Summary WG 2 - Theory

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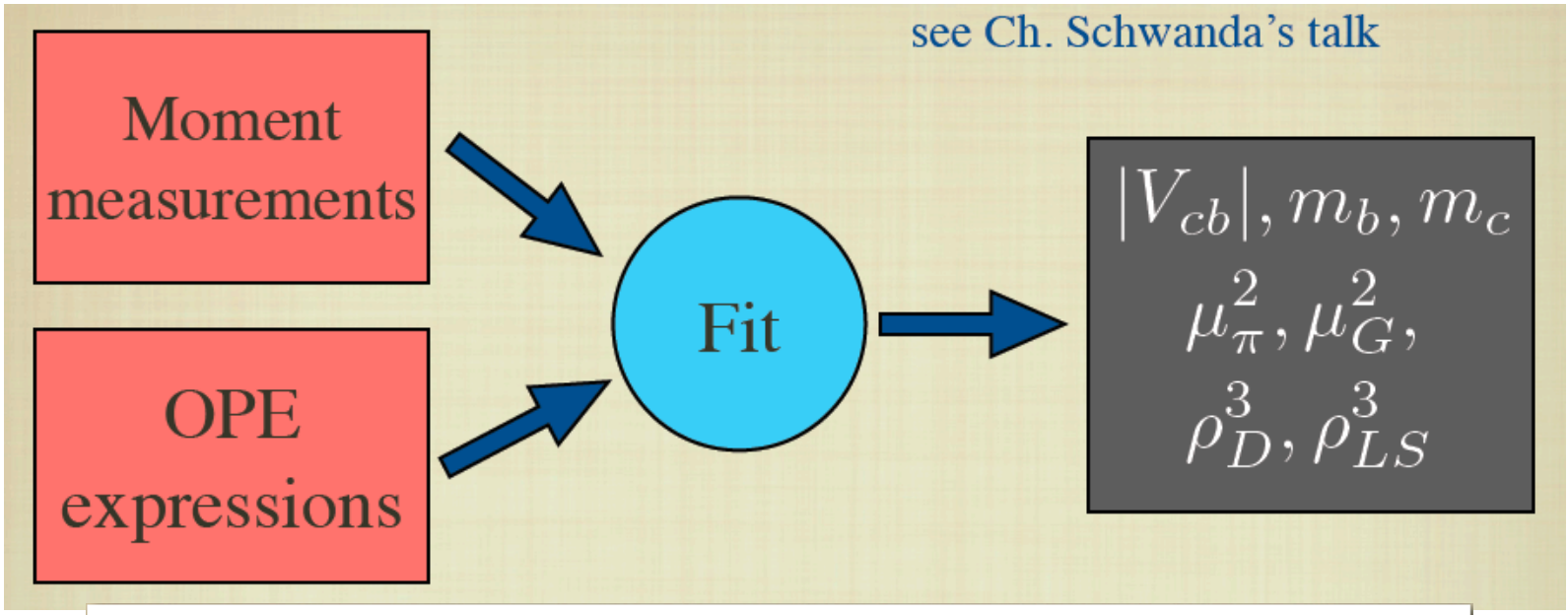
Presentations

- Nils Offen: Form factor determinations from light-cone sum rules
- Junko Shigemitsu: $B \to \pi$ semileptonic decays - Status report from lattice QCD
- Thomas Becher: $B \to X_c l \nu$ theory - Status and prospects
- Jack Laiho: Determination of F(1) and G(1)
- Nazario Tantalo: Future prospects for LQCD form factor calculations
- Einan Gardi: Theoretical review - $B \to X_s \gamma$ spectrum and moments
- Paolo Gambino: Status and prospects of inclusibe $b \to u l \nu$ theory
- Vicent Mateu: Charm and bottom mass determination from sum rules

Moment fit & HQ parameters



Fit Results in the Kinetic Scheme

Input	$\|V_{cb}\|$ (10^{-3})	m_b^{kin} (GeV)	mu^2_{pi} (GeV^2)		chi^2/ndf.
all moments ($X_c$lnu and $X_s$gamma)	41.67 +/- 0.43(fit) +/- 0.08(tau_B) +/- 0.58(th)	4.601 +/- 0.034	0.440 +/- 0.040	details	29.7 / (64-7)
$X_c$lnu only	41.48 +/- 0.47(fit) +/- 0.08(tau_B) +/- 0.58(th)	4.659 +/- 0.049	0.428 +/- 0.044	details	24.1 / (53-7)

