Discussion on V_{ub}

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V_{ub}, exclusive determination

- $B \to \pi \ell \nu_\ell$, $B_s \to K \ell \nu_\ell$, Fermilab-MILC new results coming soon

  [talk by Andreas Kronfeld]

- do we expect new results from other lattice QCD collaborations ?

- are the $B^* \pi$ states in the lattice $B \to \pi$ form factors important ?

  [O.Bär, A. Broll, R. Sommer, Lattice '22]

- an important test of the theory: the q^2-shape of a form factor

  do the shapes of the calculated $B \to \pi$ form factors agree?

  can we expect more q^2-bins from experiment for this test?

- useful quantity for V_{ub}: the width integrated over small/intermediate q^2 (vs LCSR) or over large q^2 (vs LQCD) (independent of shape and/or z-parameterization)

- LCSRs results for $B \to \pi$ and $B_s \to K$ form factors, not always agree with lattice QCD results. should we fit them together ? e.g., for $B_s \to K$ in [C.Bolognani ,D.van Dyk,K.Vos 2308.04347]

V_{ub}, exclusive determination

- V_{ub} from $B \to \rho\ell\nu_\ell$, $B \to \omega\ell\nu_\ell$ lower than from $B \to \pi\ell\nu$ by $\sim 2\sigma$

  [talk by Florian Bernlochner and refs therein]

- relying mainly on LCSR $B \to \rho, \omega$ form factors

  [Bharucha, D. M. Straub, and R. Zwicky, 1503.05534],

  an update [B.Melic, Yu-M.Wang et al.] in progress

  but: the form factors are calculated for narrow ρ, ω

- we should start from general $B \to 2\pi$ form factors in $B \to \pi\pi\ell\nu_\ell$ expanded in partial waves and invariant mass of di-pion state

  with correspondingly detailed data from Belle II

- we should agree on a uniform procedure of what is ρ and what is "nonresonant" background,

  [talks by Florian Herren and Raynette Van Tonder]

- the role of ρ', ρ'' (radially excited states) important
  up to 15 % effect, see LCSRs with B-DAs: [S.Cheng, AK, J.Virto, 1701.01633]

- $\bar{B}^0 \to \pi^+\pi^0\ell\bar{\nu}_\ell$ somewhat simpler than $\bar{B}^0 \to \pi^+\pi^-\ell\bar{\nu}_\ell$ (f_0 states!)

- any perspectives from lattice QCD ?

Discussion points

- Advanced inclusive $B \to X_u \ell \nu$ modelling and **generator**

  - Important for exclusive and inclusive $b \to u\ell\nu$ and leptonic B measurements

  - **Short-term solutions (reweighting), long-term solution (EvtGen)**

  - Better hybrid? cocktail inclusive DFN+BLNP, including interference of $N\pi$

- Common tool/recipe for D**, gap modelings

- Estimated uncertainty in |V$_{ub}$| due to **weak annihilation**: HFLAV2021 (arxiv:2206.07501)

and illustrated in Fig. 64(a). The total error is $^{+3.9}_{-3.9}\%$ whose breakdown is: statistics $(^{+1.3}_{-1.3}\%)$, detector effects $(^{+1.6}_{-1.6}\%)$, $B \to X_c\ell^+\nu_\ell$ model $(^{+0.9}_{-0.9}\%)$, $B \to X_u\ell^+\nu_\ell$ model $(^{+1.7}_{-1.7}\%)$, α_s, m_b and other non–perturbative parameters $(^{+1.8}_{-1.8}\%)$, higher order perturbative and non–perturbative corrections $(^{+1.5}_{-1.5}\%)$, modelling of the q^2 tail $(^{+1.3}_{-1.3}\%)$, weak annihilations matrix element $(^{+0.0}_{-1.1}\%)$, functional form of the distribution functions $(^{+0.1}_{-0.1}\%)$. The leading uncertainties on $|V_{ub}|$ are both from theory, and are due to perturbative and non–perturbative parameters and the modelling of the q^2 tail. The uncertainty due to weak annihilation has been assumed to be asymmetric, *i.e.* it only tends to decrease $|V_{ub}|$.

