Summary of Working Group II

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Introduction

- Semileptonic D decays
- Leptonic D decays
- Leptonic B decays
- b and c quark masses
- Semileptonic B decays and the various determinations of $|V_{xb}|$

Charm semileptonic decays

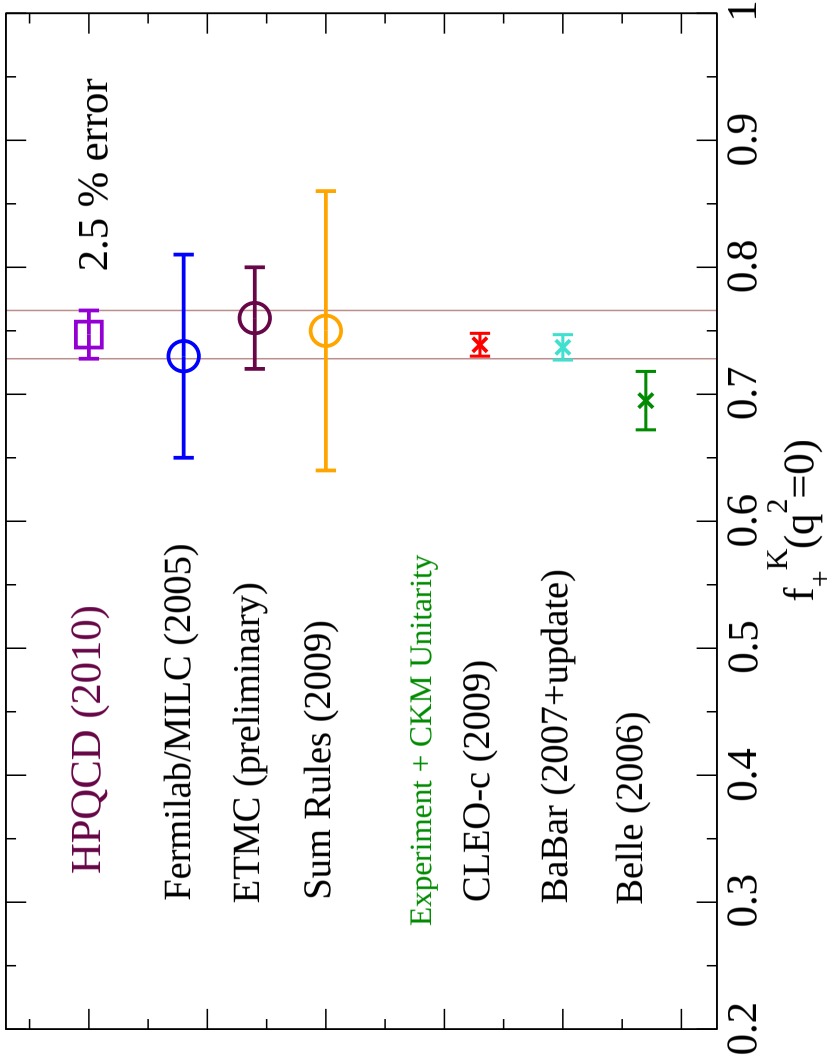
Many modes measured with new results this conference. These test experimental and theoretical methods.

$D \to \rho e\nu$, $D \to \eta e\nu$, $D \to \eta' e\nu$ from Cleo (talk by Bo Xin),
$D_s \to K^+K^-e^+\nu$, $D^+ \to K^-\pi^+e^+\nu$ from Babar (talk by Justine Serrano).

