MeV
- Used in a maximum likelihood fit to determine the Br. Fraction

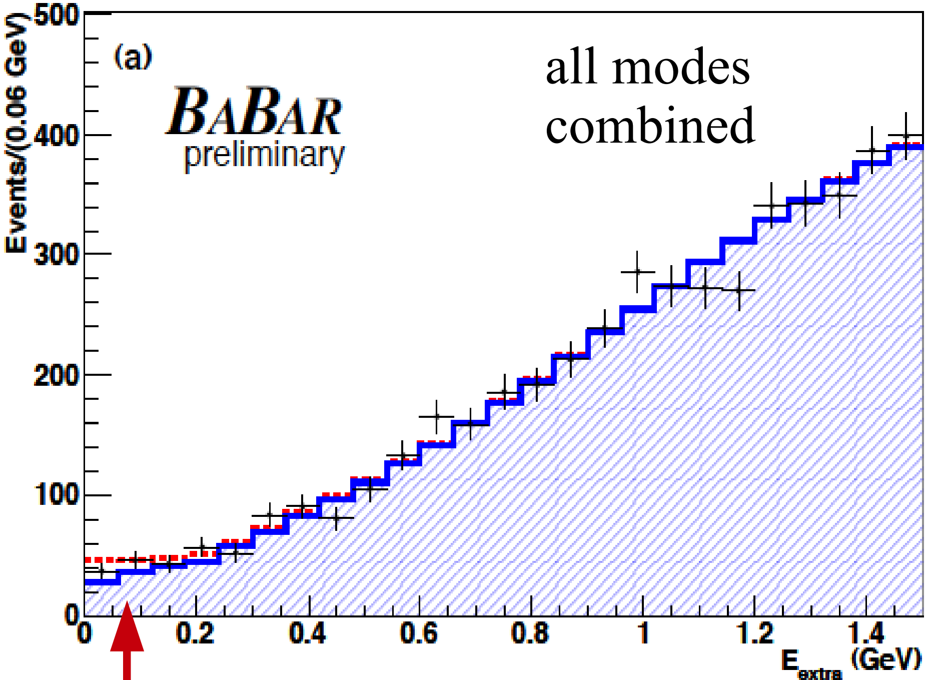
Optimized aiming at the smallest stat.+syst. uncertainty

- By means of toy MC experiments

E_{extra} validation made on double tags (had-had,had-SL)



$B^+ \to \tau^+ \nu$ - Results



Some excess of events at low E_{extra}

Simultaneous fit on the four decay modes :

Decay Mode	$\epsilon \times 10^{-4}$	Branching Fraction ($\times 10^{-4}$)	Significance σ
$\tau^+ \to e^+ \nu \bar{\nu}$	2.73	$0.39^{+0.89}_{-0.79}$	0.5
$\tau^+ \to \mu^+ \nu \bar{\nu}$	2.92	$1.23^{+0.86}_{-0.80}$	1.6
$\tau^+ \to \pi^+ \nu$	1.55	$4.0^{+1.5}_{-1.3}$	3.3
$\tau^+ \to \rho^+ \nu$	0.85	$4.3^{+2.2}_{-1.9}$	2.6
combined	8.05	$1.80^{+0.57}_{-0.54}$	3.6

$$\mathcal{B}(B \to \tau\nu) = (1.80^{+0.57}_{-0.54} \pm 0.26) \times 10^{-4}$$

Combining with the measurement with semi-leptonic tags (Phys. Rev. D 81, 051101(R) 2010) we present an average BABAR result of :

$$B(B \to \tau \nu) = (1.76 \pm 0.49) * 10^{-4}$$

preliminary

Summary

$D^+ \rightarrow K^- \pi^+ e^+ \nu$:

- Precise determination of K^{*0} lineshape and form factors
- Determination of the S-wave phase variation in SL decays (similar mass dependance as elastic scattering experiments up to a difference of π)

Exclusive V_{ub} :

- Two new precise measurements of $Br(B \rightarrow \pi l \nu)$, statistically largely independent
- Precise measurements of $Br(B \rightarrow \rho/\eta^{(\prime)} l \nu)$
- Results on $|V_{ub}|$ based on same extraction method are highly consistent
- Theory errors greatly reduced in fit BABAR + LQCD fit (theoretical uncertainties reduced by a factor 2)

Inclusive V_{ub} :

- Agreement found for V_{ub} using different calculations
- Total uncertainty on V_{ub} ~ 6 % (3.5 % exp/ error and 5.3 % theory error)

