Tau Decays at the B-Factories

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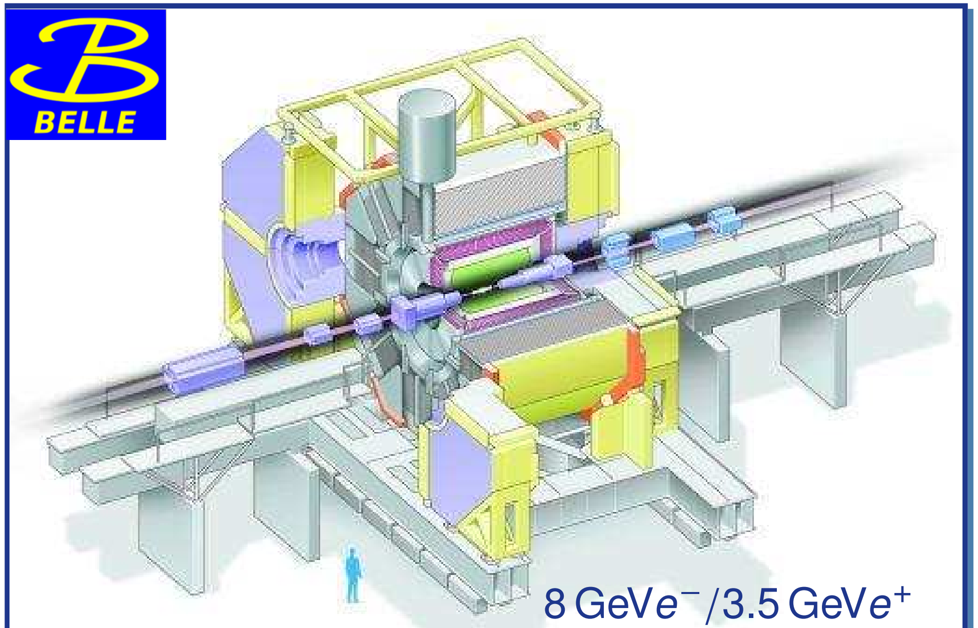
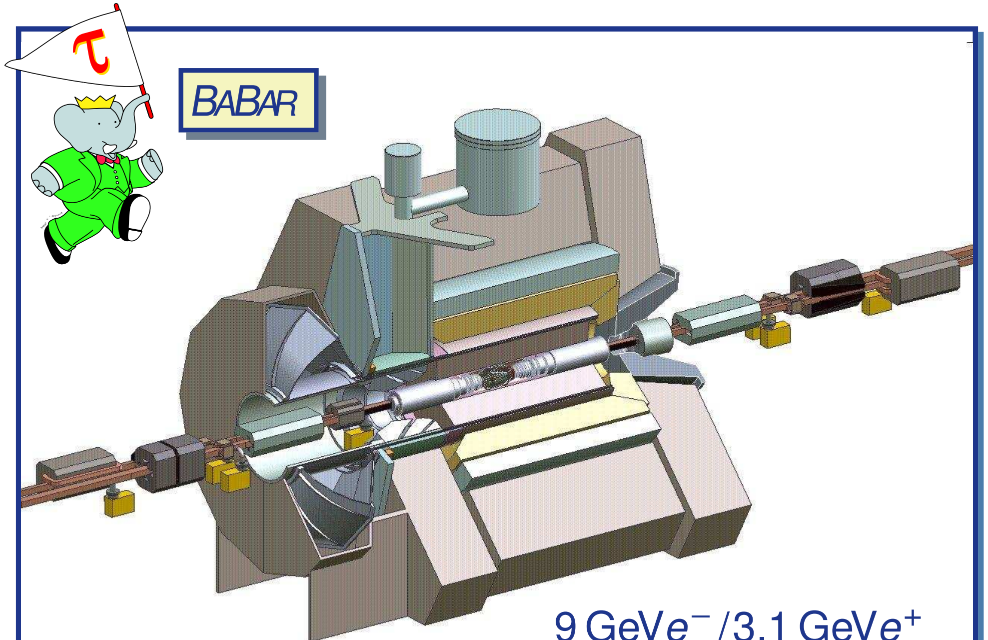
(on behalf of the *BABAR* and Belle collaborations)

Today's Tau factories are *BABAR* and Belle

- asymmetric colliders on Υ(4*S*) peak ($\sqrt{s}$ = 10.58 GeV) $\sigma(\tau^+\tau^-) \approx 0.9\,\text{nb} \approx \sigma(B\overline{B}) \approx 1.1\,\text{nb}$
- similar detectors, but for PID: *BABAR* ⇒ Cherenkov detector, Belle ⇒ threshold Cherenkov & TOF

