B, CP, Charm, Top, and HFAG

Alex Cerri (Sussex) and Wei-Ming Yao (LBNL)

PDG Advisory Meeting, Berkeley, November 7, 2014

- What's new in RPP 2014
- Heavy Flavor Averaging Group Activities (HFAG)
- Prospects for 2016 Edition

B Overseers: Alex Cerri (Sussex, GB) and Wei-Ming Yao
Encoders: Y. Kwon (Yonsei, Korea), J. Smith(retired), M. Kreps (Warwick,UK), Paula Eerola (Helsinki, Finland) is replacing Jim.

Charm Overseers: Charles Wohl and Wei-Ming Yao (D-mix)
Encoders: J. Rademacker (Bristol, UK) and D. Asner (PNNL, US)

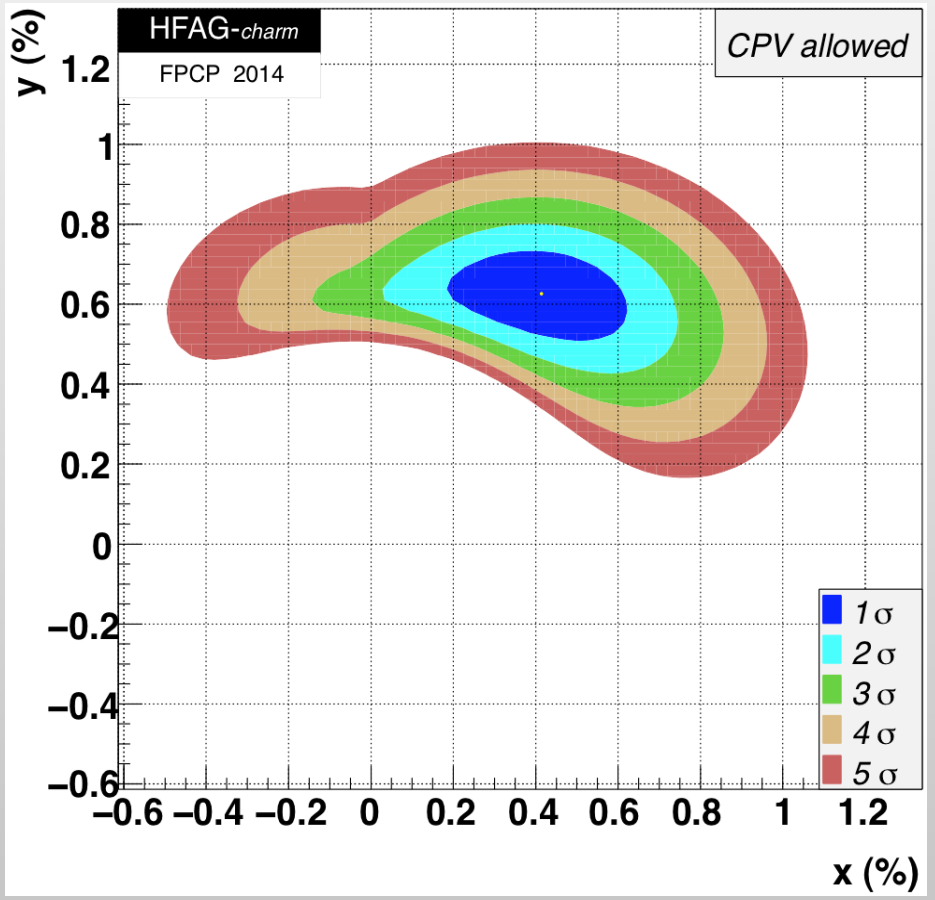
Top Overseer: Wei-Ming Yao; encoder: K. Hagiwara (KEK, Japan)

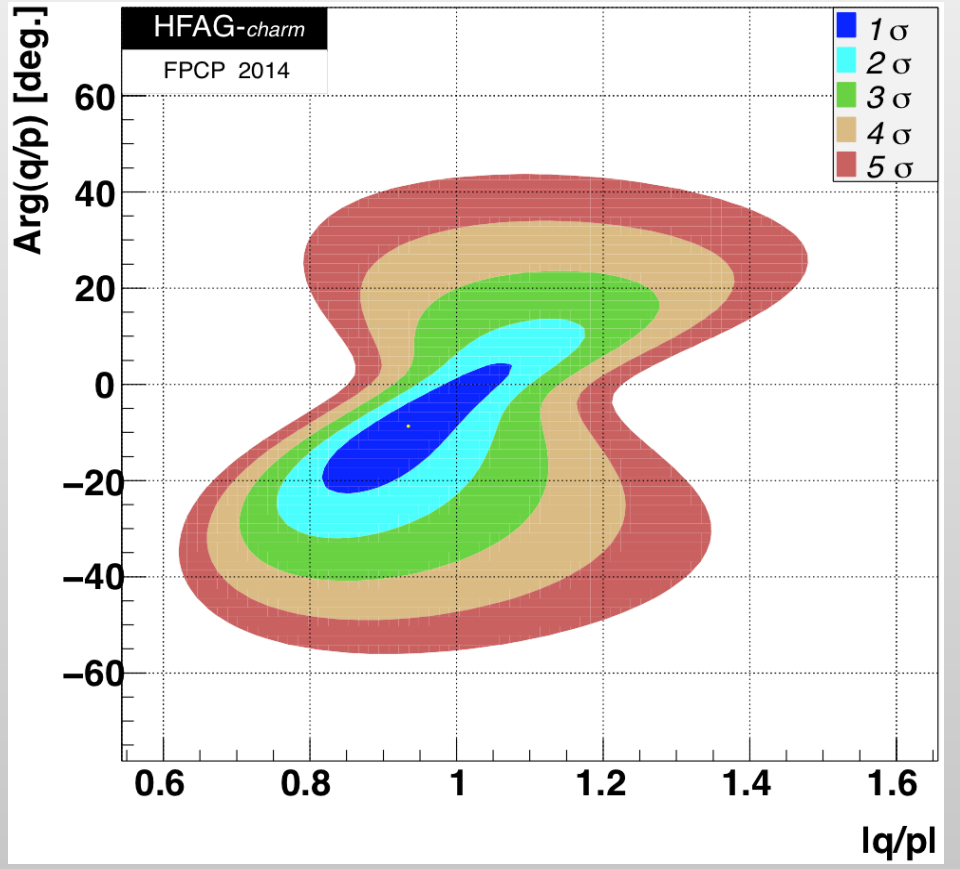
What's New in Charm

- Charm measurements are steady in RPP.
- 31 papers and 149 measurements were encoded for this edition.
- **Highlights:**
  - Including updated D0-D0bar mixing and CPV from LHCb.
  - All data are consistent with SM.
- **Excellent mini reviews:**
  - Leptonic decays of charmed pseudo-scalar mesons (J. L. Rosner and S. Stone)
  - DDbar mixing (D. Asner)
  - Ds+ Branching fractions (J. L. Rosner and C.G. Wohl)

Search for CPV in D0 Mixing

- D0-D0bar mixing has been observed, but no CPV observed yet.
- x=Δm/Γ, y=ΔΓ/Γ and q/p are CPV parameters.





Charm Baryon

- Most charm baryons are observed, but limited by $B(\Lambda_c \to pK\pi)=5.0 \pm 1.3\%$ (26%).
- Recent Belle measured $B(\Lambda_c \to pK\pi)=6.84^{+0.32}_{-0.40}\%$ with precision of 5.3% using $e^+e^- \to D^{(*)-}\bar{p}\pi^+\Lambda_c^+$ (Zupanc et al. PRL 113 (2014) 042002), big step forward!