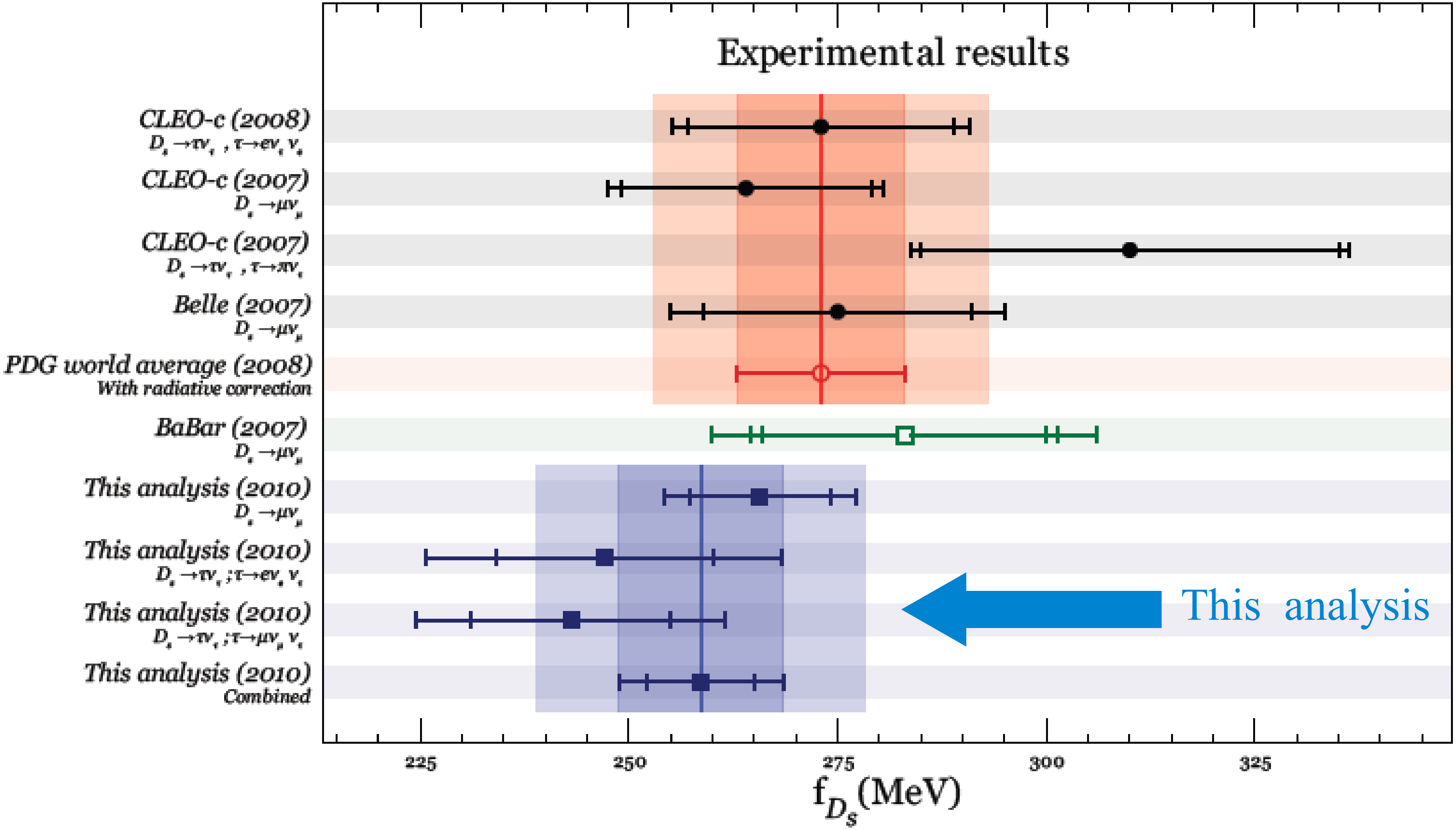
$B^+ \rightarrow \tau^+ \nu$:

- Updated analysis with full BaBar dataset with hadronic B tags;
- Excludes the null hypothesis at the 3.6 σ level;

Back-up

$D_s \to l^+ \nu$

Very competitive results !!



HPQCD (2010) give f_{D_s} = (248± 2.5) MeV (arXiv:1008.4018)

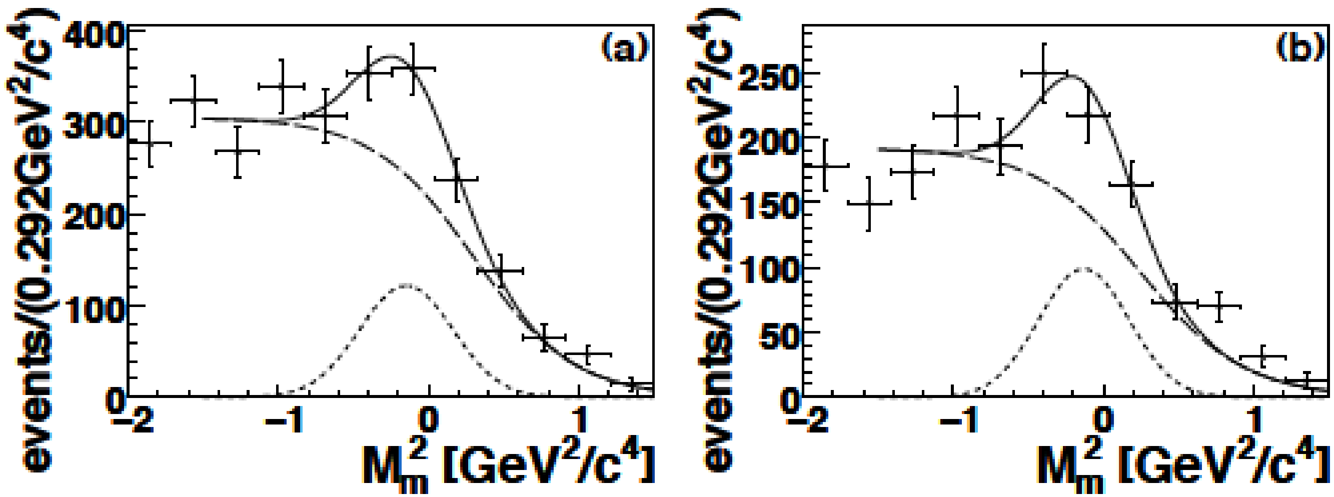
Taken from Aidan Randle-Conde, Charm2010

$B^- \to D_s^{(*)} K^- l^- \nu$

Known discrepancies between V_{cb} exclusive and inclusive. Content of high mass X_c states in $B \to X_c e^+ \nu$ not fully understood.