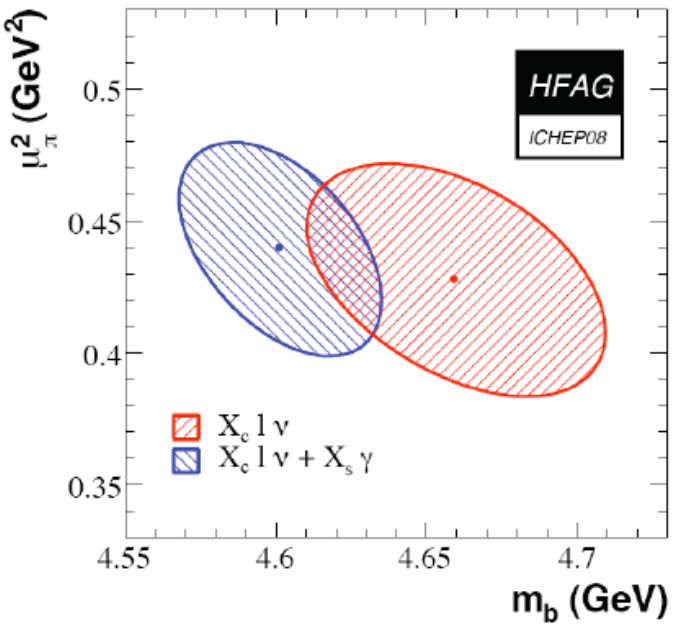
Moment fit & HQ parameters

- OPE predictions for $B \to X_c l \nu$ moments now available (soon …) including $O(\alpha_s^2)$ and $O(\alpha_s/m_b^2)$ corrections, and parametrization of $O(1/m_b^4)$ effects [Becher]
- Expected to remove important theoretical limitations, could potentially shift $|V_{cb}|$ and $m_{b,c}$ values [Schwanda]

Moment fit & HQ parameters

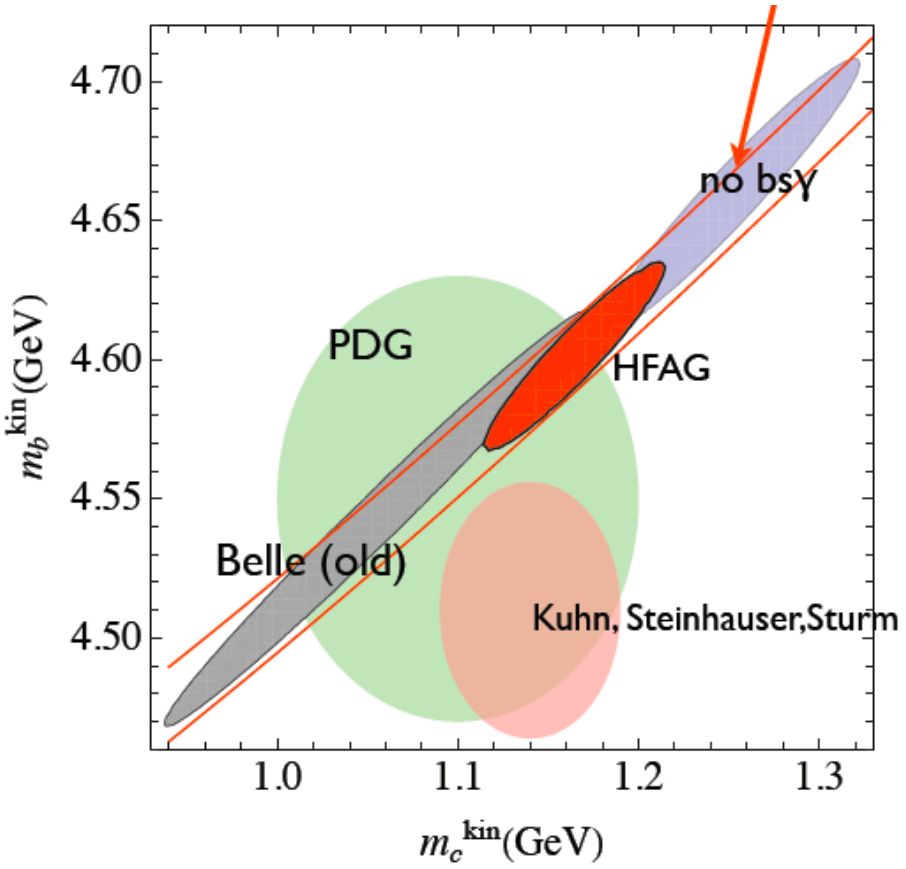
- Issues: [Becher, Gardi]
  - quark-hadron duality (X_c=D,D* for ~80% of events → hadronic mass moments?)
  - use of $B \to X_s\gamma$ moments introduces uncontrolled systematics due to shape function (E_0=1.8-2.0 GeV) and non-OPE contributions