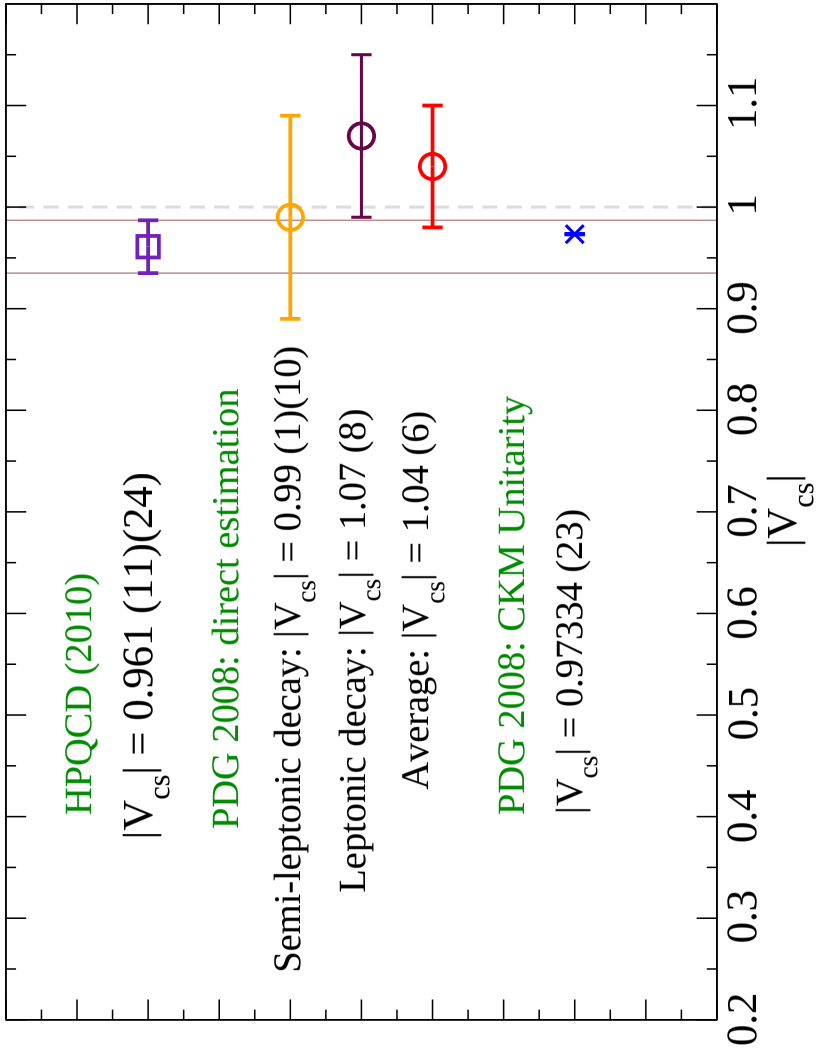
Gold plated modes $D \to K\ell\nu$ and $D \to \pi\ell\nu$ most useful for testing lattice QCD, as well as 2nd row unitarity.

New lattice results from HPQCD using HISQ (Highly Improved Staggered Quark) action improve significantly on previous lattice calculations. HISQ was specially designed to handle charm.

Overview of $D \to K\ell\nu$



Direct determination of $|V_{cs}|$



Summary of D semileptonics

Currently, $D \to K\ell\nu$ has a 1% experimental error and a 3% lattice error (HPQCD lattice result new in the last two weeks)

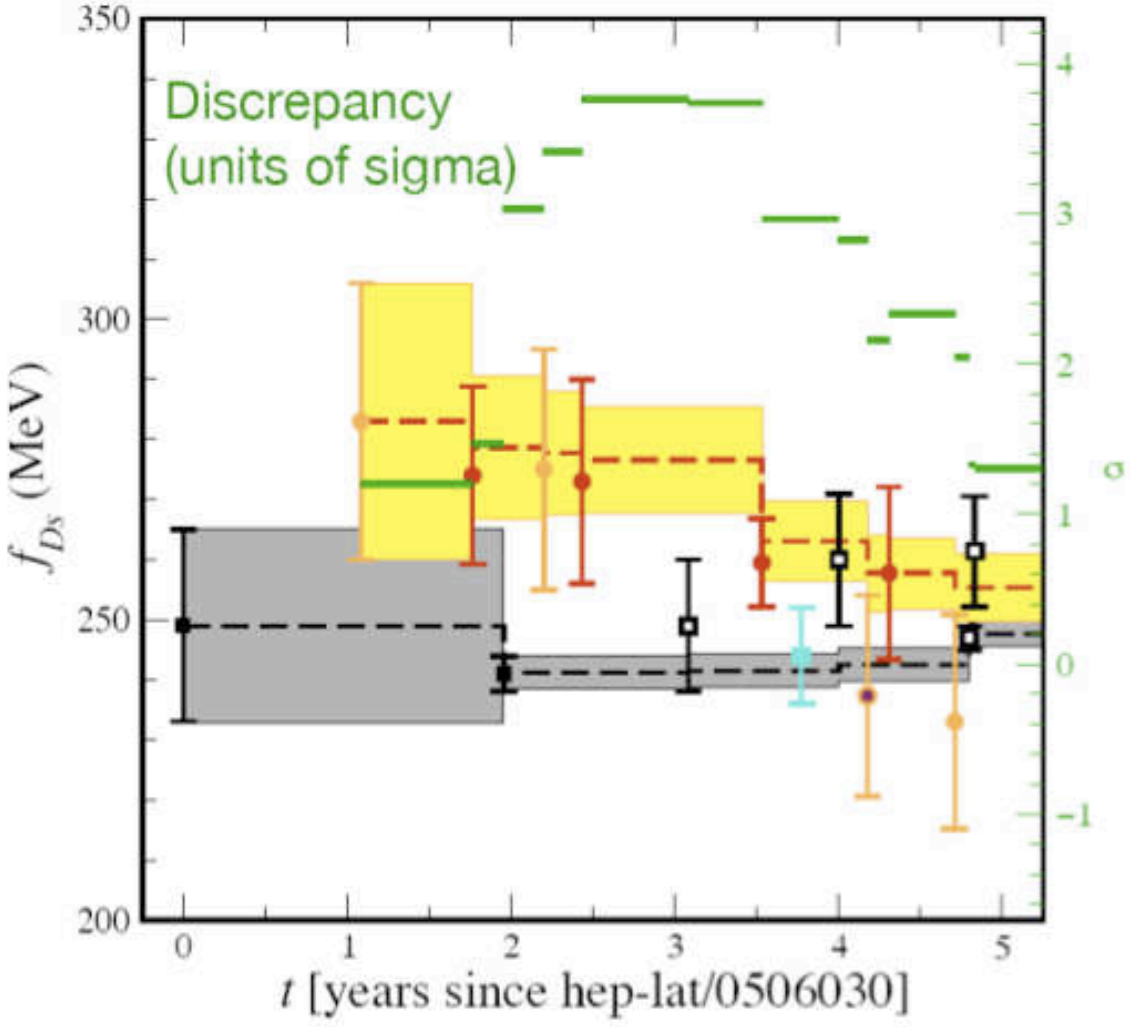
$D \to \pi\ell\nu$ has a 3% experimental error and a 10% lattice error. HPQCD plans to calculate $D \to \pi\ell\nu$ next.

