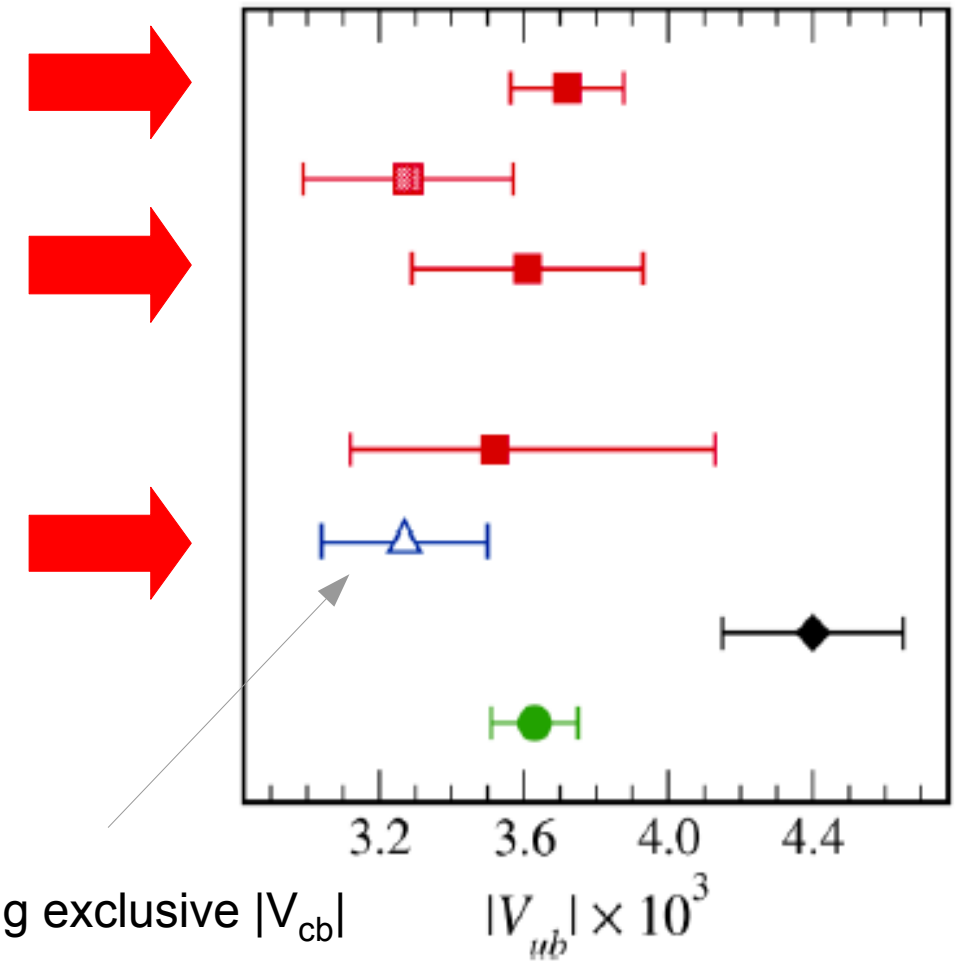
Exclusive $|V_{ub}|$

Step forward in $|V_{ub}|$ from exclusive

- With existing $B \to \pi\, l\, \nu$ measurements: reached σ_{tot} = 4.4% !
  - Great improvements in lattice (FNAL2015)

$$|V_{ub}| = (3.72 \pm 0.16) \times 10^{-3}$$

- New experimental result in the game: $\Lambda_b \to p\, \mu\nu$ from LHCb



Fermilab/MILC 2015 + BaBar + Belle, $B \to \pi l \nu$

Fermilab/MILC 2008 + HFAG 2014, $B \to \pi l \nu$

RBC/UKQCD 2015 + BaBar + Belle, $B \to \pi l \nu$

HPQCD 2006 + HFAG 2014, $B \to \pi l \nu$

Detmold *et al.* 2015 + LHCb 2015, $\Lambda_b \to p l \nu$

BLNP 2004 + HFAG 2014, $B \to X_u l \nu$

UTFit 2014, CKM unitarity

Using exclusive $|V_{cb}|$

Future steps toward a clean $|V_{ub}|$

- $B \to \pi$ l ν: simultaneous Lattice+Experiment fits are becoming standard. Use the BCL parameterization for B → light transitions
  - Move to a combined Data+FLAG (+LCSR) average
  - Caveats about theory correlations and treatments of the theoretical errors from lattice calculations.
  - LCSR and L-QCD calculations largely independent and complementary
  - Difficult mode at LHCb but very high precision expected at Belle-II
- $\Lambda_b \to p\ \mu\nu$: experimentally clean at LHCb
  - For the time being rely just on one FF calculation (Deltmod 2015)
  - Further calculations would be desirable and are actually expected in the near future
  - Measurements in q^2-bins are planned, at least in the high-q^2 region
- A further "golden" mode: $B_s \to K$ l ν Easy to handle on L-QCD: some calculations are already available others are coming
  - This channel is accessible at LHCb with the present data (and in future at Belle-II with the run at Y(5S), but very difficult !)

Other charmless modes I

- Some modes already studied at B-Factories:
  - $B \to \rho/\,\omega\; l\; \nu$ and $B \to \eta/\;\eta'\; l\; \nu$
- Full understanding of these modes is crucial to reduce uncertainties on both inclusive and exclusive $|V_{ub}|$
- Huge improvements on these modes expected from Belle-II
  - Full angular analysis of $B \to V$ will become possibile with the future datasets
- $B^+ \to \rho^0\; l\; \nu$ could be studied with the present data available @LHCb
  - L-QCD calculations are needed to extract $|V_{ub}|$: work in progress but wide resonances are difficult to simulate
  - For the time being rely on the existing LCSR, but improvements are needed
    - LCSR for $B \to \rho\; l\; \nu$ is insufficient, have to be complemented by a complete calculation of P- and S-waves ($\pi\pi$) components

Other charmless modes II

- Others in the waiting list:
  - $B \to \pi \tau \nu$: way to measure the scalar FF $f_0(q^2)$ that are only predicted by L-QCD, this is important to check because of the issues with $B \to D \tau \nu$
  - $B \to KK l \nu$: a measurement of the rate and of the KK mass distribution is interesting to evaluate contributions of the *ss-popping* rate (relevant for inclusive $|V_{ub}|$) in $b \to u$ transitions
- $B_s \to K^{*+} l \nu$: similarly to $B \to \rho l \nu$, it allows to make observables sensitive to possibile RH currents in the $b \to u$ transitions
  - Together with other inputs (from other $b \to u$ and $b \to c$ channels), this can strongly constrain some New Physics models
  - Difficult at LHCb because of the K^{*+} (it requires the reconstruction of a K_s (low efficiency) or a π^0 (low efficiency and high background)