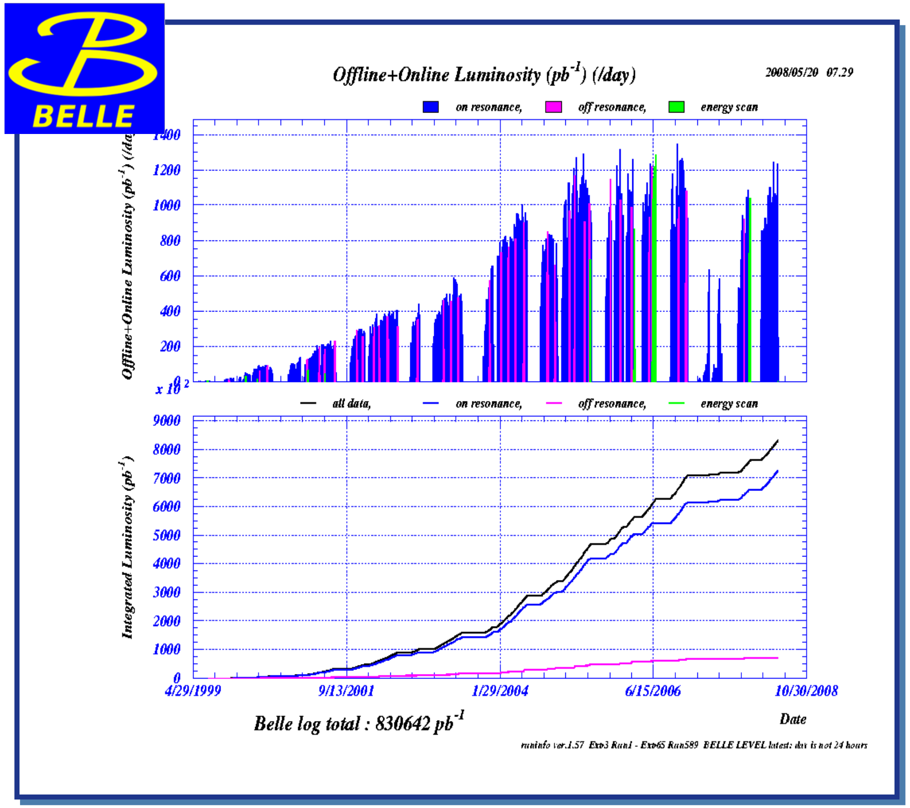


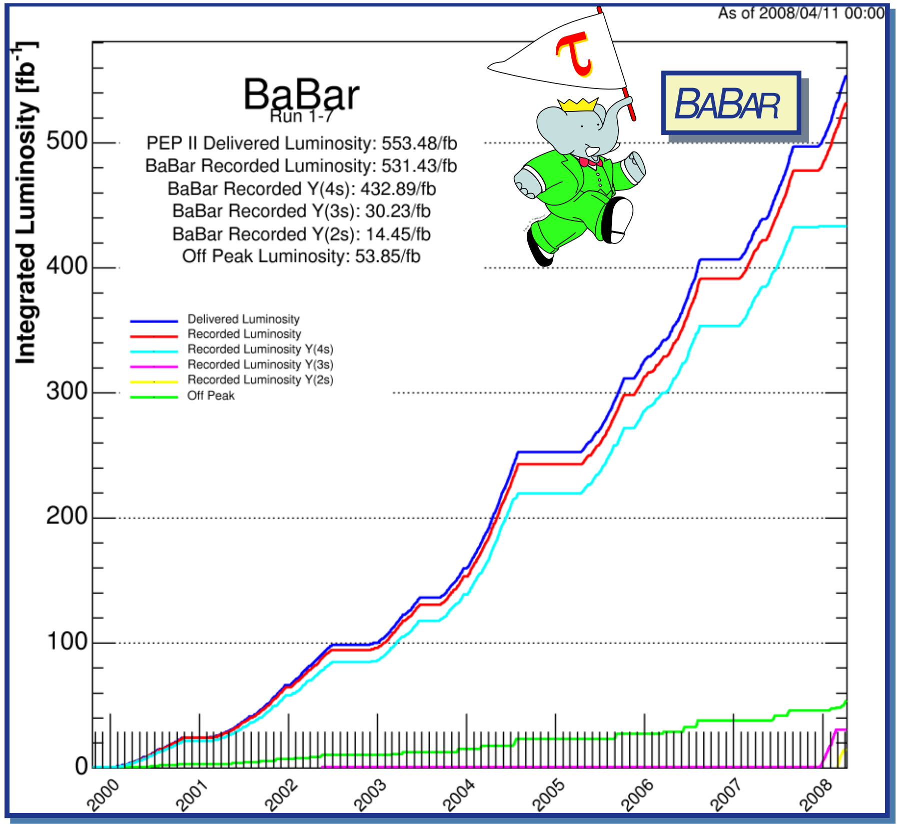
8 GeV e^-/3.5 GeV e^+
peak luminosity: $1.7{\cdot}10^{34}\text{cm}\,\text{s}^{-1}$



9 GeV e^-/3.1 GeV e^+
peak luminosity: $1.2{\cdot}10^{34}\text{cm}\,\text{s}^{-1}$

Lots of tau pairs have been collected at B-factories





End May 2008: $\int Ldt \approx 831\ \text{fb}^{-1}$ $\sim$764M tau pairs

End May 2008: $\int Ldt \approx 531\ \text{fb}^{-1}$ $\sim$488M tau pairs

(analyses typically use smaller samples)

B-factories (recent) tau physics results can be grouped as follows

Searches for LFV
- clean and unambiguous NP probes
- tau LFV searches complementary to $\mu \to e\gamma$

(semi-)hadronic decays
- QCD and resonances studies
  - $\tau \to \pi\pi^0\nu$ BF and spectrum for $a_\mu^{\pi\pi}$
- 2nd class current searches
- rare decays, small BF