Motivation : Determine Br of this decay.

From the shape of hadronic mass spectrum, one expects Br ~ 10^{-3}



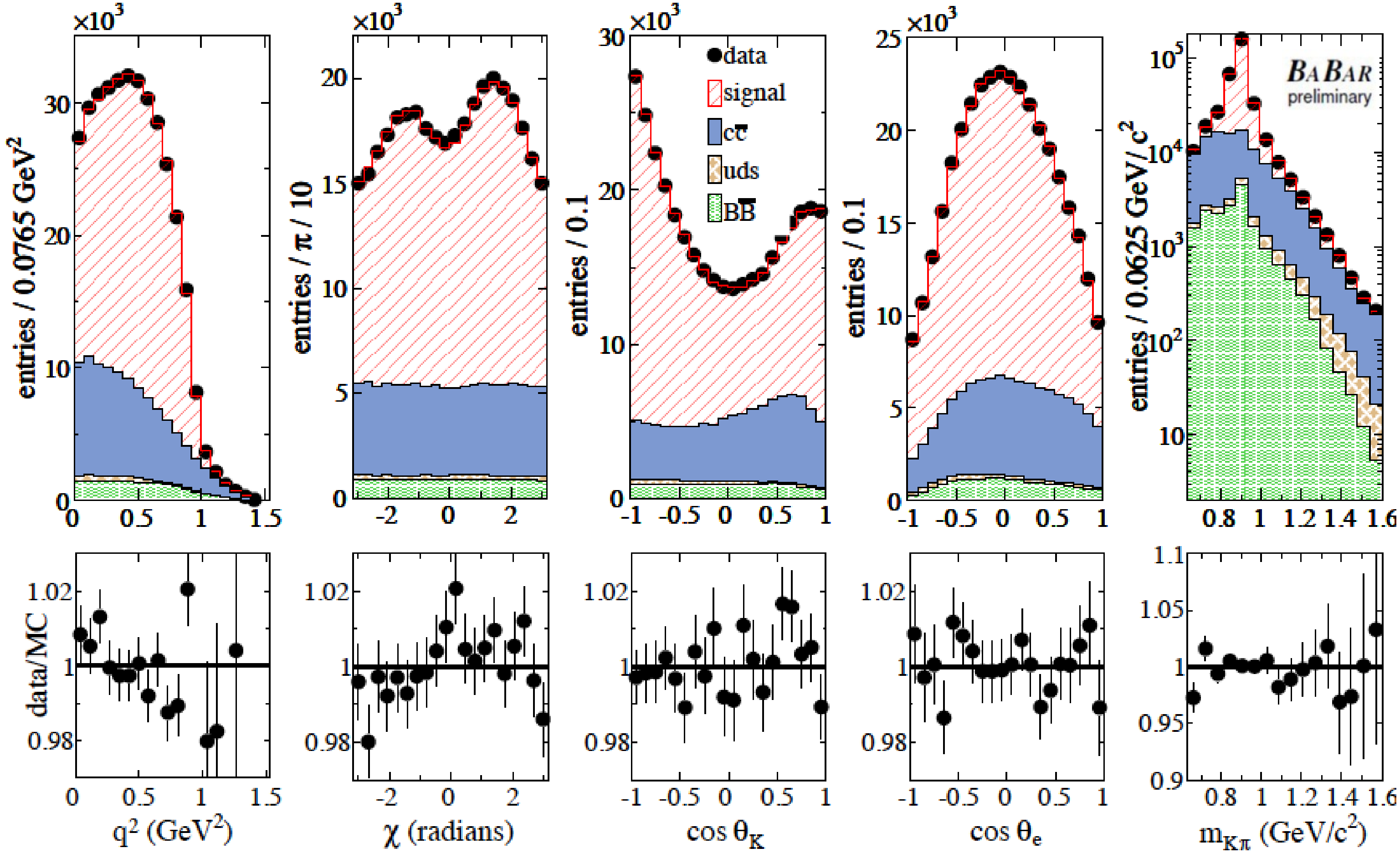
$$M_m^2 = (E_B - E_Y)^2 - |\vec{p}_Y|^2 = m_\nu^2$$

$$\mathcal{B}(B^- \to D_s^{(*)+} K^- \ell^- \overline{\nu}_\ell) = [6.13^{+1.04}_{-1.03}(\text{stat.}) \pm 0.43(\text{syst.}) \pm 0.51(\mathcal{B}(D_s))] \times 10^{-4}$$

>5σ significance

- Decay channel measured with over 5 sigmas significance
- Confirms the expected rapid decrease of the hadronic mass distribution at high values.