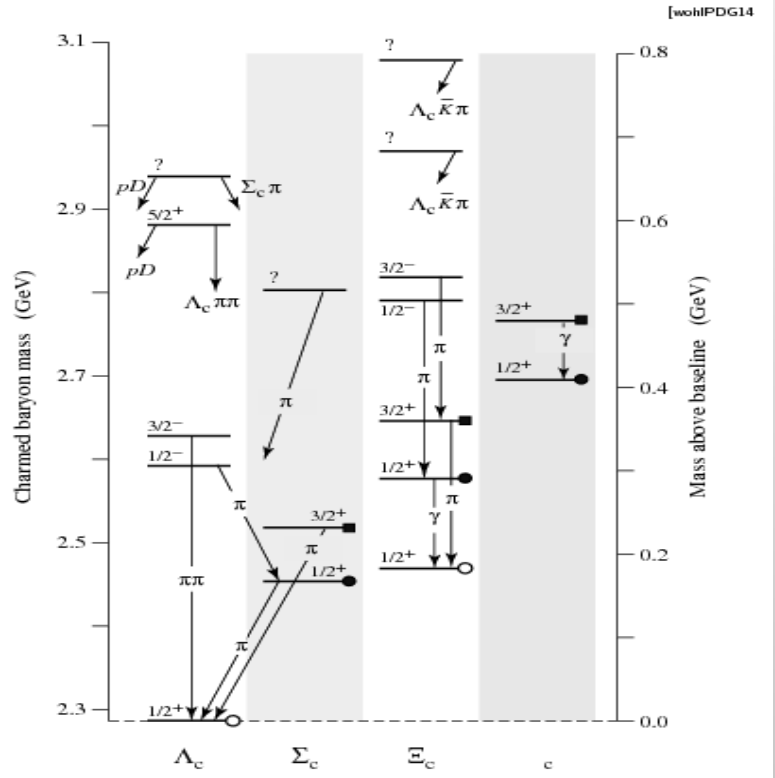


Figure 1. There are a lot of established c baryons, 17 in all.

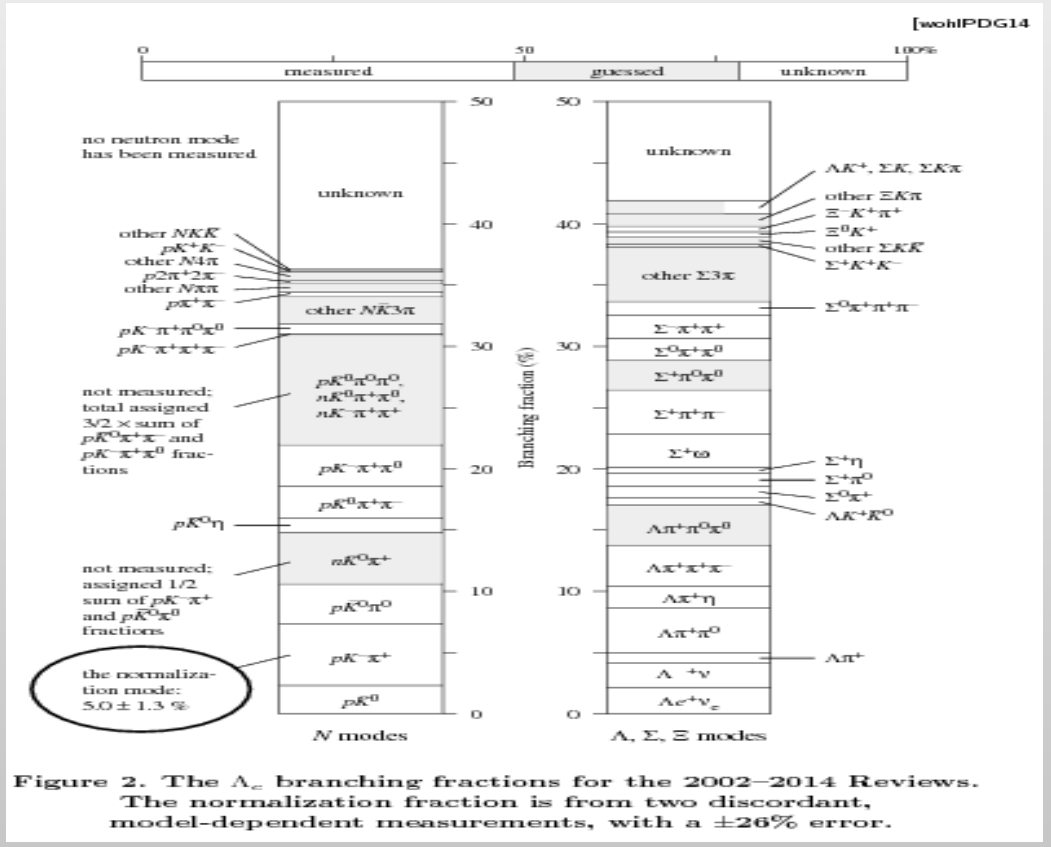


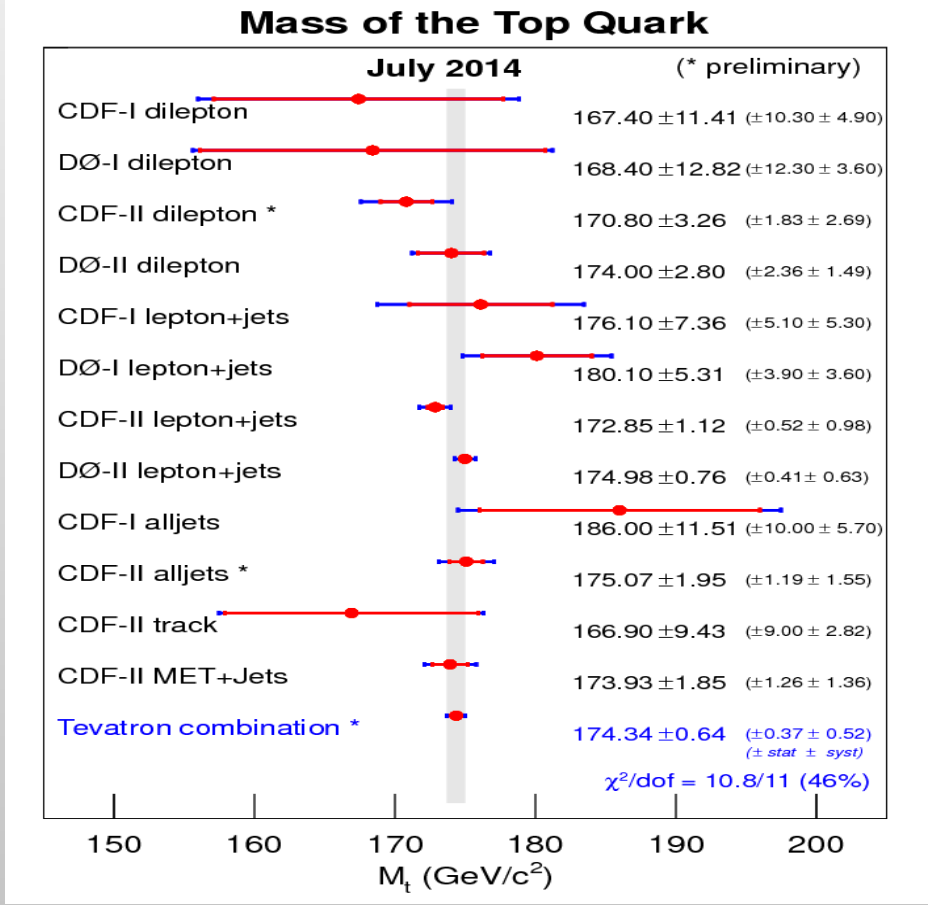
Figure 2. The Λ_c branching fractions for the 2002–2014 Reviews. The normalization fraction is from two discordant, model-dependent measurements, with a ±26% error.