    [Lee, MN, Paz (in prep.)]



Moment fit & HQ parameters

- Use of $B \to X_s\gamma$ moments driven by desire to break $m_{b,c}$ degeneracy and lower m_b to "reasonable" values
- Perhaps better to use independent determinations of $m_{b,c}$ instead



[Gambino]

Moment fit & HQ parameters

- Heavy-quark masses extracted from e^+e^- sum rules promising (many-loop results exist)
- Preliminary results (using contour-improved perturbation theory):

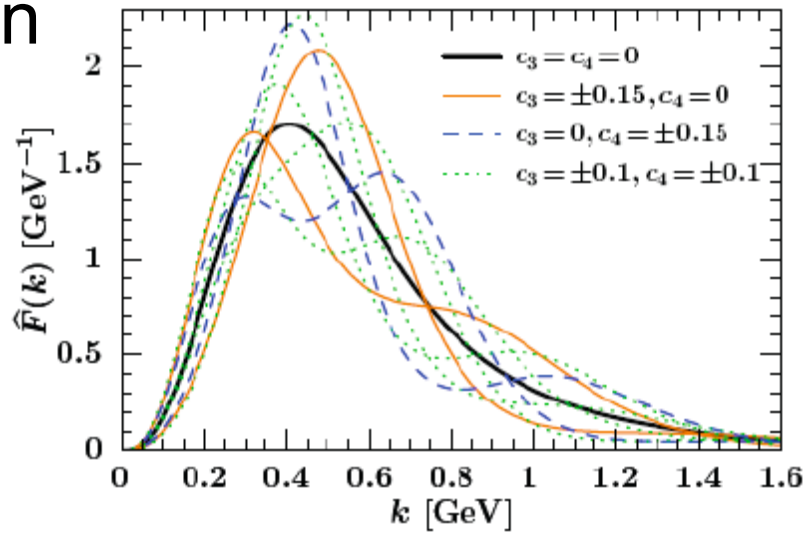
$m_c = 1.283 \pm 0.040_{\mathrm{exp}} \pm 0.016_{\mu} \pm 0.014_{method} \pm 0.001_{n}$

$m_b = 4.153 \pm 0.003_{\mu} \pm 0.009_{method} \pm 0.016_{n}$ [Matteu]

  - very competitive errors
  - more conservative than previous analysis by Kühn et al. (?)