$D^+ \to K^- \pi^+ e^+ \nu$ – Results projection in 5D



Three signal models :

Component	$S+\overline{K}^*(892)^0$ (%)	$S+\overline{K}^*(892)^0$ $+\overline{K}^*(1410)^0$(%)	$S+\overline{K}^*(892)^0$ $\overline{K}^*(1410)^0+D$(%)
S-wave	$5.62 \pm 0.14 \pm 0.13$	$5.79 \pm 0.16 \pm 0.15$	$5.69 \pm 0.16 \pm 0.15$
P-wave	94.38	94.21	94.12
$\overline{K}^*(892)^0$	94.38	$94.11 \pm 0.74 \pm 0.75$	$94.41 \pm 0.15 \pm 0.20$
$\overline{K}^*(1410)^0$	0	$0.33 \pm 0.13 \pm 0.19$	$0.16 \pm 0.08 \pm 0.14$
D-wave	0	0	$0.19 \pm 0.09 \pm 0.09$

Significance of adding P' or D ~ 4 σ (stat.)

$D^+ \rightarrow K^- \pi^+ e^+ \nu$

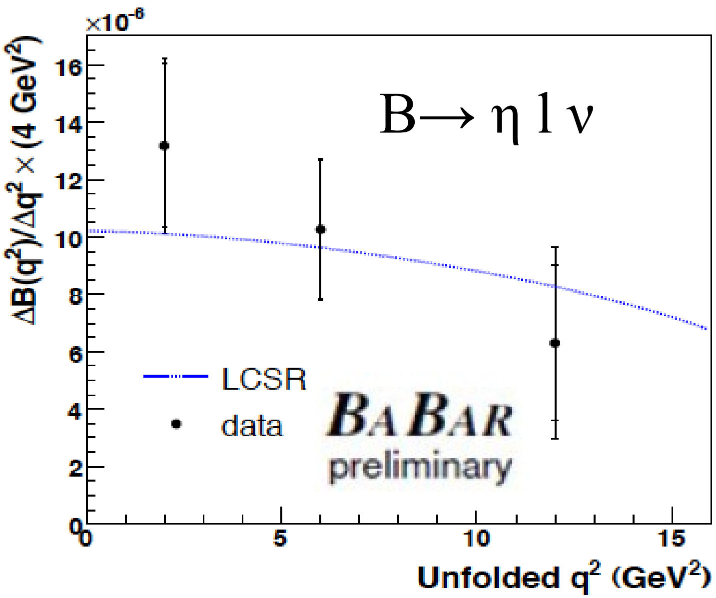
	Measured quantity	This analysis	PDG
K^{*0} lineshape parameters	$m_{K^*(892)^0}(\mathrm{MeV}/c^2)$	$895.4 \pm 0.2 \pm 0.2$	896.00 ± 0.25
	$\Gamma^0_{K^*(892)^0}(\mathrm{MeV}/c^2)$	$46.5 \pm 0.3 \pm 0.2$	50.3 ± 0.6
	$r_{BW}(\mathrm{GeV}/c)^{-1}$	$2.1 \pm 0.5 \pm 0.5$	2.72 ± 0.55
Form factor parameters (single-pole appr./)	r_V	$1.463 \pm 0.017 \pm 0.031$	1.62 ± 0.08
	r_2	$0.801 \pm 0.020 \pm 0.020$	0.83 ± 0.05
	$m_A(\mathrm{GeV}/c^2)$	$2.63 \pm 0.10 \pm 0.13$	no result
	$\mathcal{B}(D^+ \to K^-\pi^+e^+\nu_e)(\%)$	$4.04 \pm 0.03 \pm 0.04 \pm 0.09$	4.1 ± 0.6
	$\mathcal{B}(D^+ \to K^-\pi^+e^+\nu_e)_{\overline{K}^{*0}}(\%)$	$3.80 \pm 0.04 \pm 0.05 \pm 0.09$	3.66 ± 0.21
	$\mathcal{B}(D^+ \to K^-\pi^+e^+\nu_e)_{S-wave}(\%)$	$0.234 \pm 0.007 \pm 0.007 \pm 0.005$	0.21 ± 0.05
	$\mathcal{B}(D^+ \to \overline{K}^*(1410)^0 e^+\nu_e)(\%)$	$0.30 \pm 0.12 \pm 0.18 \pm 0.06$ (< 0.6 at 90% C.L.)	
	$\mathcal{B}(D^+ \to \overline{K}^*_2(1430)^0 e^+\nu_e)(\%)$	$0.023 \pm 0.011 \pm 0.011 \pm 0.001$ (< 0.05 at 90% C.L.)	

