Issues in e, μ and τ

- e, μ:
  - Encoder: C. Grab (ETH Zuerich)
  - Overseer: J. Beringer (LBNL), replaces D. Groom (LBNL)
  - Minireview authors: W. Fetscher, H.-J. Gerber (ETH Zuerich)
- τ:
  - Encoder: K.G. Hayes (Hillsdale College)
  - Overseer: K. Moenig (DESY)
  - Coordinator: J. Beringer, replaces D. Groom
  - Minireview authors: K.G. Hayes (Hillsdale College) (branching fractions)
    A. Stahl (decay parameters)

New in RPP 2004

- e, μ:
  - Updated e, μ masses , e magnetic moment anomaly, and μ/p magnetic moment ratio from 2002 CODATA
  - 2 new measurements encoded for muons (g-2, limit on $\Gamma(e^-\gamma)/\Gamma$)
- τ:
  - 15 new measurements encoded
  - "Branching Ratios" by K.G. Hayes (revised April 2004)

Change in Muon Mass

- Muon mass taken from CODATA (Committee on Data for Science and Technology), P. J. Mohr and B. N. Taylor:
  - For RPP 2002 from 1998 CODATA: 0.1134289168(34) u
  - For RPP 2004 from 2002 CODATA: 0.1134289264(30) u
- Checked back with authors regarding this rather large change
- Reply from B. Taylor:

  "Unfortunately, you are correct -- the mass of the muon in u has shifted by nearly 3 sigma. The reason is that the value depends on the electron-muon mass ratio, which comes from the experimental value and theoretical expression for the ground-state hyperfine splitting of muonium. It turns out that theoretical work completed since 1998 has shown that the previous calculations of some of the terms in the theoretical expression were in error."

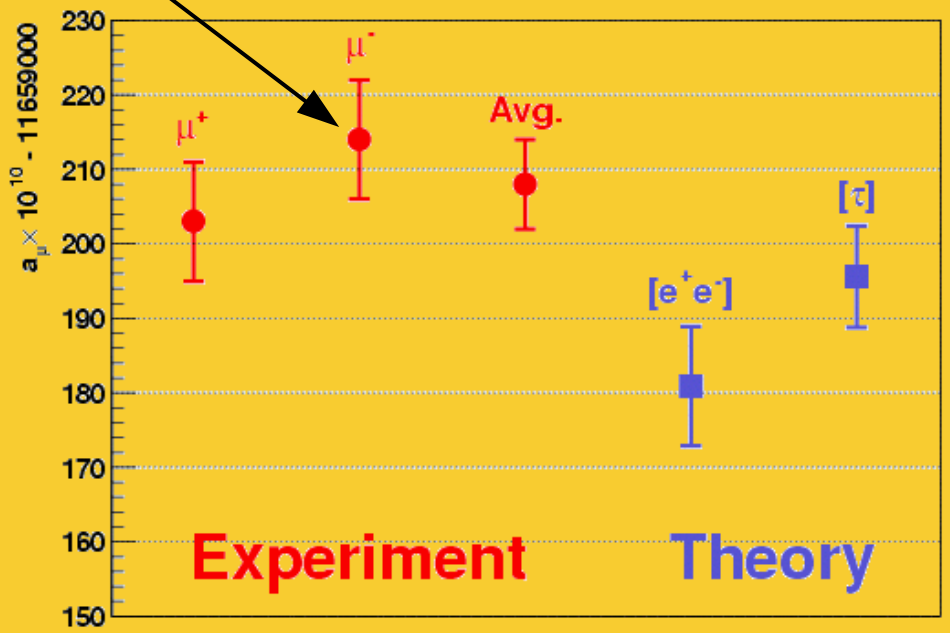
Latest Muon (g-2) Result

From http://www.g-2.bnl.gov/index.shtml:

The (g-2) value of the negative muon was announced January 8, 2004!

a_{μ^-} (BNL'01) = 11 659 214 (8)(3) × 10^{-10} (0.7 ppm)

Not yet included in RPP 2004



a_μ (exp) = 11 659 208 (6) × 10^{-10} (0.5 ppm)

★ Our paper (.ps,.pdf) based on the 2001 data set is accepted for publication in Physical Review Letters.