V_{us} from $\tau \to s$ inclusive
- small QCD theory error

Lepton universality and precision meas.
- tau lifetime
- tau mass

Lepton flavour violation in tau decays

NEW PHYSICS

LFV results from the B-Factories

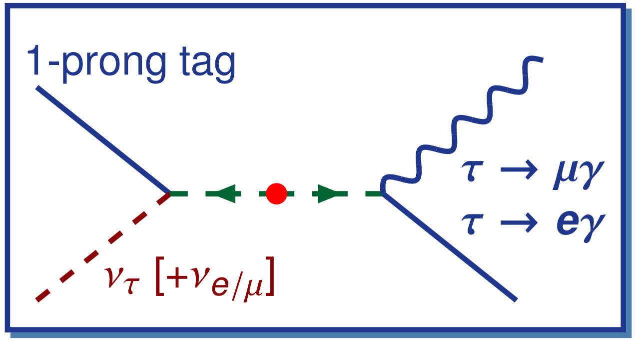
BELLE

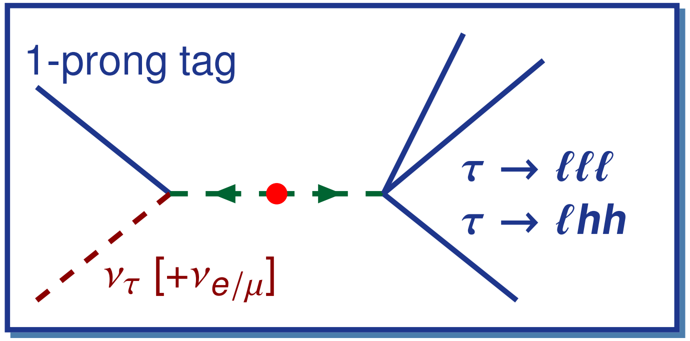
Belle channel	Reference
$\tau \to \mu\gamma$	0705.0650[hep-ex], ⇒ PLB
$\tau \to e\gamma$	0705.0650[hep-ex], ⇒ PLB
$\tau \to \ell^-(\pi^0, \eta, \eta')$	PLB 648, 341 (2007)
$\tau \to 3\ell$	PLB 660 (2008) 154
$\tau \to \ell hh'$	PLB 640 (2006) 138
$\tau \to \ell V^0$	arXiv:0801.2475
$\tau \to \overline{\Lambda}\pi^-, \Lambda\pi^-$	PLB 632 (2006) 51
$\tau \to \ell K^0_s$	PLB 639 (2006) 159
$\tau \to \ell f_0$	K.Inami, Phipsi08, April 2008

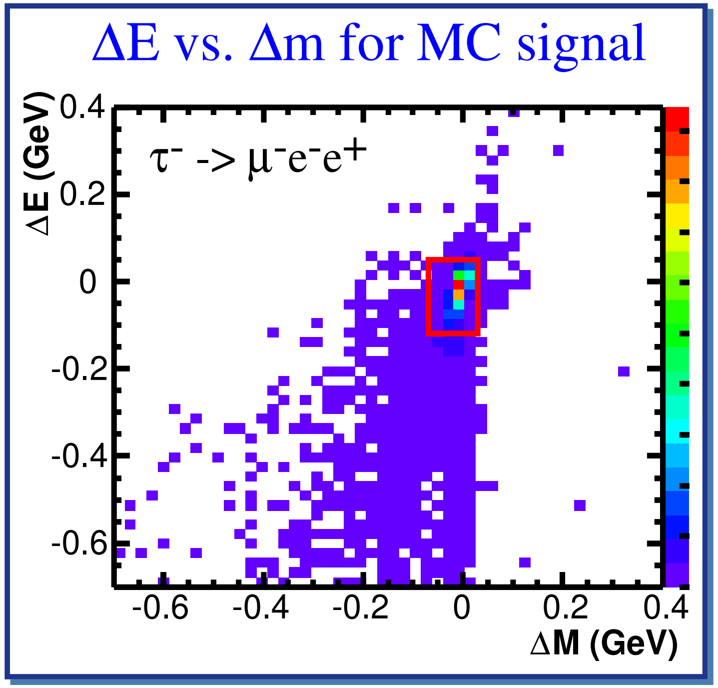
BABAR

BaBar channel	Reference
$\tau \to \mu\gamma$	PRL 95 (2005) 041802
$\tau \to e\gamma$	PRL 96 (2006) 041801
$\tau \to \ell(\pi^0, \eta, \eta')$	PRL 98 (2007) 061803
$\tau \to 3\ell$	PRL 99 (2007) 251803
$\tau \to \ell hh'$	PRL 95 (2005) 191801
$\tau \to \ell\omega$	PRL 100;071802 2008
$\tau \to \overline{\Lambda}\pi, \overline{\Lambda}K, \Lambda\pi, \Lambda K$	hep-ex/0607040
$e^+e^- \to \ell\tau$	PRD 75 (2007) 031103

Properties of events with a LFV violating tau decay (in CM system)