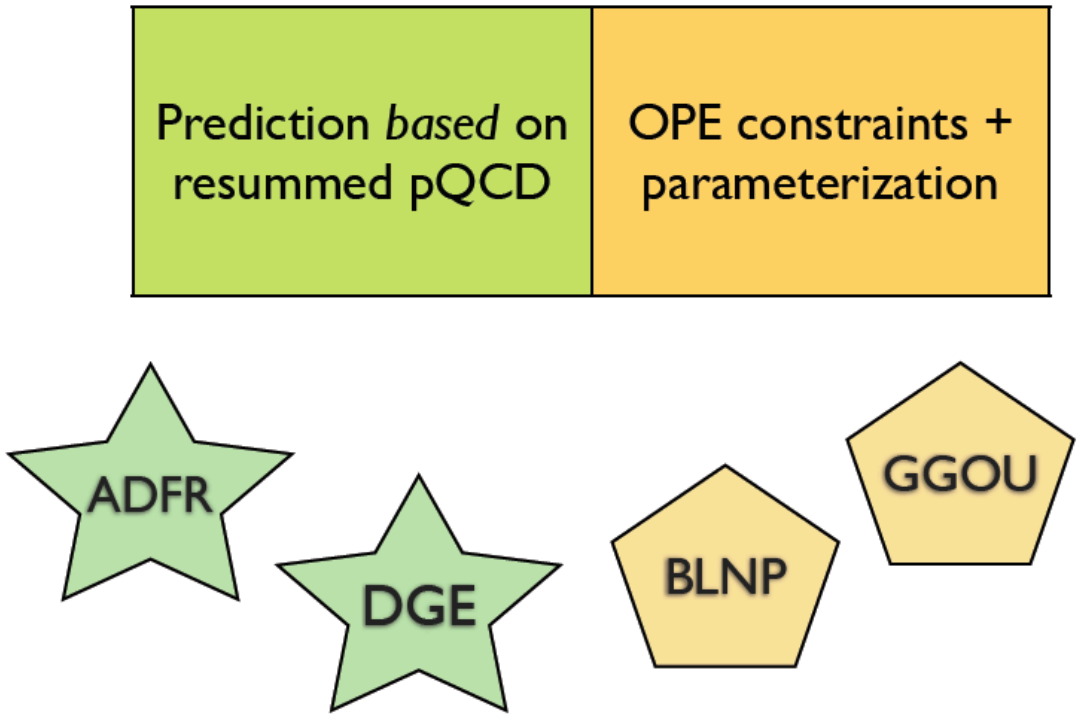
Inclusive $|V_{ub}|$

- Much recent progress in theory: [Gambino]
  - $O(\beta_0 \alpha_s^2)$ corrections to spectra calculated
  - $O(\alpha_s^2)$ corrections in shape-function region calculated [Asatryan, Greub, MN, Pecjak (in prep.)]
  - Flexible parametrization of shape functions investigated [Ligeti et al.]



Inclusive $|V_{ub}|$

- Detailed comparisons of different methods being performed



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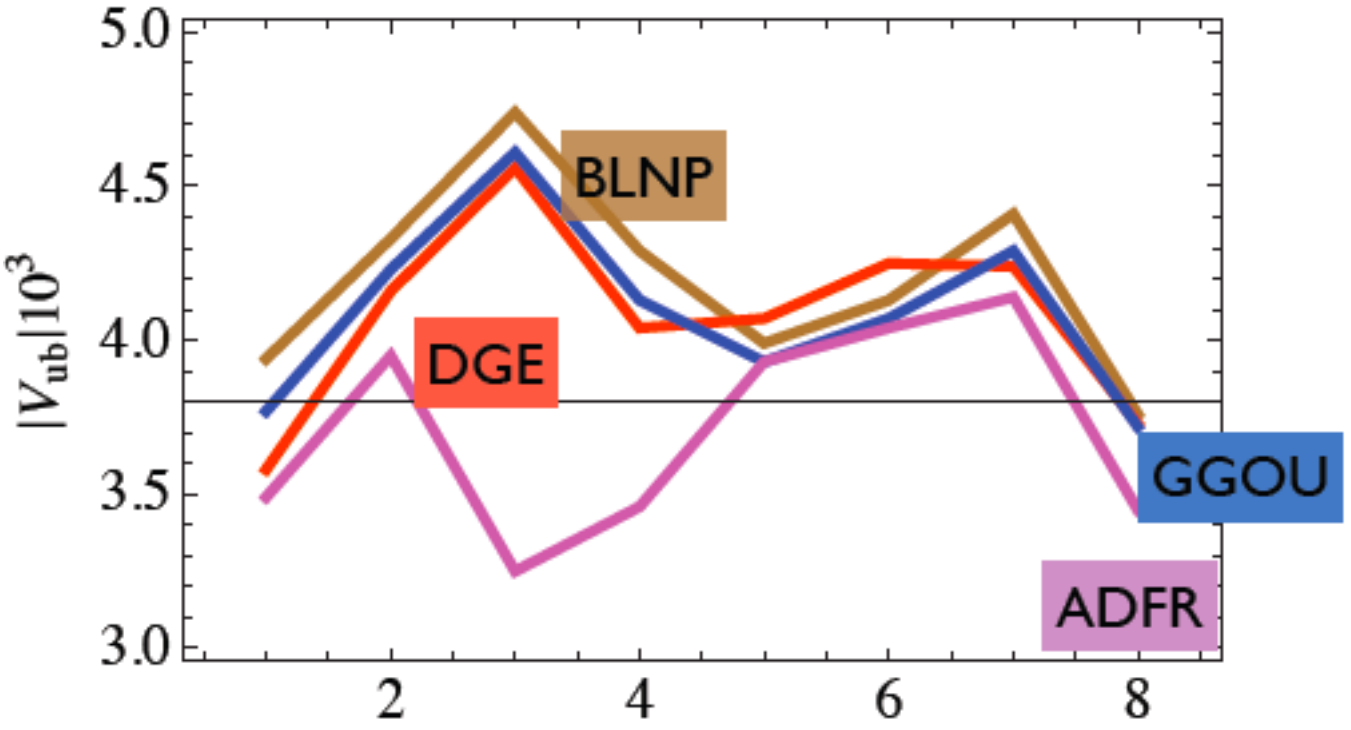