Charm decay constants

New experimental results reported by Babar and Belle for f_{D_s} (talk by Bo Xin).

New HPQCD result for f_{D_s} reported by HPQCD (plenary talk by Junko Shigemitsu).

Saga of f_{D_s} (from Andreas Kronfeld)



Status now

Experiment for f_{D_s} (MeV):

275(20) from Belle

258.6(9.9) from Babar (new)

259.0(6.9) from CLEO (new)

Preliminary experimental average from Bo Xin: 260.1(5.4)

3 flavor lattice QCD gives:

HPQCD number shifted from 241(3) to 248.0(2.5). (new)

FNAL/MILC number 260(10), ETMC $N_f = 2$ number 244(8).

Slight tension ($\sim 2\sigma$) between new experimental average and new HPQCD result.

New results for $B \to \tau\nu$

Results for $Br(B \to \tau\nu)$ from talk by Roger Barlow:

BaBar hadronic tag: $(1.80^{+0.57}_{-0.54} \pm 0.26) \times 10^{-4}$ Preliminary New
Babar semileptonic tag: $(1.7 \pm 0.97 \pm 0.2) \times 10^{-4}$
Babar combined result: $(1.76 \pm 0.49) \times 10^{-4}$

Belle hadronic tag: $(1.79^{+0.56+0.46}_{-0.49-0.51}) \times 10^{-4}$
Belle semileptonic tag: $(1.54^{+0.38+0.29}_{-0.37-0.31}) \times 10^{-4}$ New

Combined result: $(1.64 \pm 0.34) \times 10^{-4}$

Leads to some tension between $|V_{ub}|$ and sin2β in unitarity triangle fits.

New results for $B \to D^* \tau \nu$

Recent measurements by Belle:

$Br(B^+ \to \overline{D}^{*0} \tau^+ \nu_\tau) = (2.12^{+0.28}_{-0.27}(\text{stat}) \pm 0.29(\text{syst}))\%$

$Br(B^+ \to \overline{D}^{0} \tau^+ \nu_\tau) = (0.77 \pm 0.22(\text{stat}) \pm 0.12(\text{syst}))\%$

Results compatible with SM within experimental uncertainties, but still room for new physics.

New physics implications for $B \to \ell \nu$ and $B \to D \tau \nu$ presented by Jernej Kamenik.

$|V_{cb}|$ inclusive theory status update

Talk by Paolo Gambino.
Inclusive decays do not depend on the final state. OPE is used to express result in terms o matrix elements of local operators. Wilson coefficients are perturbative, matrix elements of local operators parameterize non-perturbative physics. Double series in α_s, Λ/m_b.

Non-perturbative matrix elements obtained from fits to experimental moments of form factor as a function of minimum electron momentum.

Higher order power corrections $(\Lambda/m_b)^4$, $(\Lambda/m_b)^5$ need further study to understand parameter dependence.

