HFLAV-TAU STATUS

Swagato Banerjee

UNIVERSITY OF LOUISVILLE

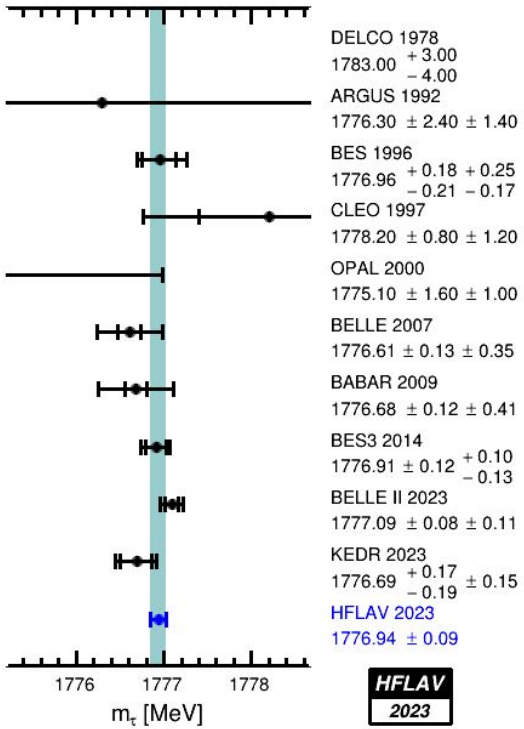
HFLAV all-hands meeting
29 June 2026

Membership

- Members
  - **Swagato Banerjee** (University of Louisville, Belle II)
  - Marcin Chrząszcz (CERN, LHCb)
  - Kiyoshi Hayasaka (Niigata University, Belle)
  - **Alberto Lusiani** (Scuola Normale Superiore and INFN Pisa, BABAR, LHCb)
  - Mike Roney (University of Victoria, BABAR / Belle II)
- Past Members [continue to stay in contact as consultants if there are any unresolved issues]
  - Boris Shwartz (BINP, Belle)
  - Hisaki Hayashii (Nara Woman's University, Belle)

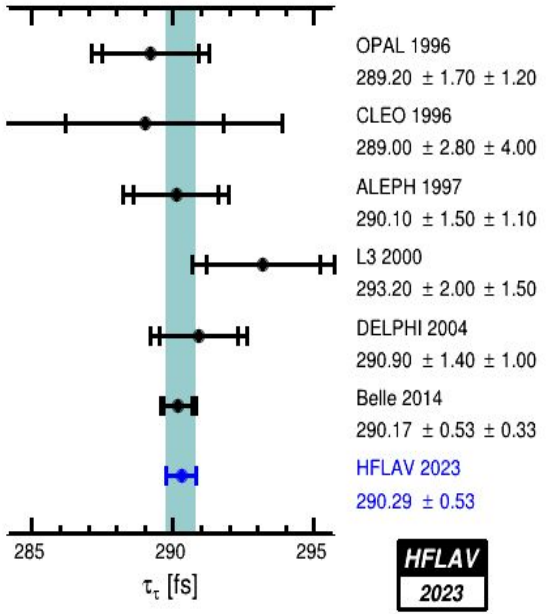
Averaging task # 1

- Tau Mass
  - Belle II measurement (2023) is most precise.
  - Newer measurement from Belle II expected but may not be available by October 2026. Probably next year.
  - No change in methodology planned:
    - Belle (II) inputs overseen by SwB
    - Fits performed by A. Lusiani/SwB



Averaging task # 2

- Tau Lifetime
  - Belle measurement (2014) is most precise.
  - Newer measurement from Belle II expected this summer.
  - No change in methodology planned
    - Belle (II) inputs overseen by SwB
    - Fits performed by A. Lusiani/SwB