Inclusive $|V_{ub}|$

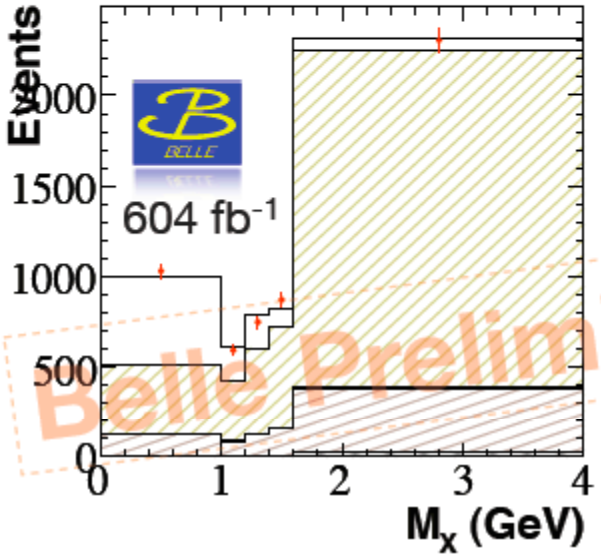
- Overall quite good consistency
- Some issues remain (weak annihilation!)
- Not all approaches of equal rigor (inclusion of subleading shape functions, consistency with OPE, systematic error estimates, …)
- When stakes are high ($|V_{ub}|$), only systematic approaches (BLNP, GGOU, DGE) should be used

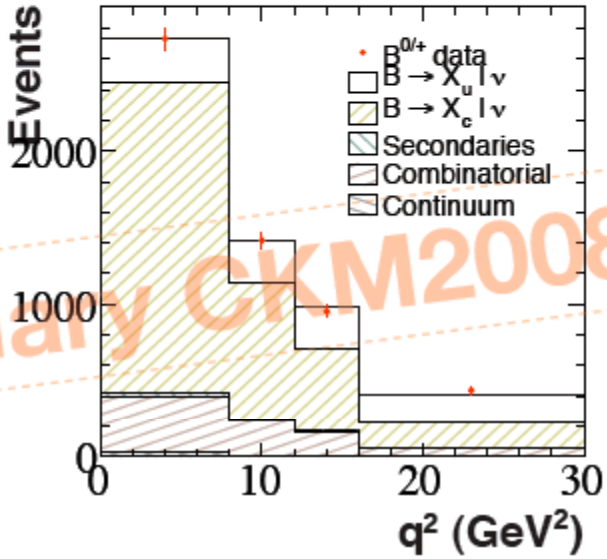
Inclusive $|V_{ub}|$

- More inclusive measurements (less restrictive cuts) reduce theory uncertainties and m_b dependence

Recent Belle measurement of uncut $B \rightarrow X_u l \nu$ rate (only requires $E_l > 1$ GeV) goes a long way and validates large $|V_{ub}|$ values!