Exclusive V_{ub} -- Strategies

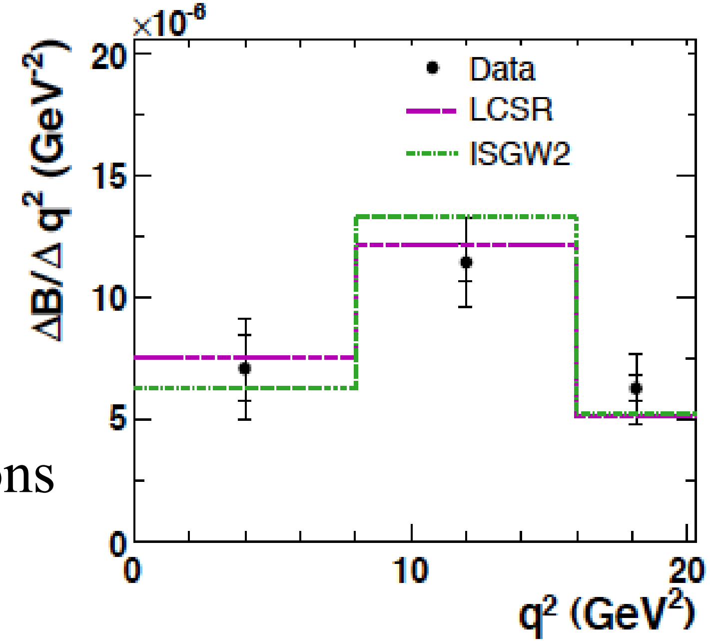
Analysis	π-η	π-ρ
Luminosity onpeak ϒ (4S)	422.6 fb^{-1}	349.0 fb^{-1}
Number of BB pair events	464 millions	377 millions
q^2 evaluation	$(P_B - P_{meson})^2$	$(P_\ell + P_\nu)^2$
Cut strategy	q^2 dependent, cuts	q^2 dependent, NN
Cut selection	Loose ν cuts	Tighter ν cuts
Signal efficiency	8% to 15%	6% to 7%
Background/Signal	11.5	6.3
$B \to \pi \ell \nu$ yield	11778 ± 435	10604 ± 376
Number of q^2 bins	12	6
Fit strategy	1-mode $(\pi^-, \eta, \eta')\ell\nu$	4-modes $(\pi^-, \pi^0, \rho^-, \rho^0)\ell\nu$
Systematic uncertainties	Full gaussian	±1σ

Statistical correlation between both data sets is fairly low (<20%)

Exclusive V_{ub}



Errors too large
to exclude predictions



Exclusive V_{ub}

elle has a new preliminary branching fraction for $B^0 \to \pi^- \ell^+ \overline{\nu}_\ell$

$$\mathcal{B} = (1.49 \pm 0.04_{\rm stat} \pm 0.07_{\rm syst}) \times 10^{-4}$$

rtial BFs are extracted in 13 bins of q^2

$_{ub}|$ is extracted by two methods

- In a model dependent way e.g. using LCSR

$$|V_{ub}| = (3.64 \pm 0.06_{stat} \pm 0.09_{syst}{}^{+0.60}_{-0.40}{}_{FF}) \times 10^{-3}$$

- In a model independent way combining Belle and MILC data

$$|V_{ub}| = (3.43 \pm 0.33_{stat+syst}) \times 10^{-3}$$

c.f. BaBar+MILC $|V_{ub}| = (2.95 \pm 0.31) \times 10^{-3}$ arXiv:1005.3288v1 [hep-ex]