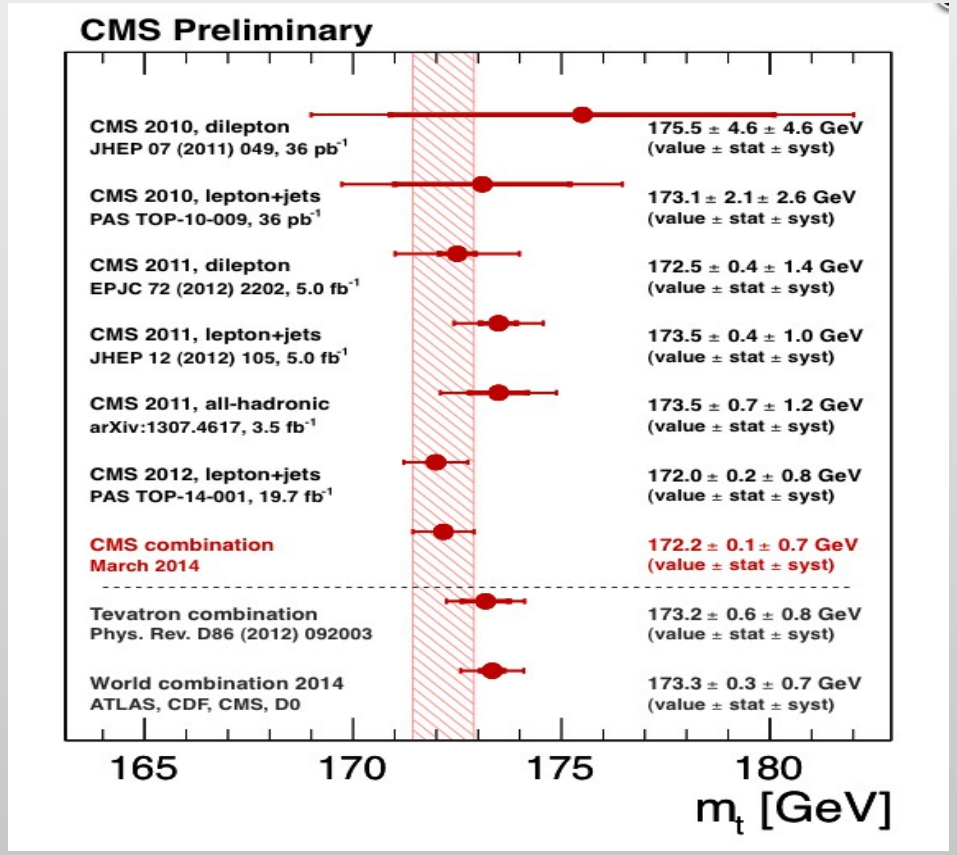
What's New in Top

- Top physics and searches with top become more productive in LHC era.
- 51(t)+15(t',b') papers and 89 measurements were encoded for this edition.
- **Highlights:**
  - Including most precise top mass measurements from LHC and Tevatron experiments.
  - All data are consistent with SM.
- **Excellent mini review:**
  - The Top Quark (T.M. Liss, F. Maltoni and A. Quadt)
  - Major revision, theory part is strengthened by Fabio.

Top Mass Measurements

- Uncertainty on top mass measurement is < 0.4%, but what's exactly measured?
- There are some tensions between Tevatron(174.34+-0.64 GeV) and LHC measurements (172.2+-0.1+-0.7 GeV).