Belle Multivariate analysis (NEW @ CKM2008) 2/2





~1035 Evts

2D fit in q2 mx. (projections shown)

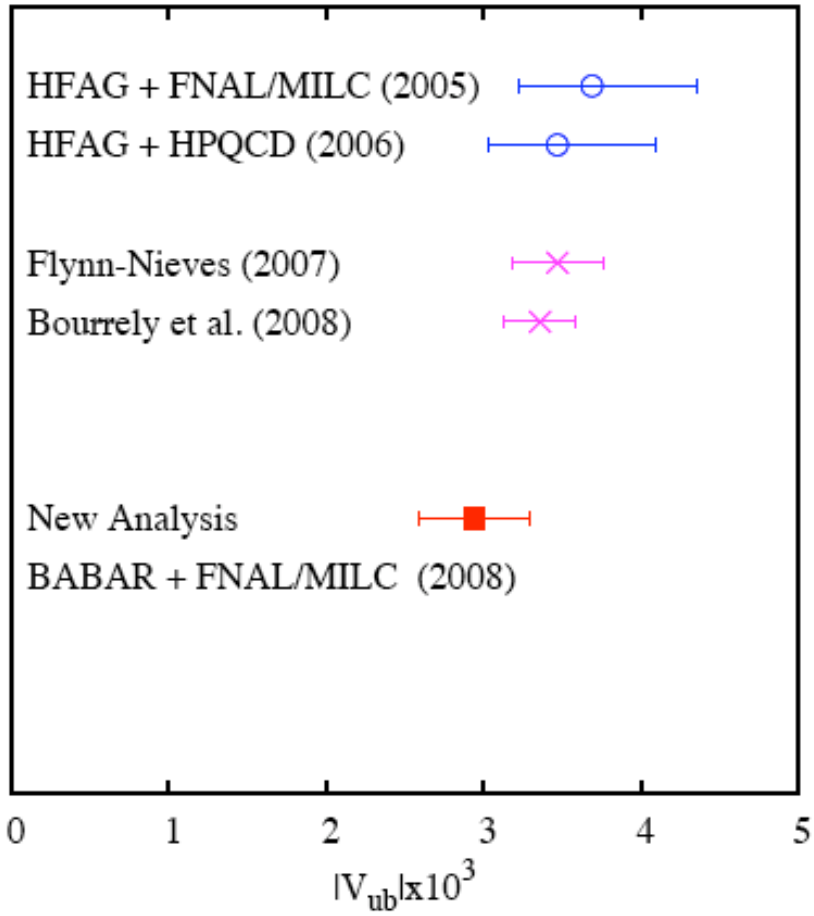
Kinematic Region	$B(B \to X_u l \nu) \times 10^{-3}$ Δ(stat. sys.)	m_b	$\|V_{ub}\|$ (10^{-3}) % error	Theory
P_{lepton} > 1.0 GeV	1.96 x (1 ± 0.088 ± 0.076)	(kinetic) 4.613 GeV, mupi=0.440 GeV^2	4.42 (± 3.1 ± 5.1)	GGOU (thanks P. Giordano)
		(MSbar) 4.243 GeV	4.47 (± 6.7)	DGE (thanks E. Gardi)

~90[†] % total phase space, thus theory error less correlated to other Vub determinations

~ same for BLNP [Urquijo]

Exclusive $|V_{ub}|$

- Lattice QCD predicts $B \to \pi$ form factor
- Recent improvements in analysis method (chiral and continuum extrapolations, simultaneous fits to lattice and experiment (+LCSR))
- Significant statistical and fitting errors remain
- Unquenched results based on staggered fermions, results using other actions needed for validation



[Shigemitsu]

Exclusive $|V_{ub}|$

- Light-cone sum rules provide alternative to lattice QCD, but method is “inherently approximate”
- No systematic error analysis (10% ?)