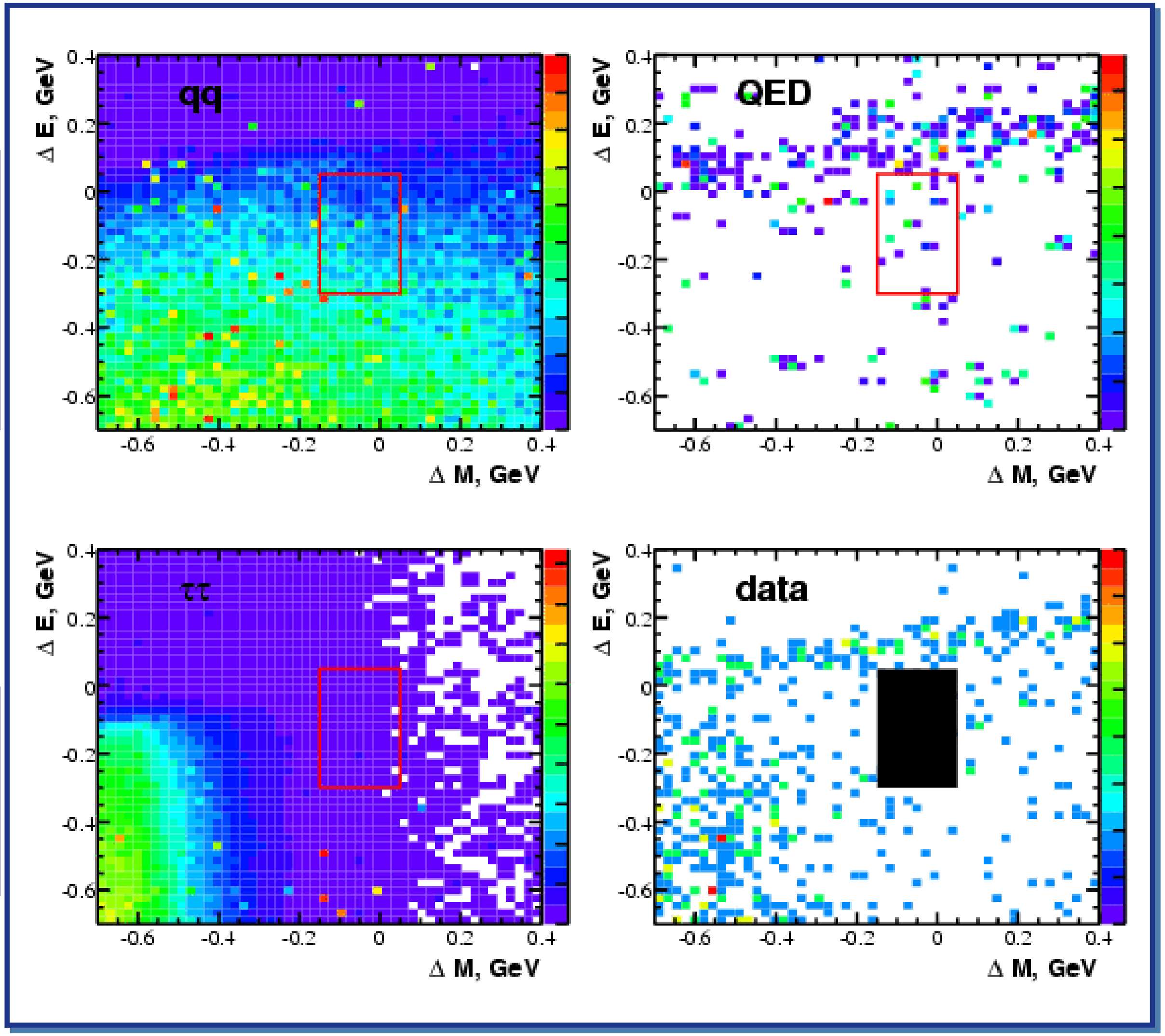


- at Υ(4S), separated $\tau^+\tau^-$ decay hemispheres
- neutrinoless tau decay
  → **no missing 4-momentum on signal side**
- **tag side** → undetected neutrino(s)
  → 1- or 3-prongs, $E<E_{beam}$, $M<M_\tau$

- $\Delta M = M_{reco} - M_\tau \approx 0$ $\Delta E = E_{reco} - E_{beam} \approx 0$
- smeared by resolution and radiative effects
- expected background from data side-bands
- count events in signal box, or max LH fit

Typical backgrounds for LFV violating tau decays

$q\overline{q}$ (uds, $c\overline{c}$, $b\overline{b}$)
($b\overline{b}$ is negligible)
uniform ΔM
$\Delta E < 0$



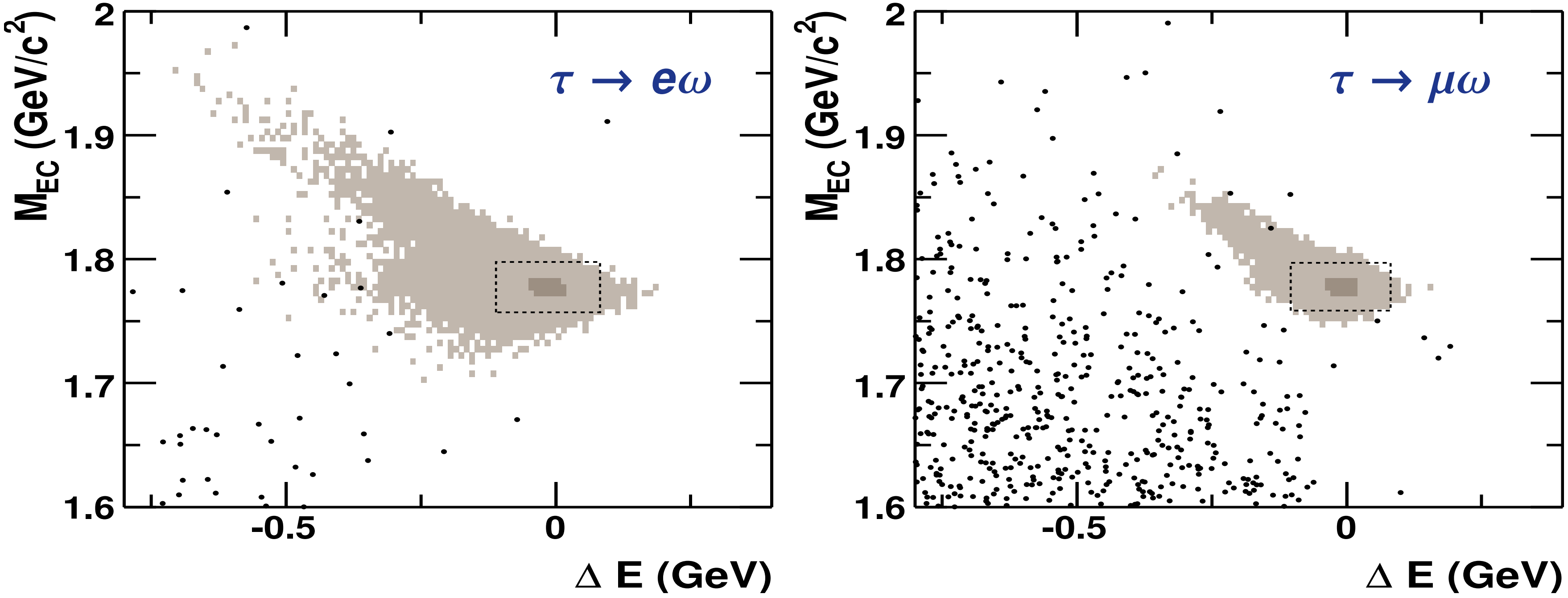
Bhabha, di-muon
uniform ΔM
$\Delta E \approx 0$ band

$\tau^+\tau^-$, two-photon
$\Delta M < 0$
$\Delta E < 0$

$\tau \to 3\ell$
data candidates

LFV $\tau \rightarrow \ell\omega$ with $\omega \rightarrow \pi^+\pi^-\pi^0$

BABAR | $384\ \text{fb}^{-1}$ | PRL 100 071802 (2008)



- signal efficiency: 2.96% – 2.56%
- expected BKG/channel: 0.35–0.73 events
- observed candidates: 0–0 events