(?) only negative and varied in different frameworks, e.g. $^{+0.0\%}_{-0.7\%}$ in BLNP

- |V$_{ub}$| tensions among exclusive modes, π, ρ, ω
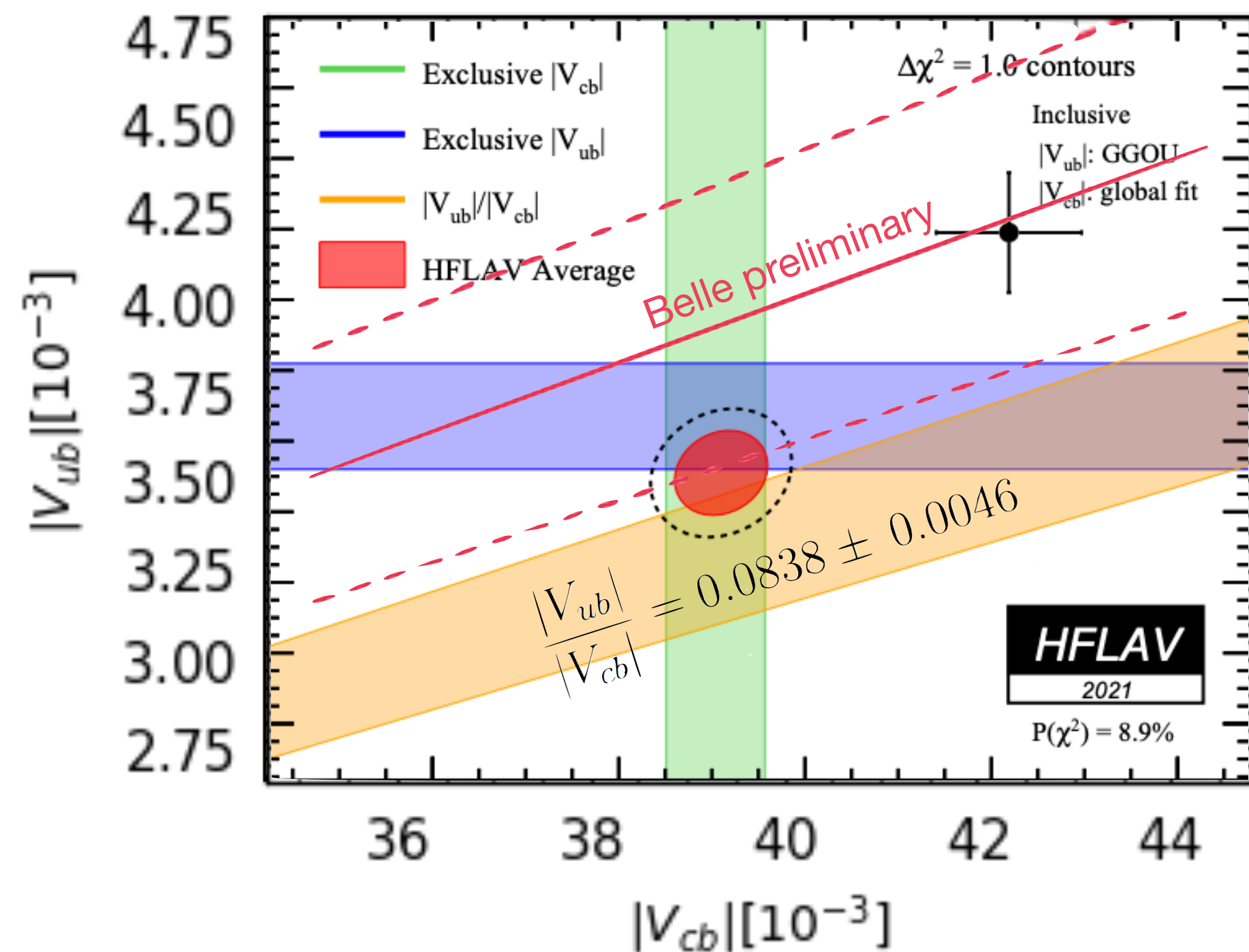
- |V$_{ub}$|/|V$_{cb}$| tensions

Ratio Measurements of $|V_{ub}| / |V_{cb}|$

Ratio of **inclusive** decays from Belle [arxiv:2311.00458]:

GGOU, $\pm 4.2\%_{\mathrm{stat}} \pm 3.9\%_{\mathrm{syst}} \pm 2.3\%_{\Delta\Gamma(\bar{B}\to X_u\ell\bar{\nu})} \pm 2.0\%_{\Delta\Gamma(\bar{B}\to X_c\ell\bar{\nu})}$

$$\frac{|V_{ub}|}{|V_{cb}|} = 0.0996 \pm 0.0065$$

Ratio of **exclusive** decays from LHCb:

Average from $\Lambda_b^0 \to p\mu\nu$ and $B_s^0 \to K\mu\nu$ (high q²) [HFLAV2023, preliminary]

$$\frac{|V_{ub}|}{|V_{cb}|} = 0.0823 \pm 0.0035$$