$O(\alpha_s/m_b^2)$ corrections coming soon

Theoretical error on $|V_{cb}|$ can reach 1%, but more work is needed.

Results for $|V_{cb}|$ inclusive

Talk by Christoph Schwanda

	$\|V_{cb}\|(10^{-3})$	χ^2/dof
kinetic scheme	41.85 ± 0.73	$29.7/59$
1S scheme	41.87 ± 0.25	$32.0/57$

Slightly different, but consistent, results obtained if only $X_c\ell\nu$ moments are used.

When assumptions about theory correlations are introduced into the moments fit, results can change somewhat outside of errors.

Refinements to fit with higher orders in progress.

$|V_{cb}|$ exclusive

Updated result for $|V_{cb}|$ from $B \to D^* \ell \nu$, talk by Paul Mackenzie

$$F(1) = 0.908(05)(9)(8)(9)(3)(3)$$

Errors are statistics, $g_{DD^*\pi}$, χ extrapolation, HQ discretization, mass tunings, perturbative matching.

$|V_{cb}|F(1) \times 10^3 = 36.04 \pm 0.52$ from HFAG end of year 09 leads to

$$|V_{cb}| = 39.7(7)(7) \times 10^{-3}.$$

Errors are experiment and theory.

Compare with $41.85 \pm 0.73 \times 10^{-3}$ from inclusive. Discrepancy is smaller.

Semileptonics from LHCb

Talk by Phillip Urquijo.

Can do $B \to D_s^{(*)} \ell \nu$ decays at LHCb, which would help constrain $|V_{cb}|$.

Early results encouraging. Have to wait to see how competitive this is with b factories.

Lattice calculation is straightforward.

b and c quark masses

Talk by Andre Hoang.
Claim that perturbative truncation errors from Karlsruhe group are significantly underestimated.

Also claim that experimental errors used by Karlsruhe are underestimated.

Preliminary result $m_c(m_c) = 1.2759 \pm 0.0247$, with errors bigger than Karlsruhe by ~ 2.

Results from Karlsruhe plus lattice (HPQCD) avoids issue of experimental errors for moments, and compares to both pseudoscalar and vector currents on lattice. Non-trivial test of method. Also, Karlsruhe results are in good agreement with lattice determination of m_b/m_c, which is independent of perturbation theory.

Interesting to look at Hoang et al calculations with lattice moments.

BaBar result for $|V_{ub}|$ exclusive

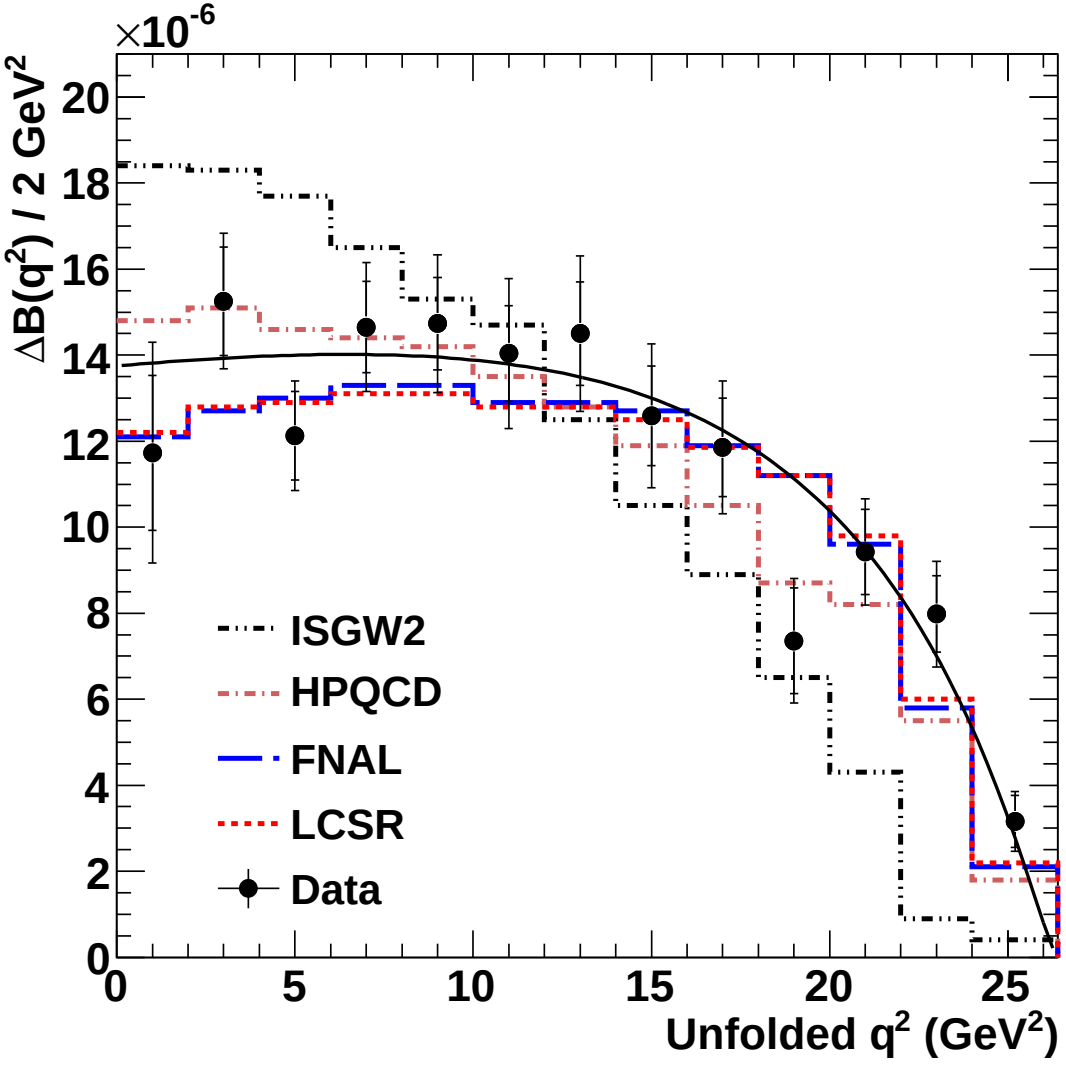
Talk by Martin Simard. Two different analyses, π-η analysis and π-ρ analysis.