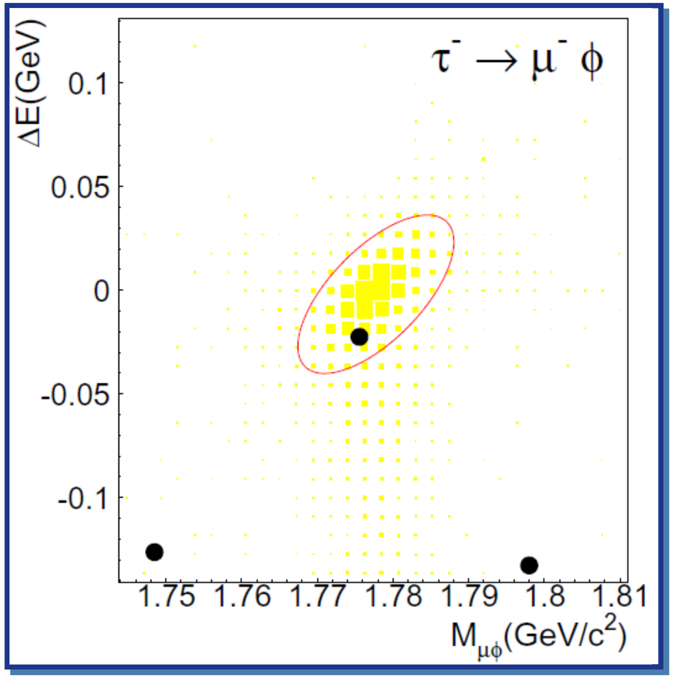
- **$BF(\tau \rightarrow \ell\omega) < 11\text{–}10 \cdot 10^{-8}$ (90% CL)**
- PRL 100 071802 (2008) (arXiv:0711.0980 [hep-ex])

LFV search for $\tau \to \ell V^0$

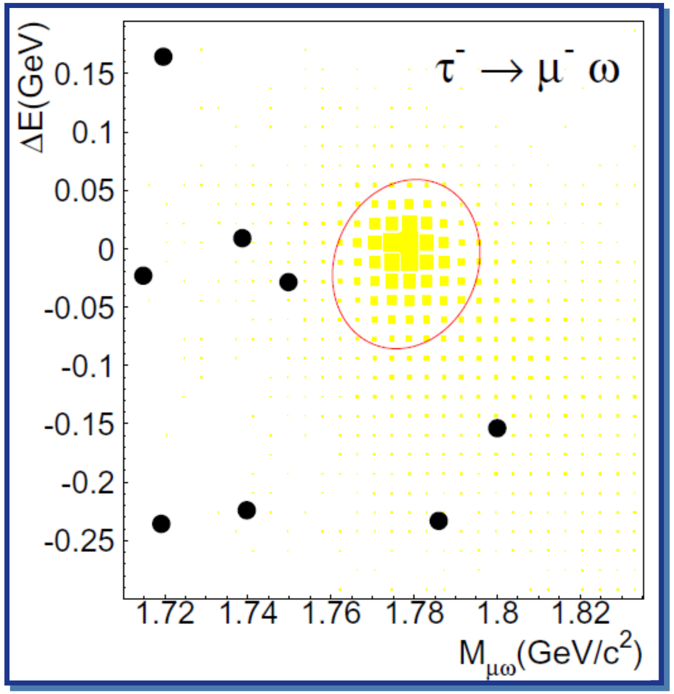
preliminary | $543\ \mathrm{fb}^{-1}$ | arXiv:0801.2475

- 10 modes are investigated:
  - $\ell = e, \mu$
  - $V^0 = \phi,\ \omega,\ K^{*0},\ \overline{K}^{*0},\ \rho^0$
- signal efficiency 2.5–4.9%
- expected bkg: 0.0–1.0 events
- main BKG: $\tau \to \pi\omega\nu, \pi\pi\pi\nu$

- data candidates:
  - 1 events for $\tau \to \mu\phi, e\omega, eK^{*0}$
  - 0 events for other modes
- **BF < [5.9–18]·10^{-8} (90% CL)**