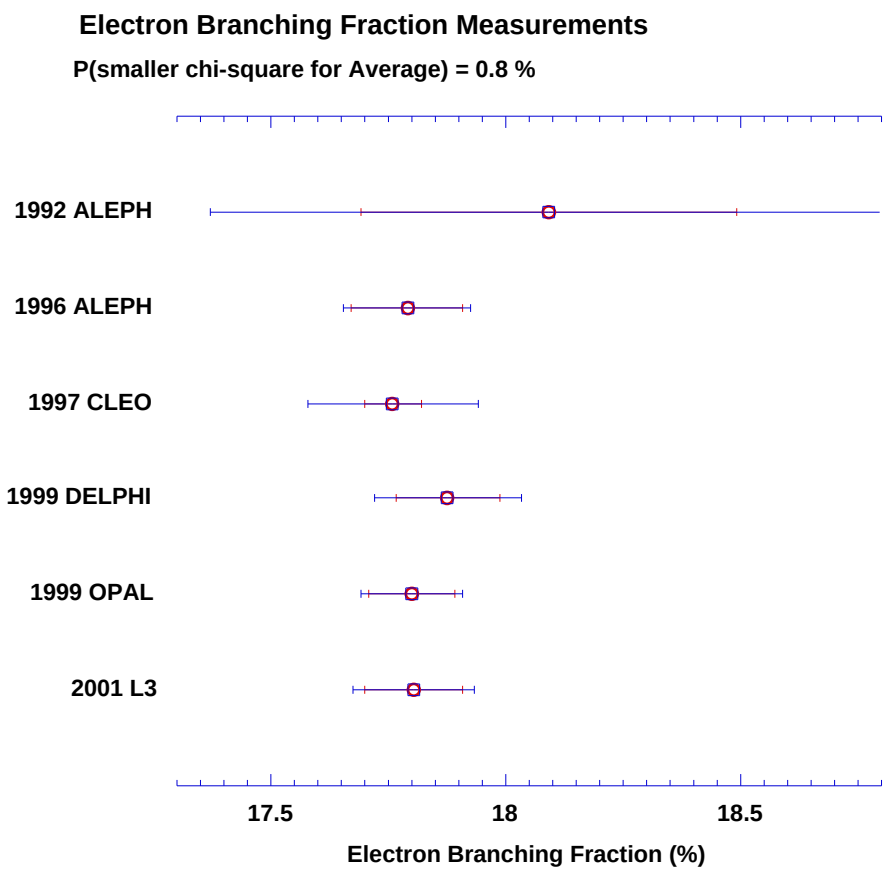
Constrained Fit to τ Branching Fractions

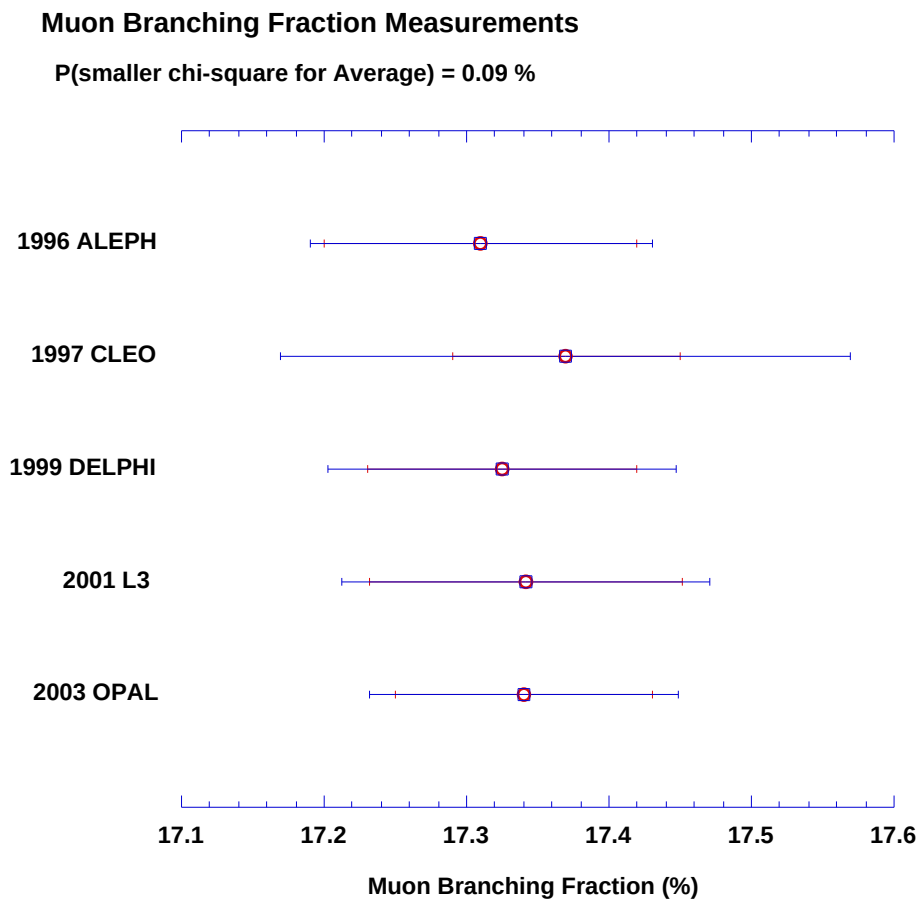
- Branching fraction values for 79 out of 109 conventional τ decay modes are derived from a constrained fit
  - Fit uses 31 basis modes forming an exclusive set whose branching fractions sum to 1.
  - Correlations between fit data allowed starting in 2002.
- **Procedure for handling fit scale factors with correlated data not settled**
  - Ran out of time to resolve issue in February 2004