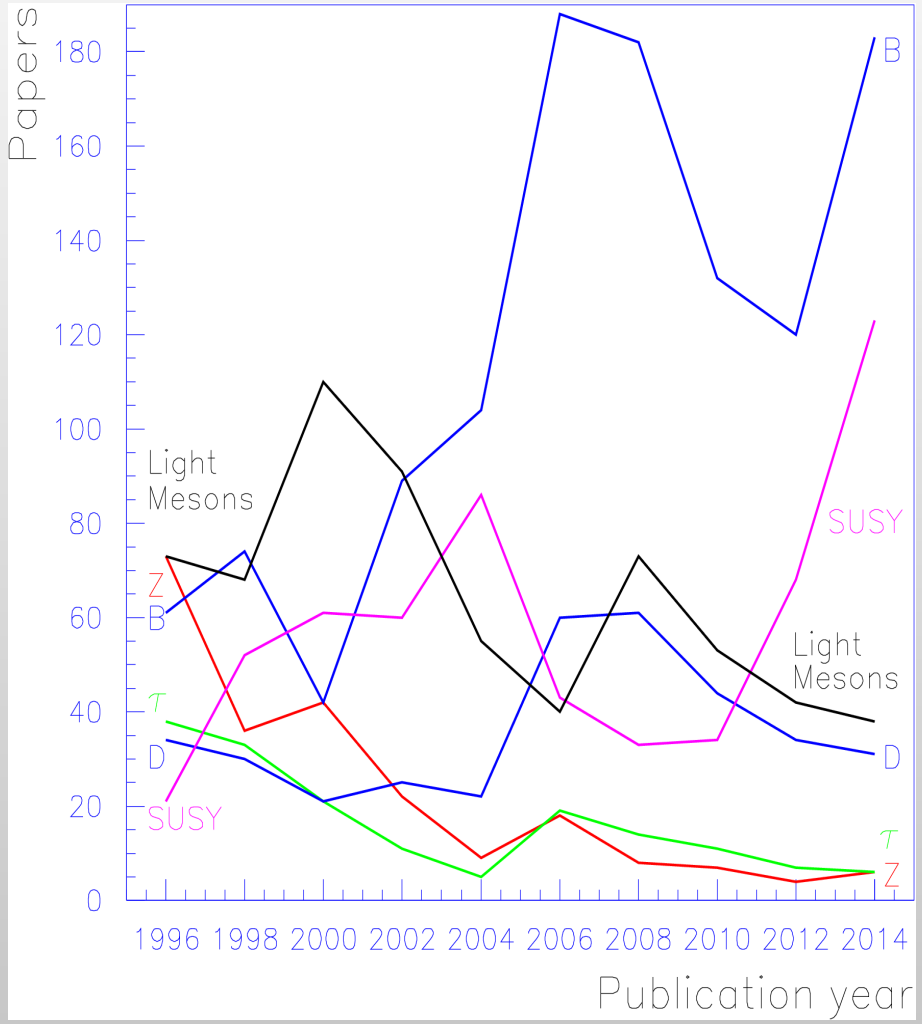


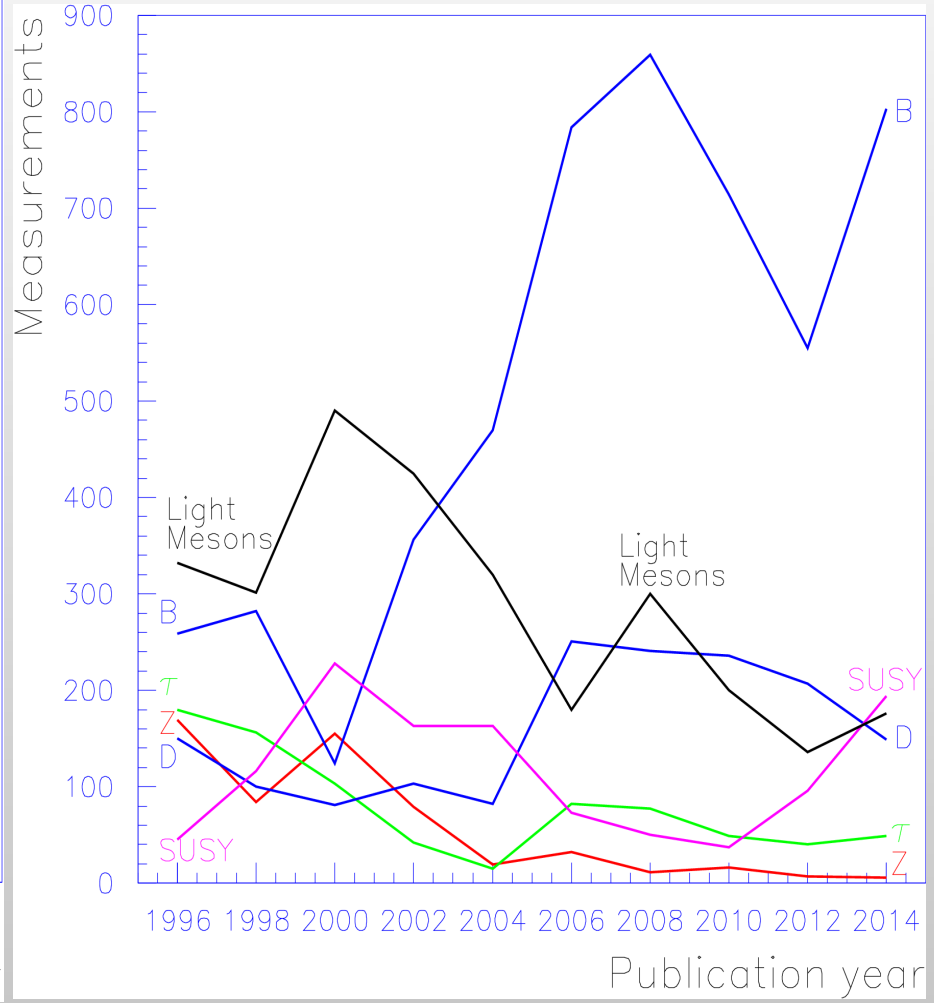
What's New in B's

- B physics continues to be one of the most productive fields in RPP.
- 183 papers and 803 measurements were encoded for this edition.
- **Highlights:**
  - Including first observation of $B_s \to \mu^+\mu^-$ from LHCb and CMS.
  - Many more precised measurements and fewer anomalies.
  - Unfortunately, all data are consistent with SM.
- **Excellent mini reviews:**
  - B production and decays (Kwon, Kreps, and Smith)
  - BBbar mixing (Schneider)
  - Vcb/Vub determinations (Kowalewski and Mannel)
  - B Polarization (Gritsan and Smith)

B Papers/Measurements

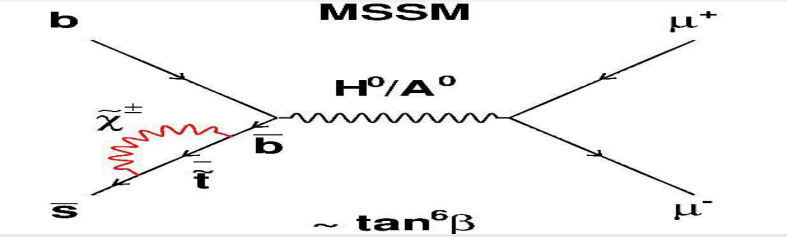
- **B's are going strong, thanks for the success of LHC experiments !**