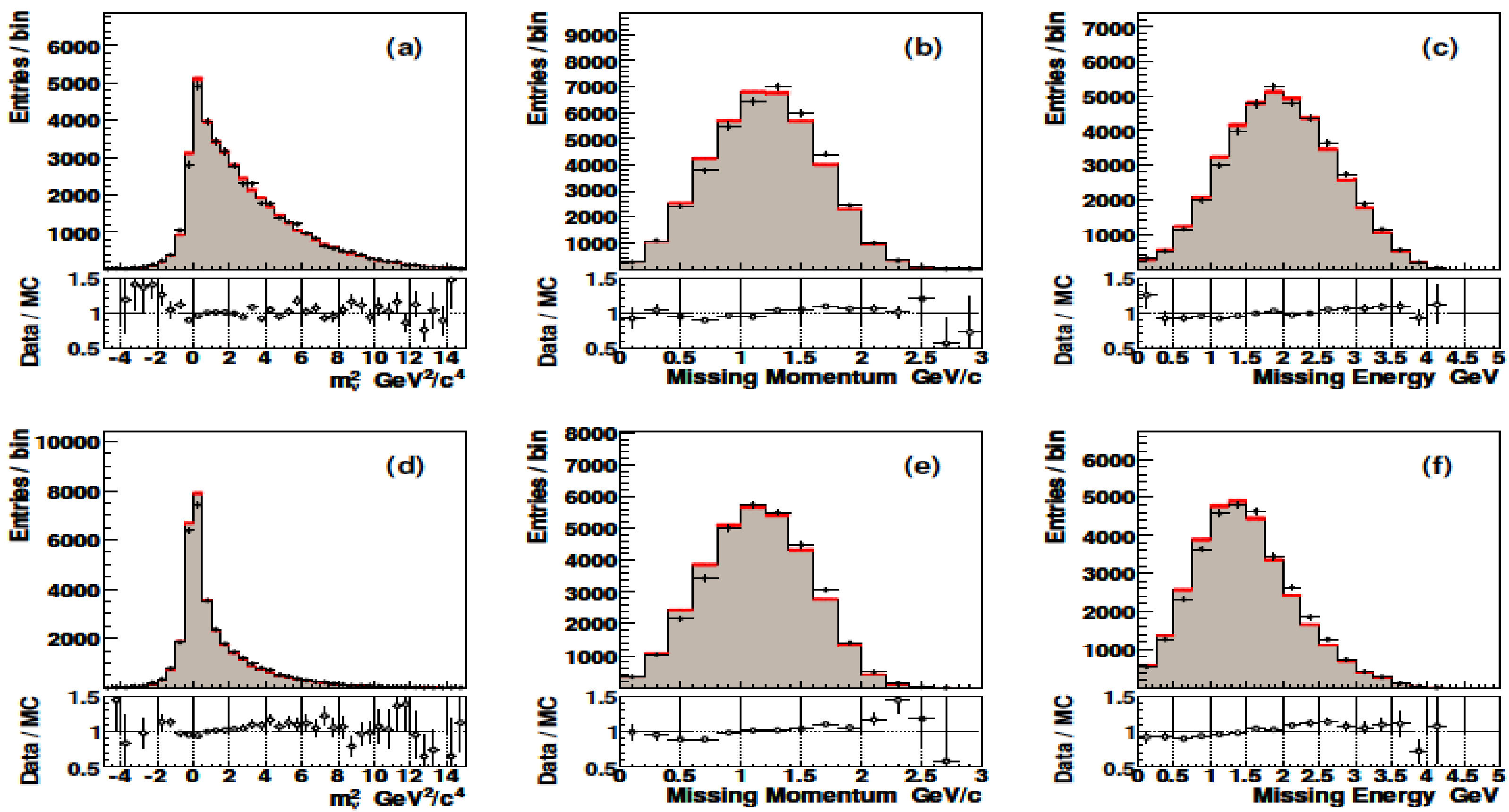
Good agreement
Between B-factories

Slide taken from Kevin Varvell from Belle, at CKM2010 Warwick

Inclusive V_{ub} with hadronic tag - Validation

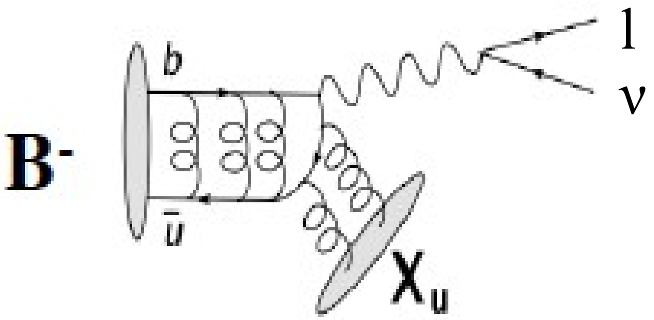
Signal depleted sample

Signal enriched sample



Good agreement between data and simulation in both subsamples

Inclusive V_{ub} with hadronic tag – WA limits



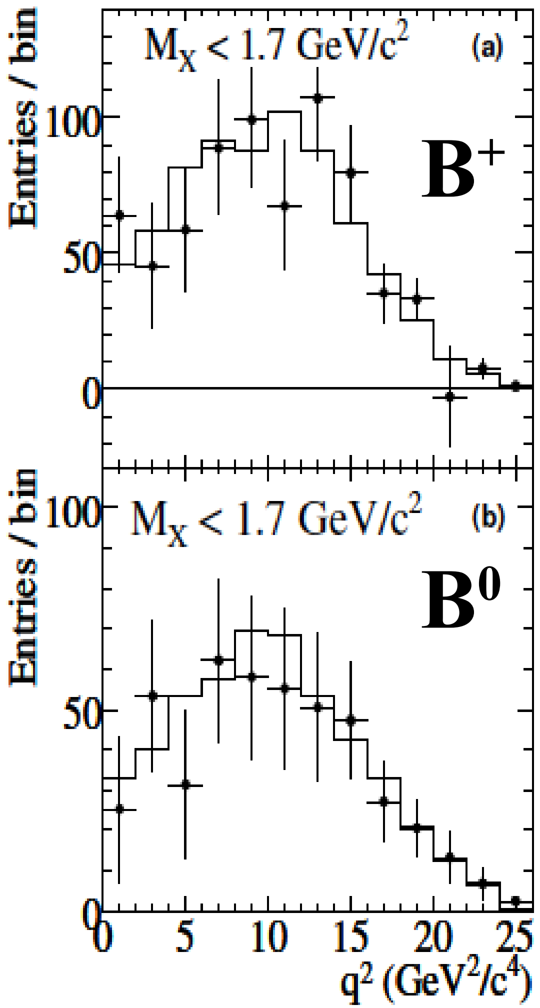
These contributions could cause asymetries in Br between B^0 and B^+ that may affect $|V_{ub}|$

$$R^{+/0} = \frac{\Delta\Gamma^+}{\Delta\Gamma^0} = \frac{\tau^0}{\tau^+} \cdot \frac{\Delta\mathcal{B}(B^+ \to X_u \ell\nu)}{\Delta\mathcal{B}(B^0 \to X_u \ell\nu)}$$

$$\frac{\gamma_{WA}}{\Gamma} = \frac{f_u}{f_{WA}} \cdot R^{+/0},$$

f_u : fraction of signal in fit region

	$R^{+/0}-1$	C.L. (90%)
$M_X \leq 1.70,\ q^2 \geq 8$	$0.042 \pm 0.066 \pm 0.009$	$-0.07 \leq \gamma_{WA}/\Gamma \leq 0.15$
$M_X \leq 1.55$	$-0.020 \pm 0.066 \pm 0.003$	$-0.13 \leq \gamma_{WA}/\Gamma \leq 0.09$
$M_X \leq 1.70$	$0.071 \pm 0.117 \pm 0.011$	$-0.12 \leq \gamma_{WA}/\Gamma \leq 0.26$
$(M_X,\ q^2)\ p_\ell^* > 1.0$	$0.109 \pm 0.157 \pm 0.019$	$-0.15 \leq \gamma_{WA}/\Gamma \leq 0.37$