Overconsistency of Leptonic τ Branching Fractions

- Measurements from CLEO, ALEPH, DELPHI, L3 and OPAL, after excluding measurements which together would contribute 5% of the weight in the average
- RPP 2004 weighted average:
  - $B_e \equiv B(\tau^- \to e^- \overline{\nu}_e \nu_\tau)$
    - (17.81 ± 0.06) %
    - Fit: N = 6 $\chi^2 = 0.49$ $P(\chi^2 < 0.49) = 0.75\ \%$
  - $B_\mu \equiv B(\tau^- \to \mu^- \overline{\nu}_\mu \nu_\tau)$
    - (17.33 ± 0.06) %
    - Fit: N = 5 $\chi^2 = 0.08$ $P(\chi^2 < 0.08) = 0.09\%$

Overconsistency of Leptonic τ Branching Fractions





Overconsistency of Leptonic τ Branching Fractions

- Ratio systematic / statistical error:

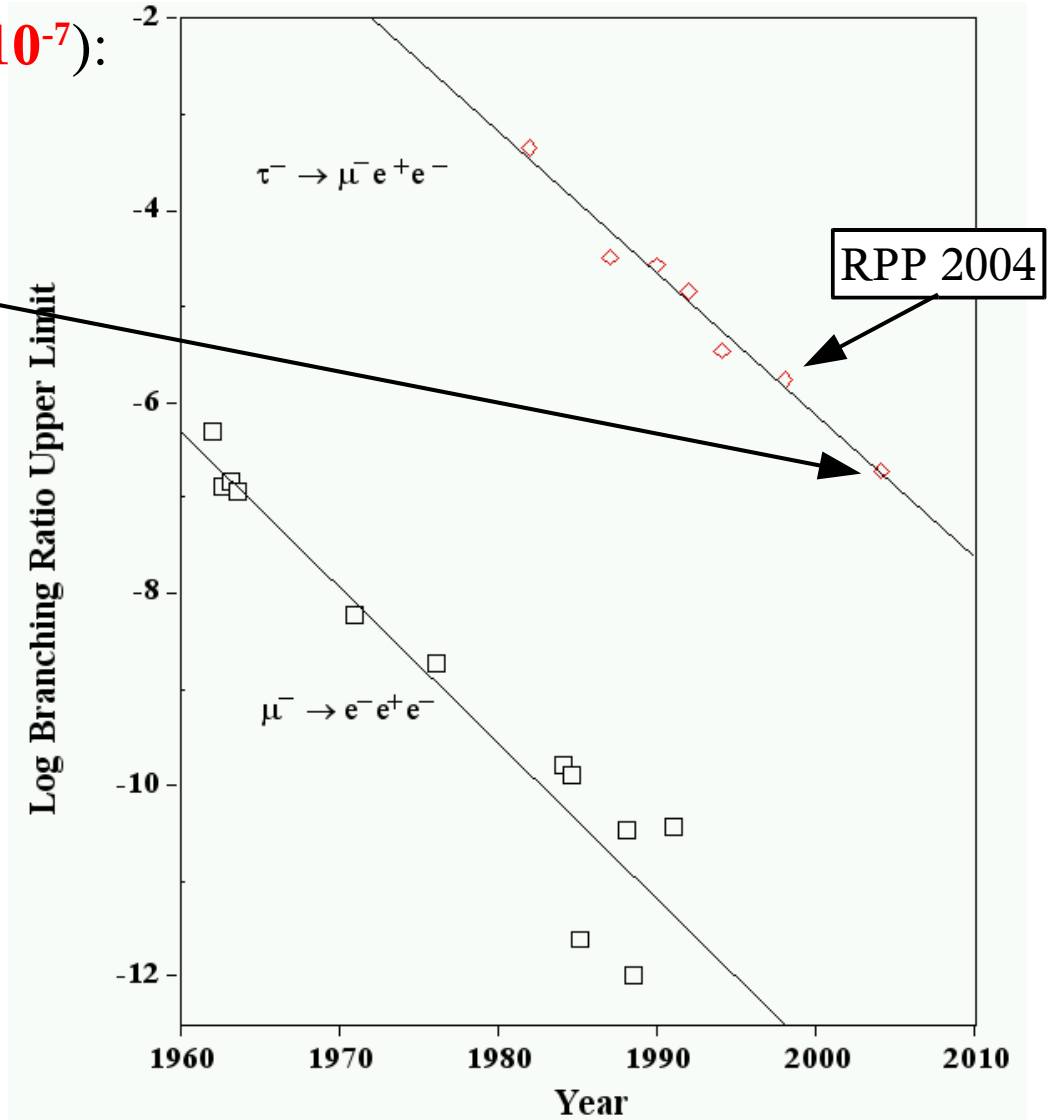
	B_e	B_μ
CLEO	2.83	2.25
ALEPH	0.50	0.45
DELPHI	1.01	0.81
L3	0.73	0.61
OPAL	0.67	0.67

- Weighted average using only statistical errors:
  - **B_e:** N = 6 $\chi^2 = 1.35$ $P(\chi^2 < 1.35) = 7.1\ \%$ (was 0.75%)
  - **B_μ:** N = 5 $\chi^2 = 0.24$ $P(\chi^2 < 0.24) = 0.7\ \%$ (was 0.09%)
  - Largest component is bias, not overestimated errors
- PDG averages for B_e and B_μ used to test lepton universality