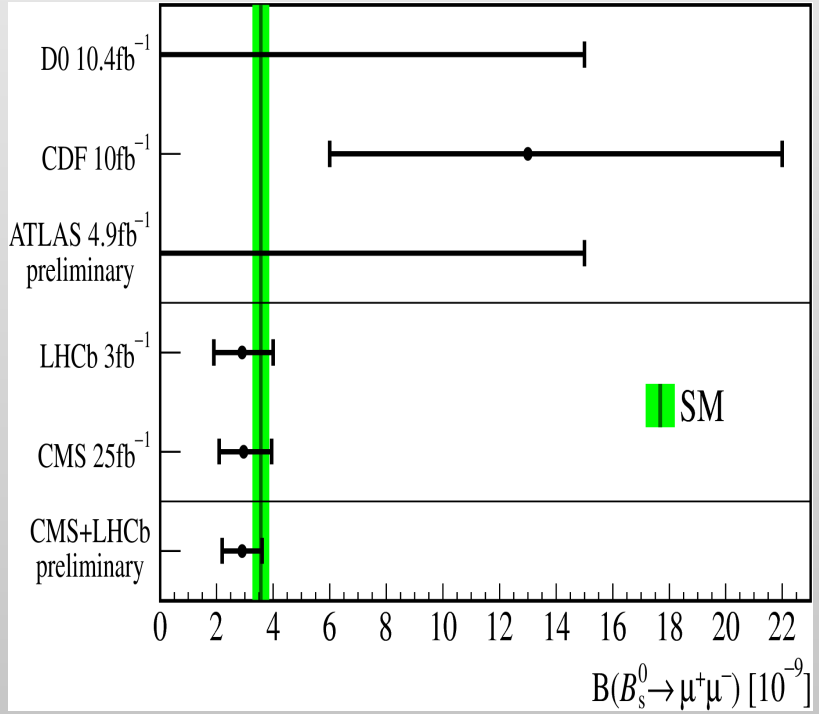


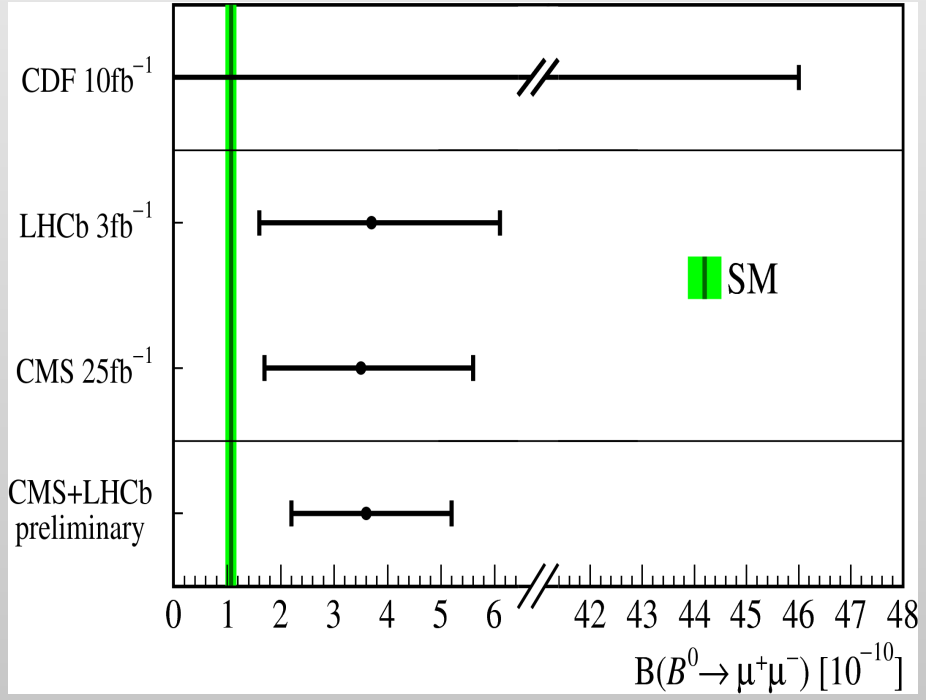


Observation of $B_s \to \mu^+\mu^-$

- $B_{s(d)} \to \mu^+\mu^-$ is highly suppressed in SM, sensitive to NP(~$\tan^6\beta$).
- CMS and LHCb combination:
  - $B(B_s \to \mu^+\mu^-) = (2.9^{+0.7}_{-0.7}) \times 10^{-9}$ (6.2σ).
  - $B(B_d \to \mu^+\mu^-) = (3.6^{+1.6}_{-1.4}) \times 10^{-10}$ (3.2σ).







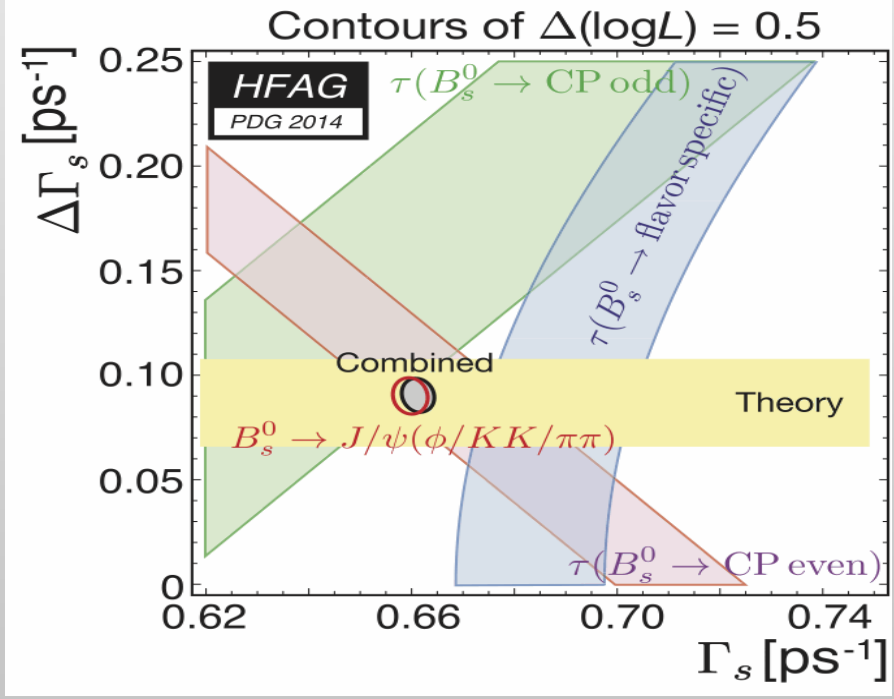
B_s Lifetimes

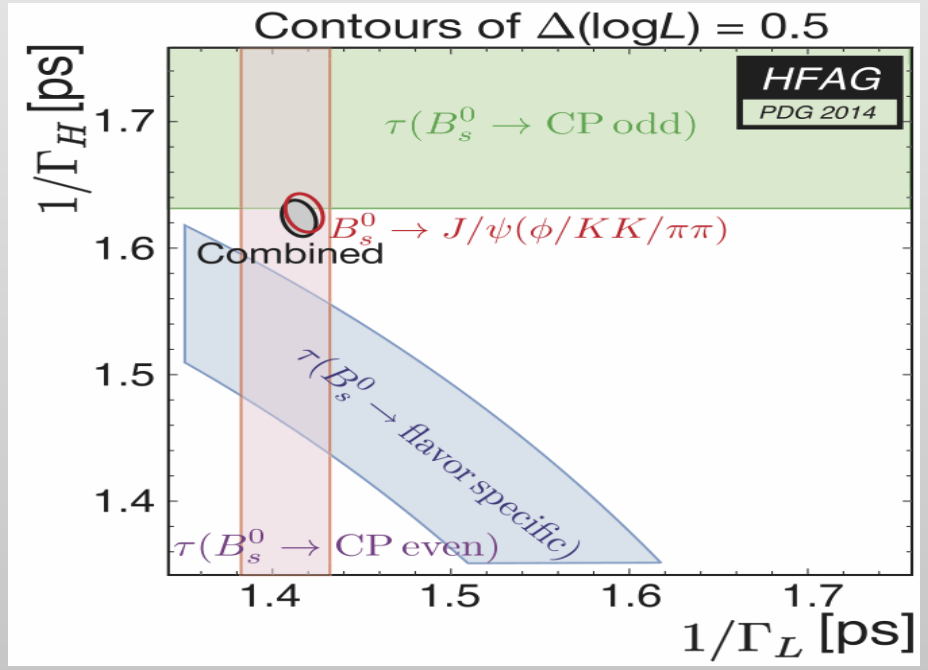
- B_s short and long states have been measured precisely.

CP-odd final state	effective lifetime from single exponential fits
$B_s \to J/\psi\, f_0,\ J/\psi\, \pi\pi$	1.656 ± 0.033 ps
$B_s \to J/\psi\, K^0_S$	1.75 ± 0.14 ps
Average of above	1.661 ± 0.032 ps

CP-even final state	effective lifetime from single exponential fits
$B_s \to K^+K^-$	1.452 ± 0.042 ps
$B_s \to D^+_s D^-_s$	1.379 ± 0.031 ps
Average of above	1.405 ± 0.025 ps