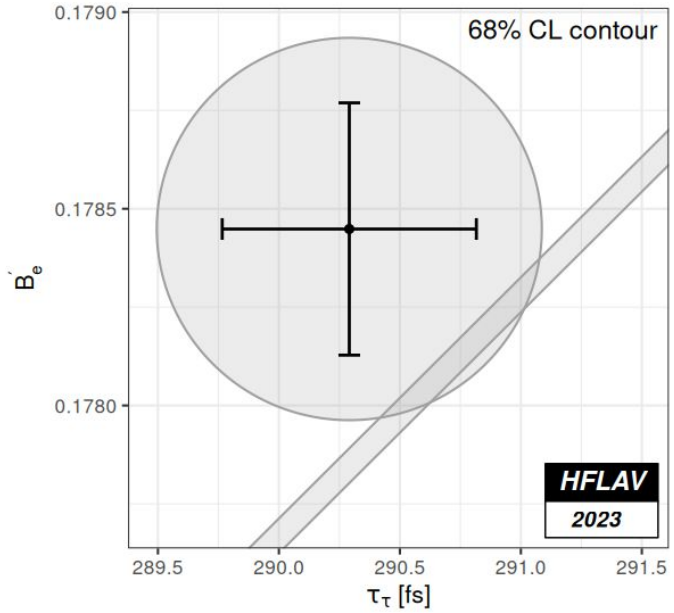


Averaging task # 3

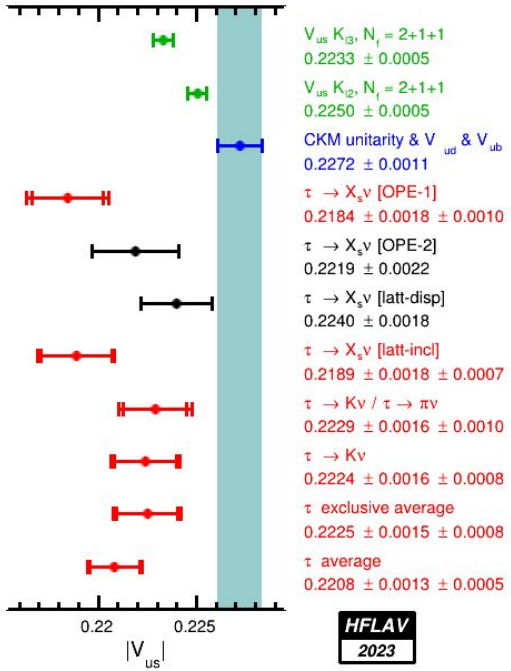
- Tau branching fractions (expected in the Standard Model)
  - 2 fits performed : with and without constraining sum of all branching fractions equal to unity
  - Fit inputs:
    - 171 tau branching fractions and ratio measurements from 13 experiments:
      - ALEPH, CLEO, BABAR, OPAL, BELLE, BELLE II, DELPHI, L3, CLEO3, TPC, ARGUS, HRS, CELLO
    - 1 nuisance parameter: B($a_1^- \to \pi^- \gamma$)
    - 91 constraints on branching fractions and ratios expressed in terms of base decay modes
    - Chi-square restricted to tau branching fractions: χ^2/d.o.f. = 138/125. Confidence level = 20%
    - Unity residual: $B_{ur} = 1 - B_{all} = 0.0007 \pm 0.0011$
  - Several new branching fraction measurements from Belle II expected this year and over the coming years.
  - Changes in methodology planned:
    - Additional nuisance parameters representing branching fractions of mesons (η, ω, ϕ, etc.)
    - Reduced chi-square calculations restricted to just the tau branching fractions
  - Belle (II) inputs overseen by K. Hayasaka/SwB
  - Fits performed by A. Lusiani/SwB

Interpretations

- Lepton Universality tests

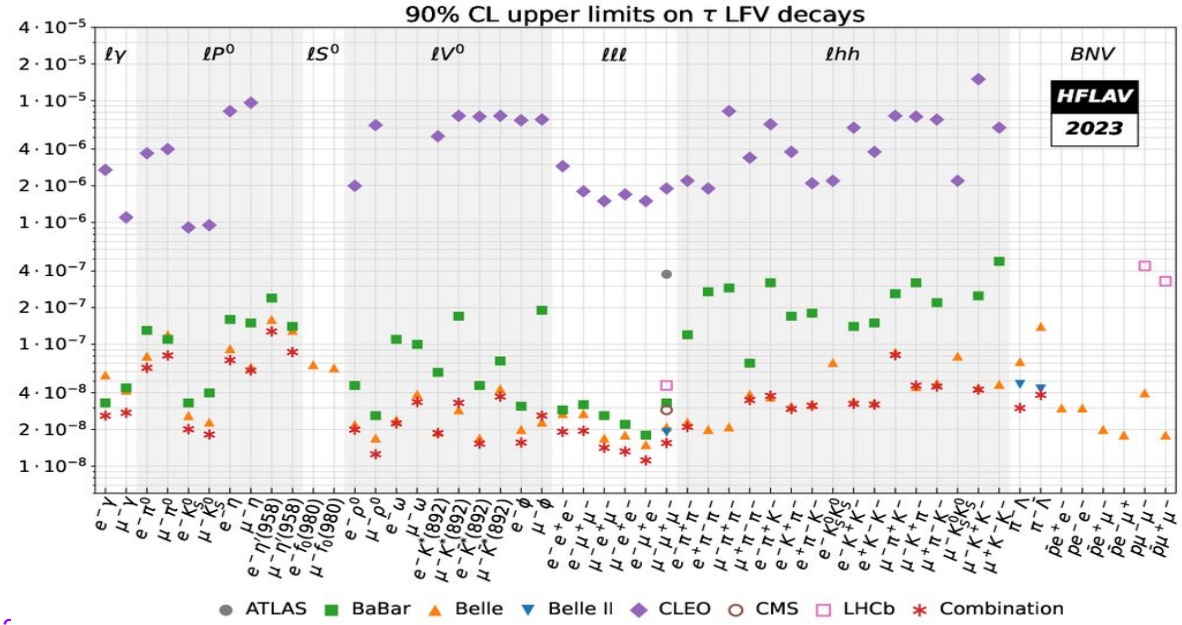


- Quark mixing element $|V_{us}|$



Averaging task # 4

- Combined upper limits on Lepton Flavor Violating tau decays
  - Several new results from Belle II expected this year.
  - No change in methodology planned, but effect of correlated systematics in combination to be documented
  - Belle (II) inputs overseen by SwB/M. Roney, LHCb inputs by A. Lusiani/M.Chrząszcz
  - Fits performed by SwB/M. Roney



Recent updates & Plans for October

- Published the branching fraction fit results in Zenodo with the new HFLAV format
  - Linked the Zenodo records to PDG tau branching fraction fit values
- New branching fractions fits planned including all recent results from Belle II
  - Current fits uses R based and C++ based codes
    - Explore Python based fitting codes
  - Modernize the outputs plots on website
- Several upper limits available from Belle II, LHCb, CMS and ATLAS
  - Combination to be updated using existing methodology
    - Document effect of correlated systematics
    - Compare CL_s based upper limits along with traditional CL_{s+b} approach
  - Modernize the output plots on website
- New HFLAV website implies that there is a new non-negligible amount of work to do that is suitable to be assigned as responsibility to group members.