Other results :

CLEO, *studing the q^2 spectra*
PRL 96,12801 (2006)

$$\frac{|\Gamma_{WA}|}{\Gamma_u} < 7.4\,\%\ @\ 90\,\%\ C.L.$$

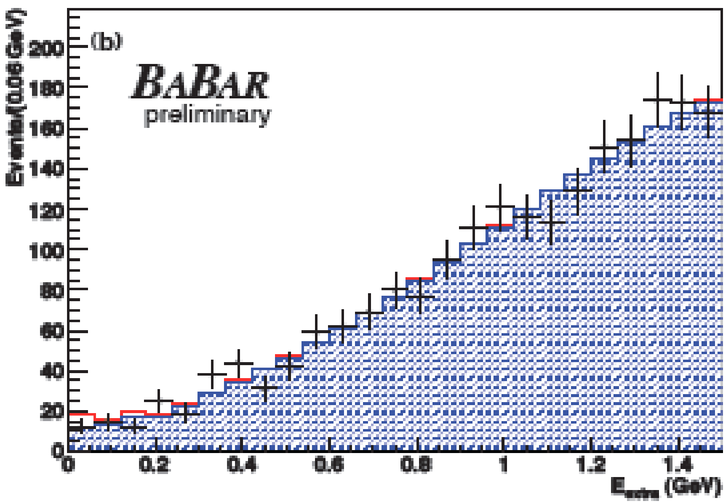
BaBar ArXiv: 0808.1753
383 M BB

$$\frac{|\Gamma_{WA}|}{\Gamma_u} < \frac{3.8\%}{f_{WA}(2.3-2.6)}\ @90\%C.L.$$

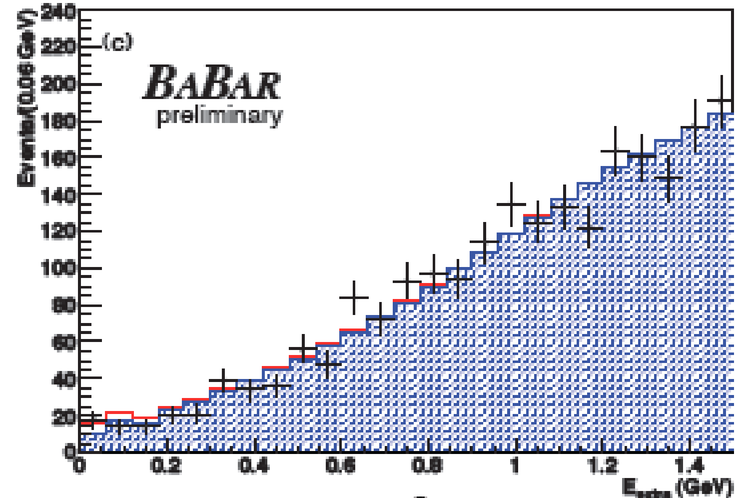
$B^+ \rightarrow \tau^+ \nu$