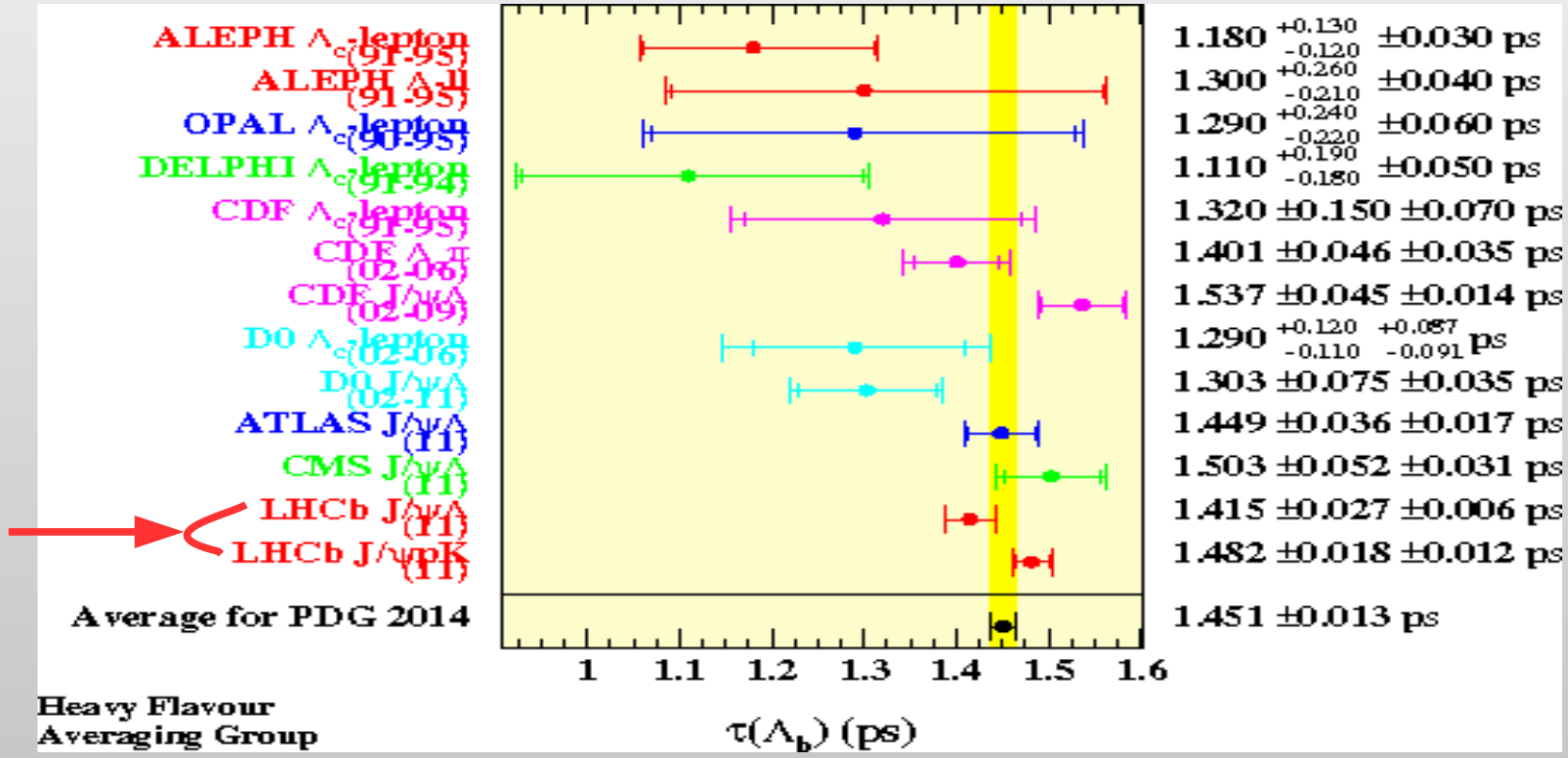
mixture of the two B_s mass eigenstates	effective lifetime from single exponential fits
$B_s \to$ flavour specific	1.465 ± 0.031 ps
$B_s \to D_s X$	1.469 ± 0.031 ps
$B_s \to J/\psi\, \phi$	1.479 ± 0.012 ps





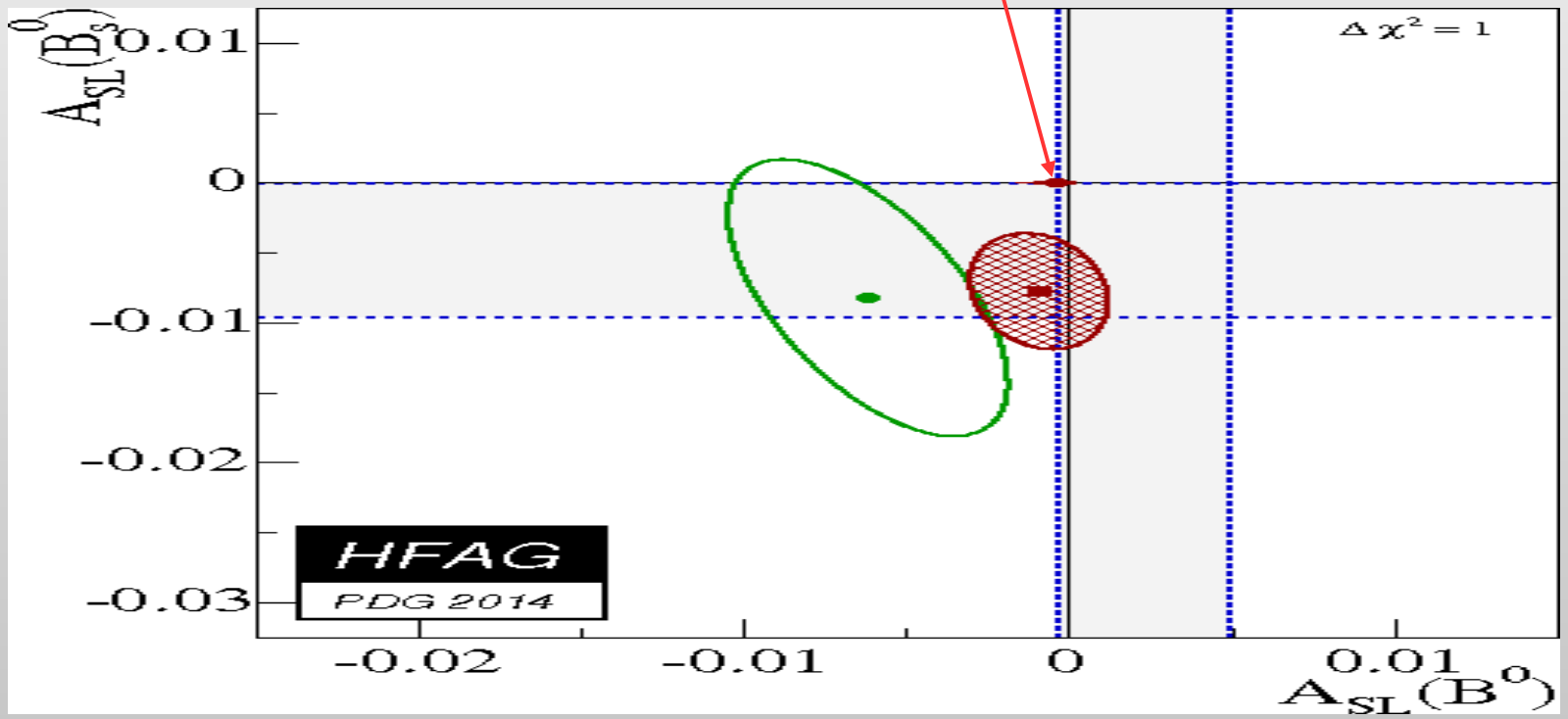
Λ_b Lifetimes

- A long-standing mystery of the Λb lifetime is resolved.
  - $\tau(\Lambda_b)$=1.451+-0.013 (ps)
  - $\tau(\Lambda_b)/\tau(B_0)$=0.955+-0.009, close to 1 by HQE prediction.