signal MC
data events

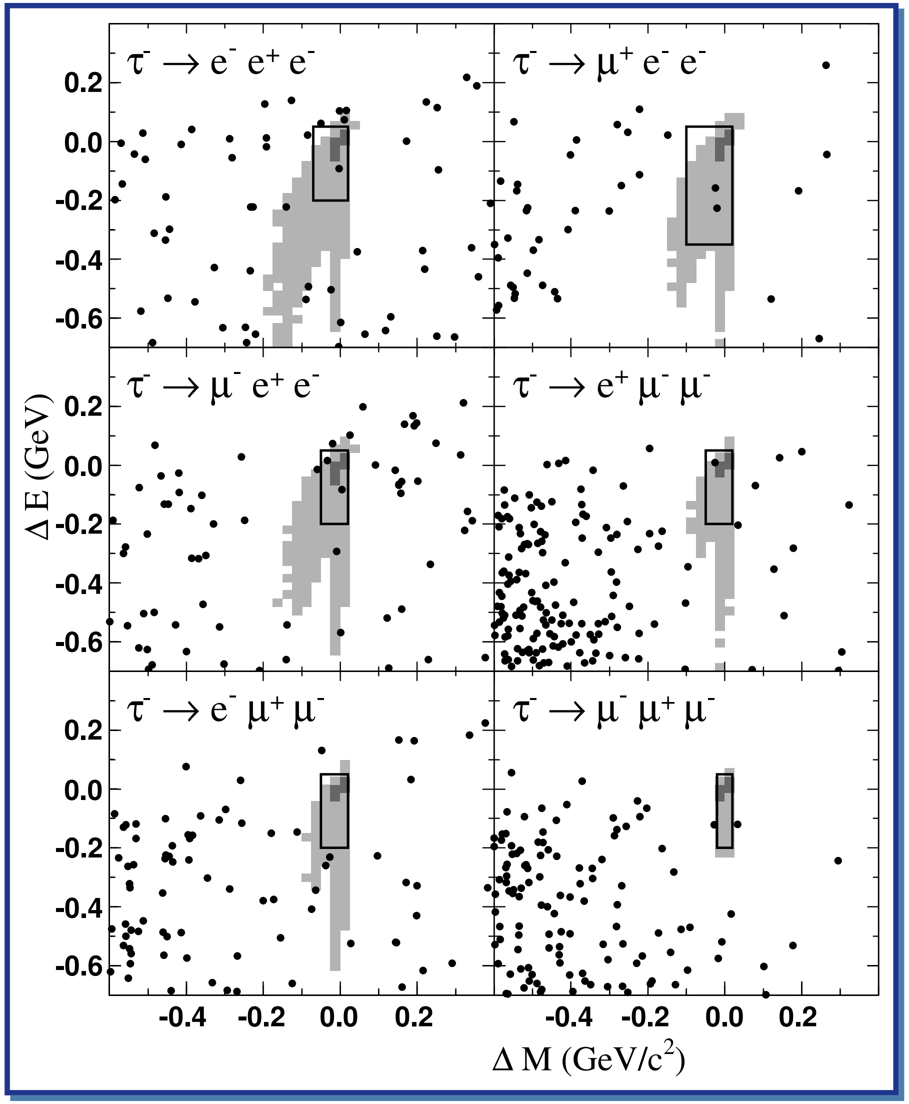


$\tau \to \ell\ell\ell$ LFV search

BABAR | 376 fb^{-1} | PRL 99 251803 (2007)

- selection and SB optimized for best exp. UL
- signal efficiency 5.5–12.4%
- background estimated with 2D ΔM-ΔE fit
- expected bkg: 0.3–1.3 events
- data candidates: 0–2 events
- Cousin & Highland
- **BF < [3.7–8.0]·10^{-8} (90% CL)**
- PRL 99 251803 (2007) (arXiv:0708.3650 [hep-ex])

Mode	Eff. [%]	$N_{\rm bgd}$	$UL_{90}^{\rm exp}$	$N_{\rm obs}$	$UL_{90}^{\rm obs}$
$e^-e^+e^-$	8.9 ± 0.2	1.33 ± 0.25	4.9	1	4.3
$\mu^-e^+e^-$	8.3 ± 0.6	0.89 ± 0.27	5.0	2	8.0
$\mu^+e^-e^-$	12.4 ± 0.8	0.30 ± 0.55	2.7	2	5.8
$e^+\mu^-\mu^-$	8.8 ± 0.8	0.54 ± 0.21	4.6	1	5.6
$e^-\mu^+\mu^-$	6.2 ± 0.5	0.81 ± 0.31	6.6	0	3.7
$\mu^-\mu^+\mu^-$	5.5 ± 0.7	0.33 ± 0.19	6.7	0	5.3

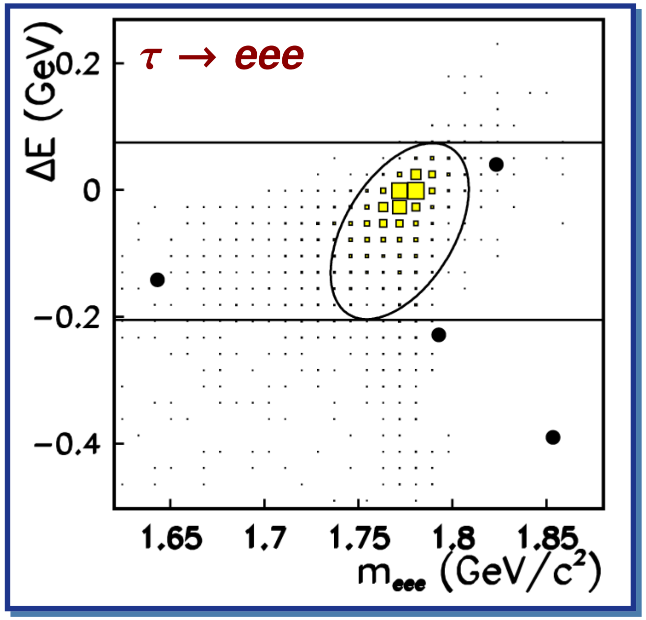


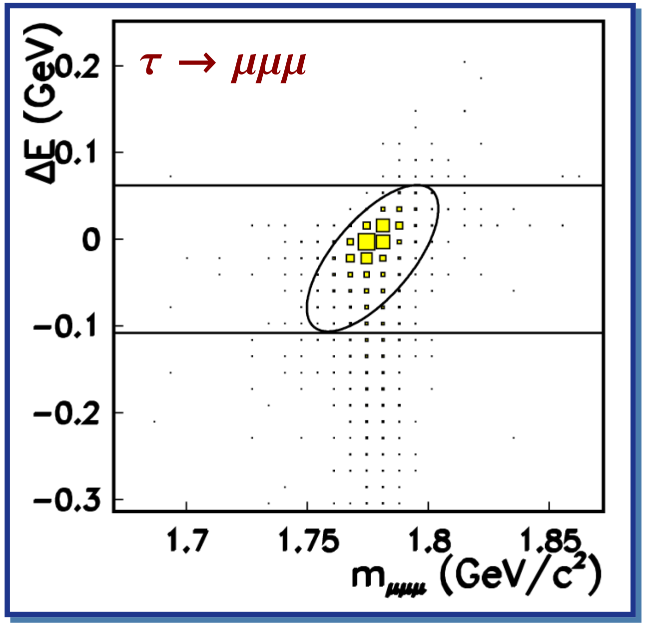
LFV search for $\tau \to \ell\ell\ell$

BELLE 535 fb^{-1} PLB 660 (2008) 154

- event selection optimized by mode separately
- signal efficiency 6.0–12.5%
- expected bkg: 0.0–0.4 events
- data candidates: 0 events
- **BF < [2.0–4.1]·10^{-8} (90% CL)**