  - Influences significance of universality tests
- **How should this overconsistency be treated in the τ listings?**

New τ Results from B Factories

- BaBar and Belle are also τ factories – at $\Upsilon(4S)$:
  - $\sigma(\tau^+\tau^-) = 0.9$nb
  - $\sigma(b\bar{b}) = 1.1$nb
- Data collected as of September 2004:
  - BaBar: 244/fb $\rightarrow$ 220 million $\tau^+\tau^-$
  - Belle: 288/fb $\rightarrow$ 260 million $\tau^+\tau^-$
  - Corresponds to several times total LEP τ sample/experiment each day!
- New publications on lepton family number violating τ decays give typical factor 10 improvement over RPP 2004
- In addition, 27 new upper τ decay limits already presented at recent conferences

Example: Lepton Family Violating τ Decays

- New published results (90% CL, **x10^{-7}**):

Mode	BELLE	BABAR
$\tau^- \to e^-e^+e^-$	<3.5	<2.0
$\tau^- \to \mu^-e^+e^-$	<1.9	<2.7
$\tau^- \to \mu^+e^-e^-$	<2.0	<1.1
$\tau^- \to e^-\mu^+\mu^-$	<2.0	<3.3
$\tau^- \to e^+\mu^-\mu^-$	<2.0	<1.3
$\tau^- \to \mu^+\mu^-\mu^-$	<2.0	<1.9
$\tau^- \to \mu^- \gamma$	<3.1	
$\tau^- \to \mu^- \eta$	<3.4