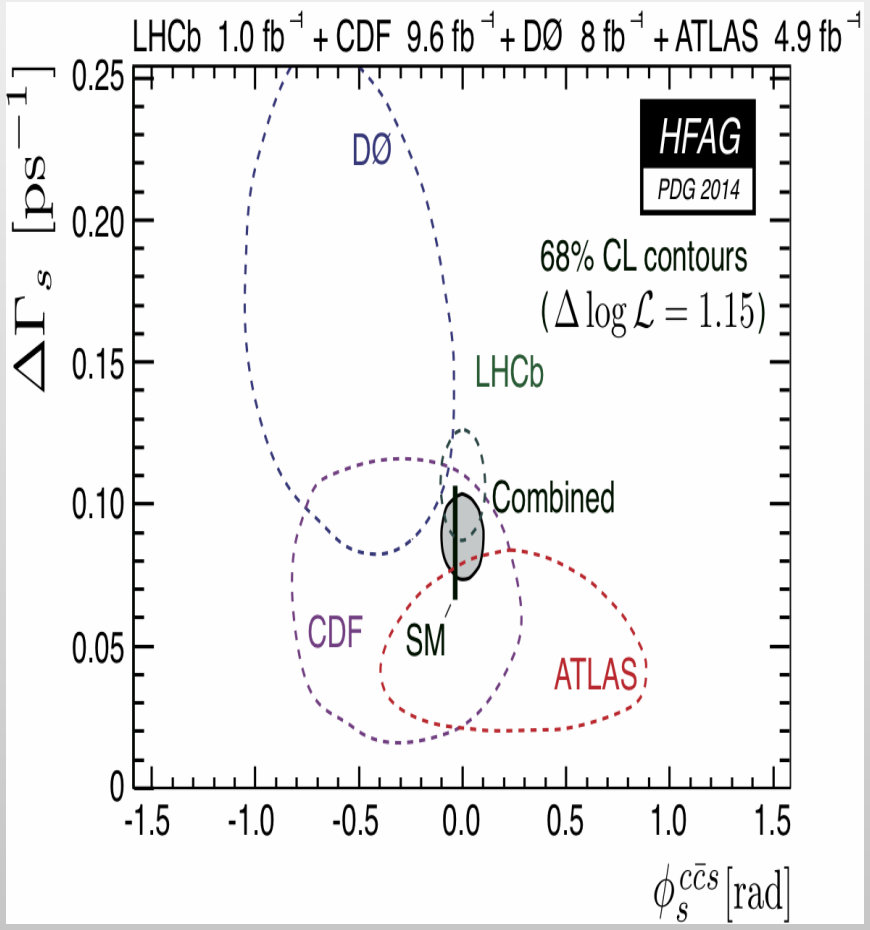
CPV parameter in $B_{d,s}$ Mixing

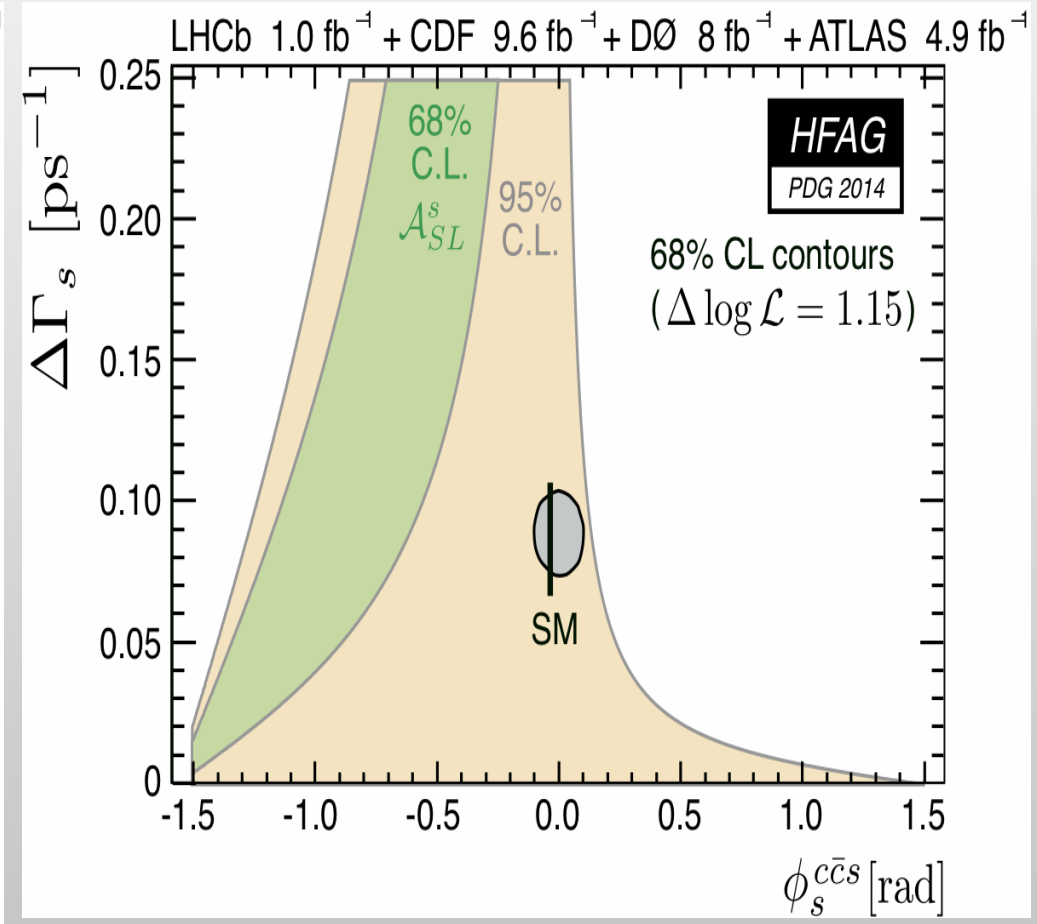
- $a_{sl}(B_{d,s}) = (N^{++} - N^{--})/(N^{++} + N^{--})$
  - D0 measurement (green) is 3σ from SM.
  - World average(red):
    - $a_{sl}(B_0)$=-0.0009+-0.0021
    - $a_{sl}(B_s)$=-0.0077+-0.0042 (<2σ from SM)