Mode	ε (%)	N_{BG}	σ_{syst} (%)	N_{obs}	s_{90}	$\mathcal{B}(\times 10^{-8})$
$\tau^- \to e^-e^+e^-$	6.00	0.40±0.30	9.8	0	2.10	3.6
$\tau^- \to \mu^-\mu^+\mu^-$	7.64	0.07±0.05	7.4	0	2.41	3.2
$\tau^- \to e^-\mu^+\mu^-$	6.08	0.05±0.03	9.5	0	2.44	4.1
$\tau^- \to \mu^-e^+e^-$	9.29	0.04±0.04	7.8	0	2.43	2.7
$\tau^- \to e^+\mu^-\mu^-$	10.8	0.02±0.02	7.6	0	2.44	2.3
$\tau^- \to \mu^+e^-e^-$	12.5	0.01±0.01	7.7	0	2.46	2.0





LFV search for $\tau \to \ell f_0$

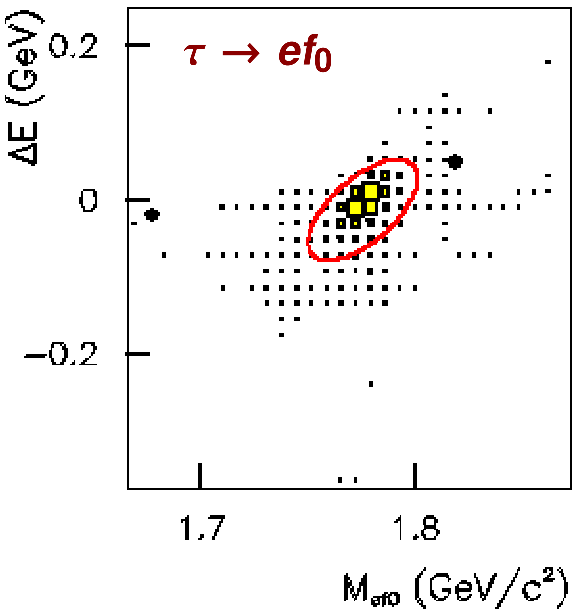
BELLE preliminary $671\ fb^{-1}$

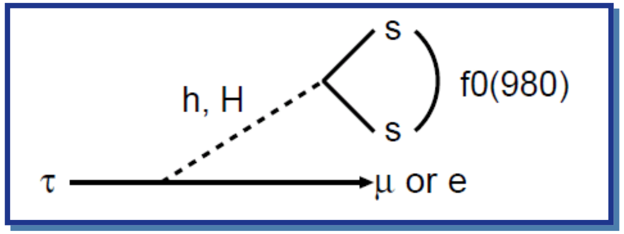
- with scalar Higgs mediation:
  $BF(\tau\to\mu f_0) : BF(\tau\to 3\mu) : BF(\tau\to\mu\eta)$
  $= 1.3 : 0.54 : 1$
  (C.H.Chen et al, PRD 74:035010 (2006))
- use $f_0 \to \pi\pi$

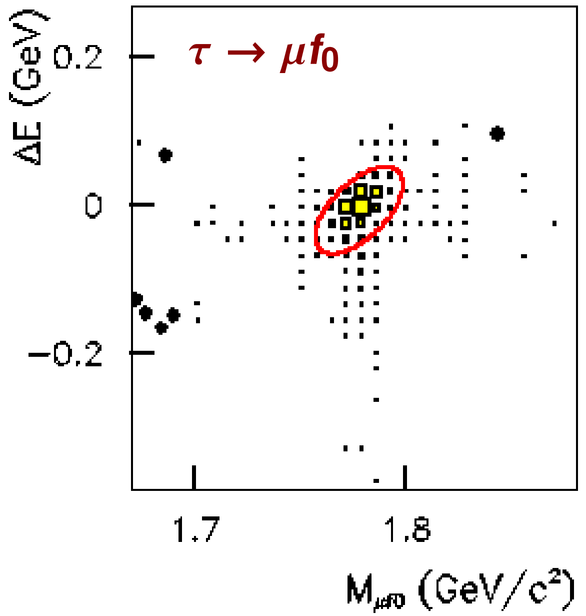
- signal efficiency 5.8–6.0%
- expected BKG: 0.10–0.11 events
- data candidates: 0 events

$BF(\tau \to \ell f_0 \to \ell\pi\pi) < [3.3\text{–}3.4]\cdot 10^{-8}$ (90% CL)

(first time this search has been done)







- signal MC
- data events

B-Factories LFV searches summary

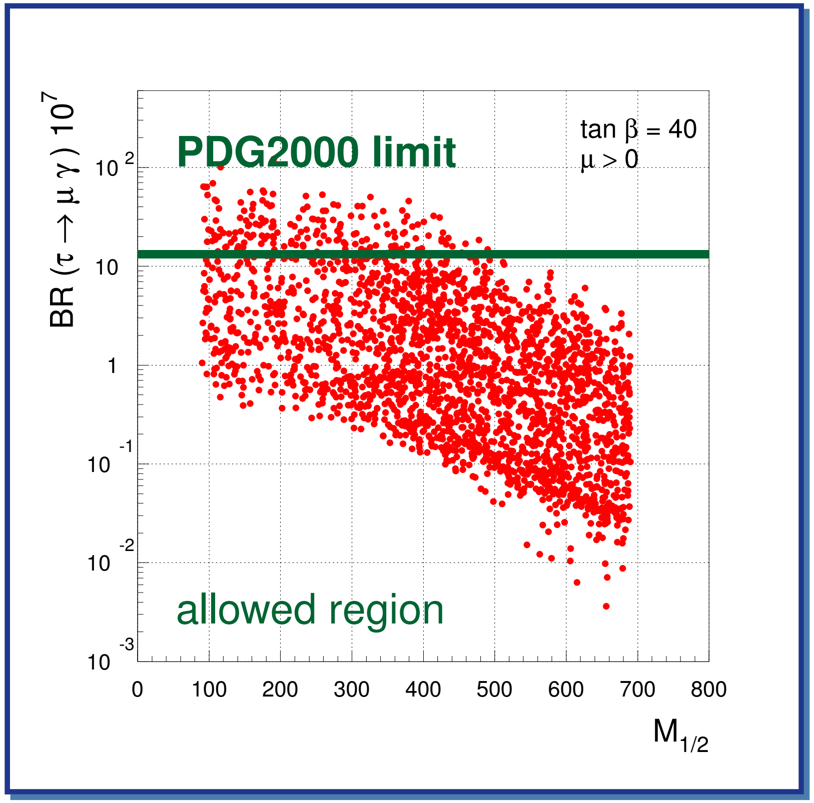
	Belle		BaBar	
	UL90 (10^{-8})	Lumi (fb^{-1})	UL90 (10^{-8})	Lumi (fb^{-1})
$\mu\gamma$	4.5*	535	6.8	232
$e\gamma$	12*	535	11	232
$\mu\eta$	6.5	401	15	339
$\mu\eta'$	13	401	13	339
$e\eta$	9.2	401	16	339
$e\eta'$	16	401	24	339
$\mu\pi^0$	12	401	15	339
$e\pi^0$	8	401	13	339
$\ell\ell\ell$	2–4	535	4–8	376
$\ell hh'$	21–155	158	7–48	221
μV^0	10–15	543	11	384
eV^0	8–19	543	10	384