Different fit and cut strategies. Fits to different numbers of modes, loose vs tight ν cut selection.
Results for $|V_{ub}|$ consistent within the different approaches. Results from π-η analysis:

Theory	$q^2(\text{GeV})^2$	$\lvert V_{ub}\rvert(10^{-3})$
HPQCD	> 16	$3.24 \pm 0.13 \pm 0.16^{+0.57}_{-0.37}$
FNAL	> 16	$3.14 \pm 0.12 \pm 0.16^{+0.35}_{-0.29}$
LCSR	< 12	$3.70 \pm 0.07 \pm 0.09^{+0.54}_{-0.39}$

Exclusive $B \to \pi \ell \nu$ and $|V_{ub}|$

New result from Belle (talk by Kevin Varvell)



Results for $|V_{ub}|$

Using a BK parameterization for Belle experimental data $|V_{ub}|$ was extracted from the partial branching fraction for a number of different theories to give the normalization.

Simultaneous fit to lattice (Fermilab/MILC) and Belle q^2 dependence (using the z parameterization) leads to a model independent result of $|V_{ub}| = (3.43 \pm 0.33) \times 10^{-3}$.

The same procedure with the latest BaBar data leads to $|V_{ub}| = (2.95 \pm 0.31) \times 10^{-3}$.

$|V_{ub}|$ status update from LCSR

Talk by Patricia Ball.

LCSR yields value for $f_B f_+(q^2)$, and for consistency, calculation in progress to determine f_B from QCD sum rules. Test sensitivity to radiative corrections by doing calculation to order α_s^2.

Sum rule results for $|V_{ub}|$ have an $\sim 10\%$ irreducible theory uncertainty, but are still useful at the moment, given the current precision of the lattice and the tension with the inclusive determination.

Sum rule results (which use exclusive $B \to \pi \ell \nu$) tend to be less than 4 and in better agreement with lattice.

$|V_{ub}|$ inclusive status

Talk by Einan Gardi:
Different approaches DGE, BLNP, GGOU yield consistent spectra $1\Gamma \frac{d\Gamma}{dM_X}$ as a function of $M_X(GeV)$ and consistent $|V_{ub}|$ from each analysis within non-parametric theory uncertainty.

Talk by Frank Tackman: SIMBA to provide global fit that combines all available information, including $Br(B \to X_s\gamma)$ to get $|V_{ub}|$.

Talk by Concezio Bozzi: Updates from Babar and Belle for inclusive branching fractions.

Questions for experts

What to use as “standard” value for $|V_{ub}|$ from inclusive determination in CKM fits?

Can be averaged with exclusive determination. Should we use PDG prescription for inflating error when averaging inconsistent results?

Conclusions

Important progress has been made on determinations of heavy quark masses, $|V_{cx}|$, and $|V_{xb}|$, but more work remains!

Thank you for staying to the end, and have a safe journey back!