CP Asymmetry in Bs→J/Ψφ

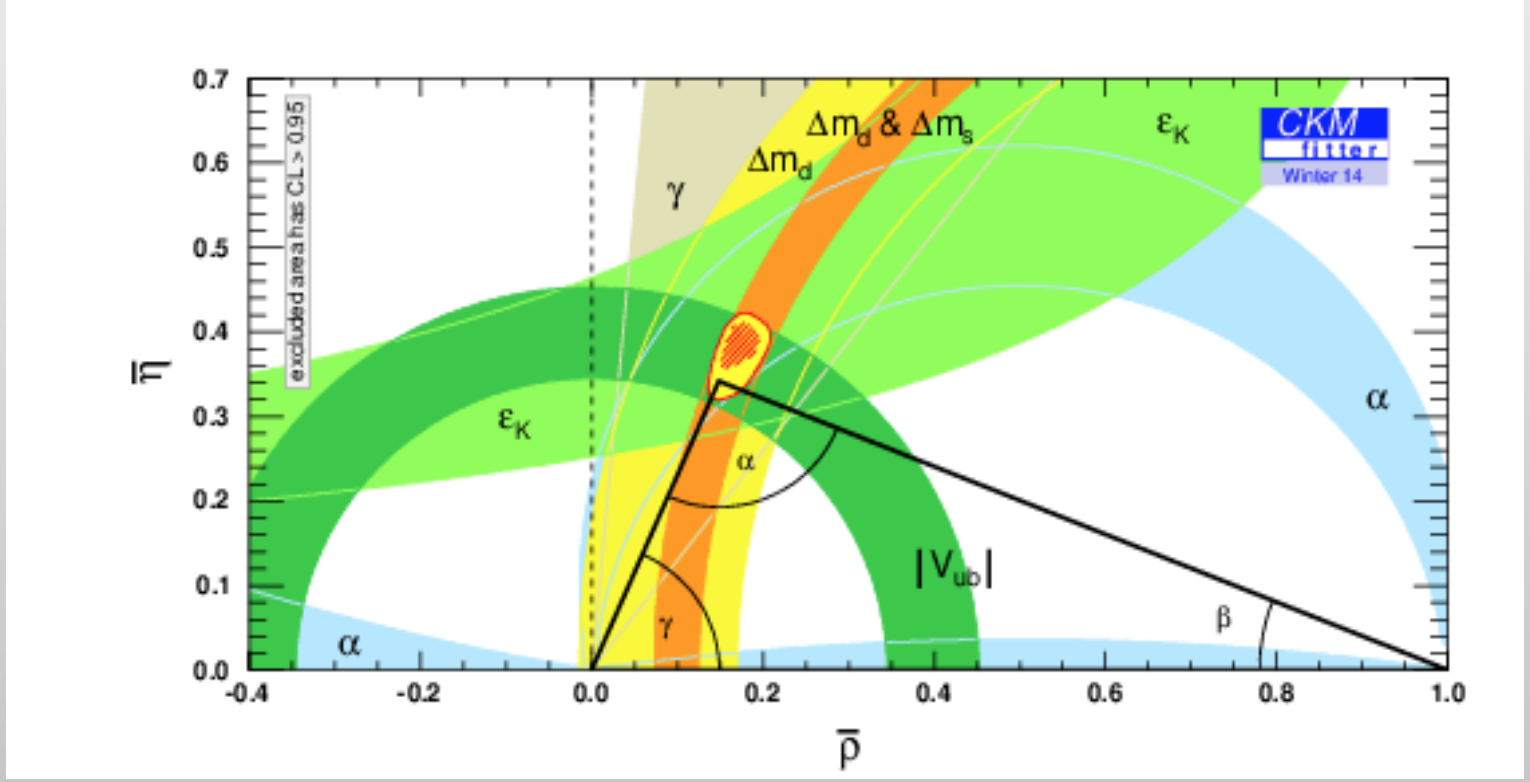
- **Bs→J/ψφ measures B_s mixing phase $-2\beta_s(\phi_s)$, Sensitive to NP at loop.**
- **CDF, D0, LHCb, and ATLAS updated results, is consistent with SM.**





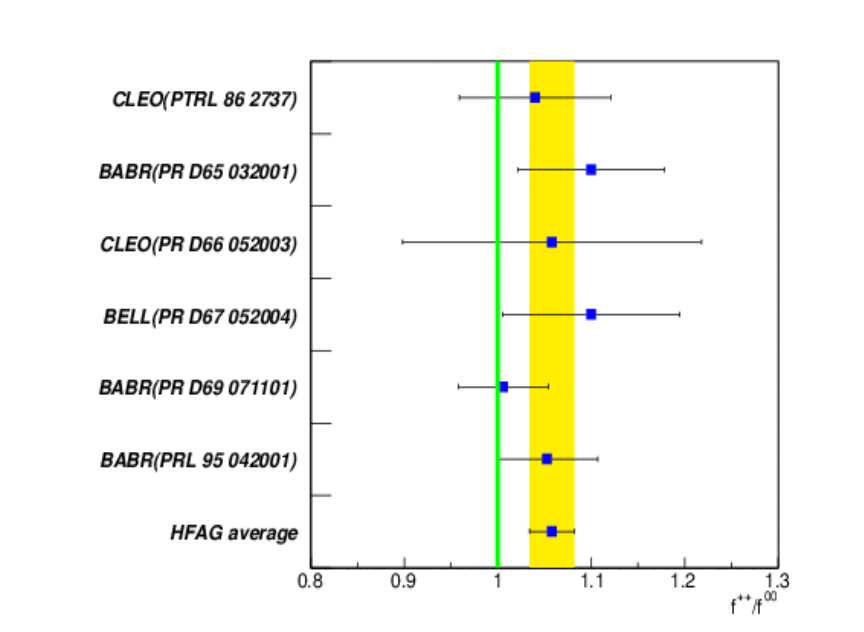
CKM Matrix Elements

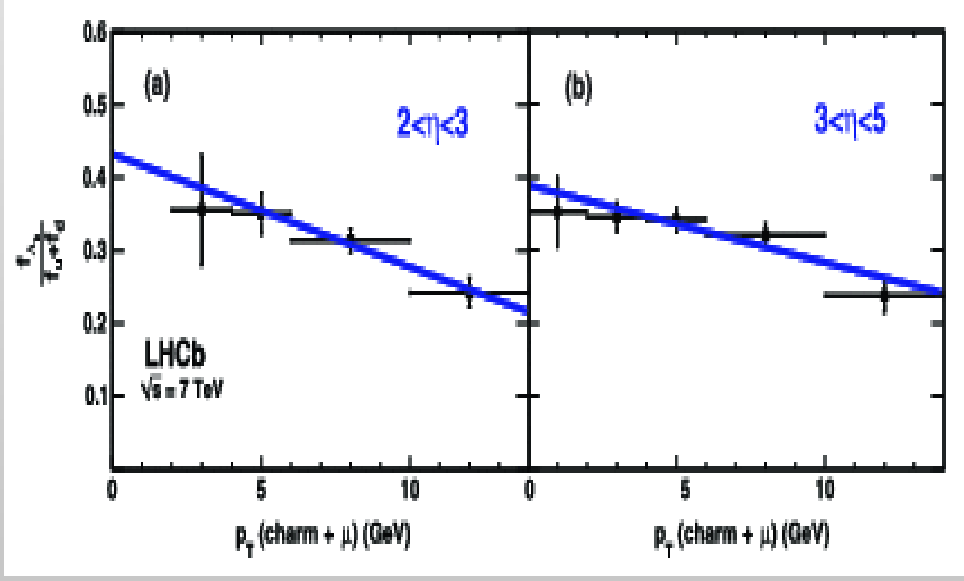
- Most CKM elements are measured based on branching ratios or decay asymmetry with some help of theoretical assumptions.
- B section provides: Δm_d, Δm_s, φ_1, φ_2, φ_3, V_{cb}, $V_{ub,}$ V_{ts}/V_{td}
- They are discussed in mini-review or CKM review



Issues of B Production Fractions

- The B production fractions are required for precision measurement of BR.
- At B factories: $f=B(\Upsilon(4S)\to B^+B^-)/B(\Upsilon(4S)\to B^0B^0)$ is measured to be 1.058+-0.024, about 2σ higher than what is assumed 1.0 in the listing. We may have to rescale the existing measurements once the value of f is 3σ from 1.0.
- The b fractions above Y(4S) might be collider dependent (Pt).





Outside Working Groups (HFAG)

- The PDG averaging method is not designed for handling correlations in statistical and systematic errors between measurements and experiments.
- Have to rely heavily on the outside working groups and their expertise to provide the best averages for PDG that use only published results.
- HFAG provided their averages for PDG for many years, whose combination procedure takes all known correlations into account as well as re-scaling each individual measurements using the common set of input parameters before averaging.
- HFAG consists of 7 subgroups: B lifetime/Mixing, Semileptonic B decays, Unitarity Triangle, Rare B Decays, b→c Decays, Charm, and τ physics.
- Details see the slides from HFAG (Alan Schwartz, Tim Gershon).

Prospects for 2016 Edition

- Continue to work with HFAG, LHC working groups to provide the world best parameters for B, charm and top.
- Planning for data driven minireviews:
  - Update existing mini-reviews for B, charm and Top.
  - Add New mini-review on b→sγ physics.
- All data are consistent with SM, but BSM may show up soon!
- We will continue to meet the challenges in 2016.