Simultaneous fit projections

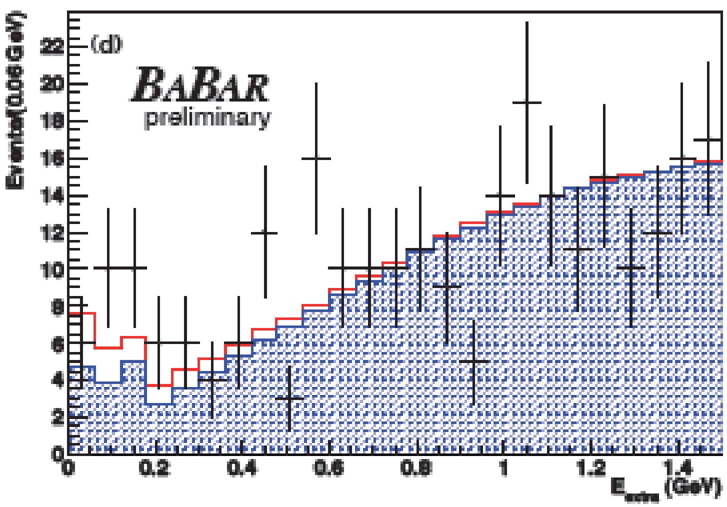
$\tau \rightarrow e \nu \nu$



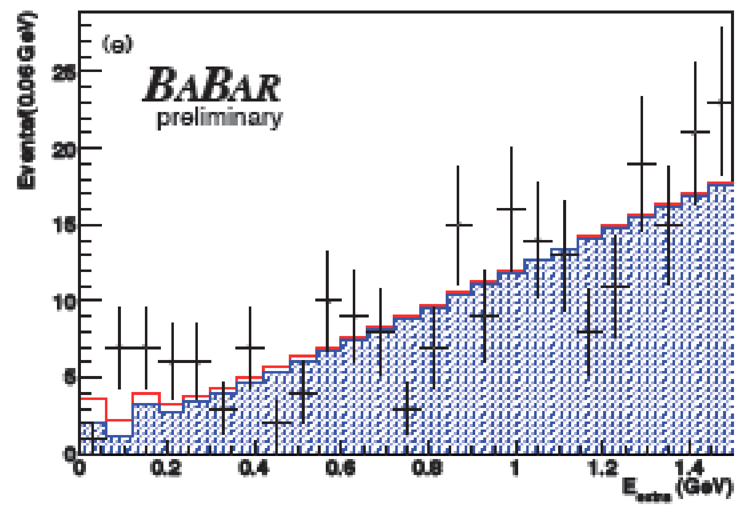
$\tau \rightarrow \mu \nu \nu$



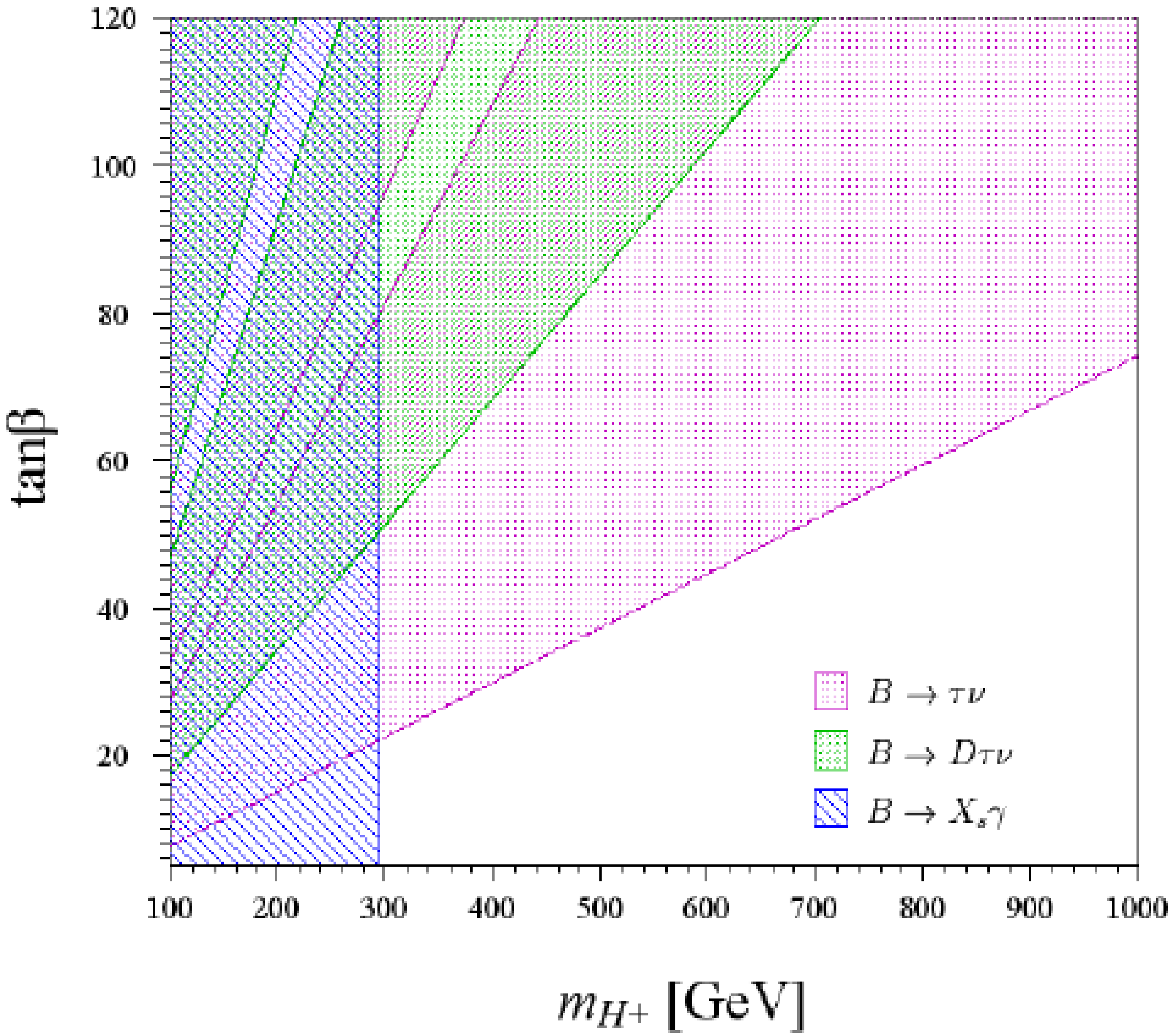
$\tau \rightarrow \pi \nu$



$\tau \rightarrow \pi \pi^0 \nu$



$B^+ \to \tau^+ \upsilon$



95% prob. exclusion

UTFit for 2HDM-II, preICHEP