comparison of exclusive determinations		
Method	$\|V_{ub}\| \times 10^{-3}$	Ref.
Lattice-QCD	$3.78 \pm 0.25 \pm 0.52$	Fermilab/MILC ’05
Lattice-QCD	$3.55 \pm 0.25 \pm 0.50$	HPQCD ’07
Omnes-FF	$3.47 \pm 0.29 \pm 0.03$	Flynn, Nieves ’07
BCL-FF	$3.36 \pm 0.23 \pm 0.01$	Bourrely et al. 08
LCSR	$3.5 \pm 0.4 \pm 0.1$	Ball ’06
LCSR	$3.5 \pm 0.4 \pm 0.2 \pm 0.1$	Duplančić et al. 08

[Offen]

The $|V_{ub}|$ Crisis

$$|V_{ub}|_{\text{incl}} \sim (4.0 - 4.5) \cdot 10^{-3}$$

$$|V_{ub}|_{\text{excl}} \sim (3.0 - 3.5) \cdot 10^{-3}$$

may stay with us for a long time …

Inclusive $|V_{cb}|$

- $|V_{cb}|$ is output of global moment fit
- Present value might be reduced when theoretical improvements (higher-order corrections) will have been included

	$\|V_{cb}\|$ (10^{-3})	m_b (GeV)	μ^2_π (GeV^2)	χ^2/ndf
default	41.67+/-0.43(fit)+/-0.08(τ_B)+/-0.58(th)	4.601+/-0.034	0.440+/-0.040	29.7/57
new	40.85+/-0.68(fit)+/-0.08(τ_B)+/-0.57(th)	4.605+/-0.031	0.312+/-0.060	54.2/57

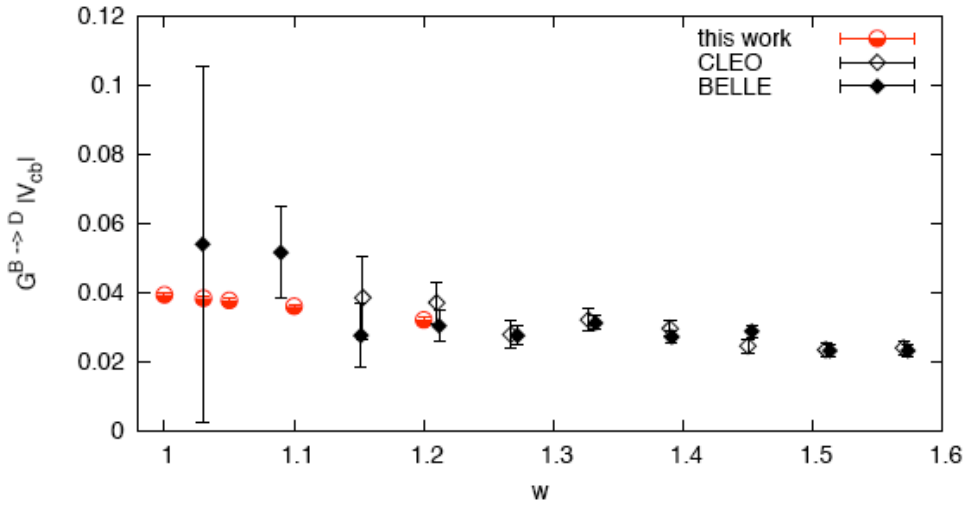
(rough estimate of "theory correlations")

[Schwanda]

Exclusive $|V_{cb}|$

- Lattice QCD results in good shape [Laiho]
- New results based on $B \to Dl\nu$ BaBar analysis encouraging

de Divitiis, et al, arXiv:0707.0582



[Tantalo]

New result using a step-scaling method. ← a big advance (?)

Exclusive $|V_{cb}|$

- New unquenched result for $B \to D^* l \nu$:

$$h_{A_1}(1) = 0.921(13)(20) \qquad \text{Fermilab/MILC}$$

$$|V_{cb}| = (38.7 \pm 0.9_{exp} \pm 1.0_{theo}) \times 10^{-3} \qquad \text{[Laiho]}$$

- Somewhat larger value obtained from $B \to D l \nu$

The $|V_{cb}|$ Situation

Prospects for a consistent value of $|V_{cb}|$ from both inclusive and exclusive methods

(if we're lucky …)