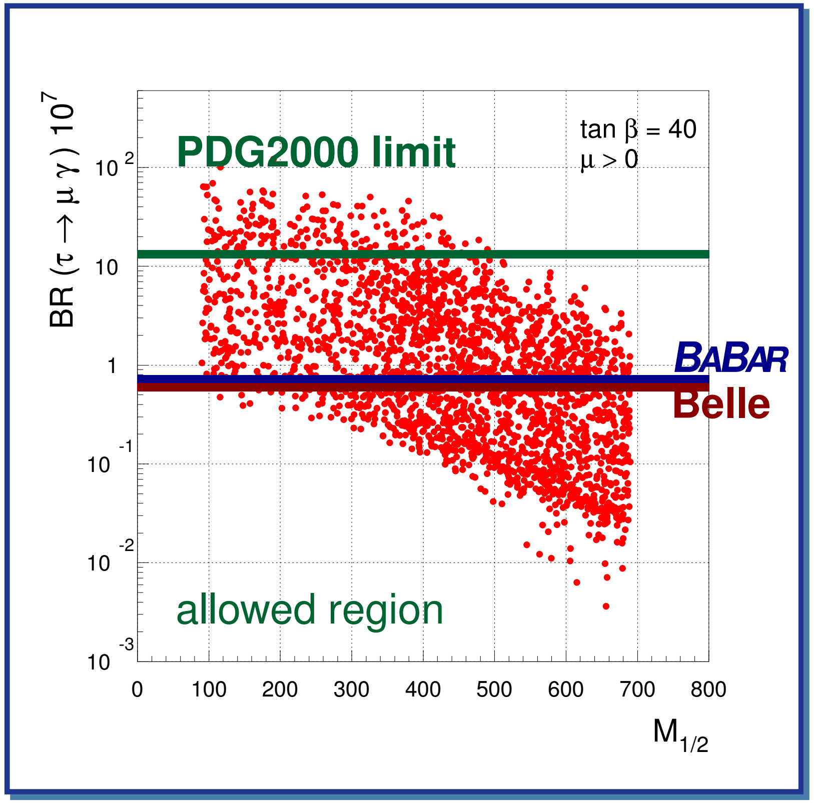
	Belle		BaBar	
	UL90 (10^{-8})	Lumi (fb^{-1})	UL90 (10^{-8})	Lumi (fb^{-1})
μK_S	0.49	281		
eK_S	0.56	281		
μf_0	3.3*	671		
ef_0	3.4*	671		
$\Lambda\pi, \overline{\Lambda}\pi$	7.2–14	154	5.8–5.9*	237
$\Lambda K, \overline{\Lambda}K$			7.2–15*	237
$\sigma_{\ell\tau}/\sigma_{\mu\mu}$			400–890	211

(* preliminary)

$V^0 = \omega$ for BaBar, $V^0 = \rho, \phi, \overset{(-)}{K^{*0}}, \omega$ for Belle

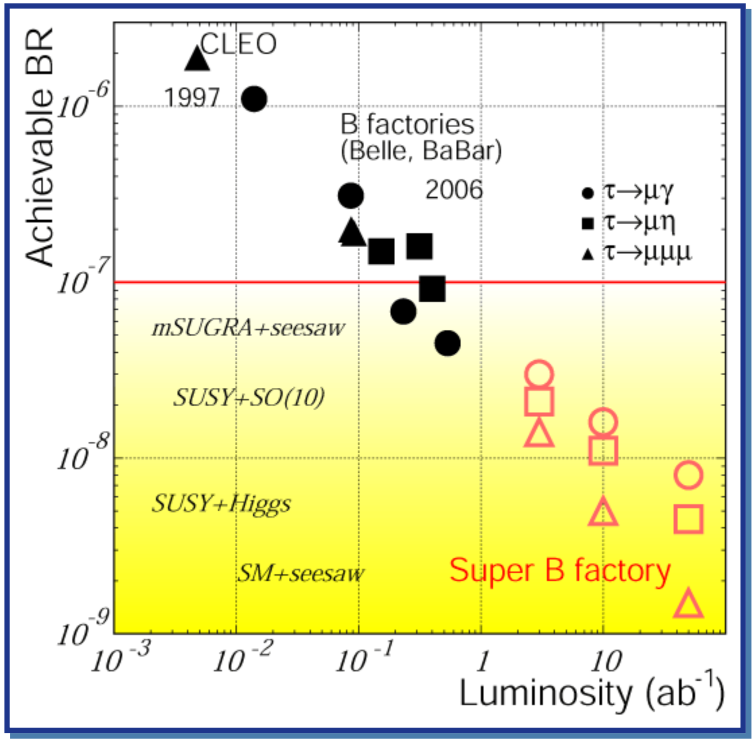
Progress on $\tau \to \mu\gamma$ since pre-B-factory era

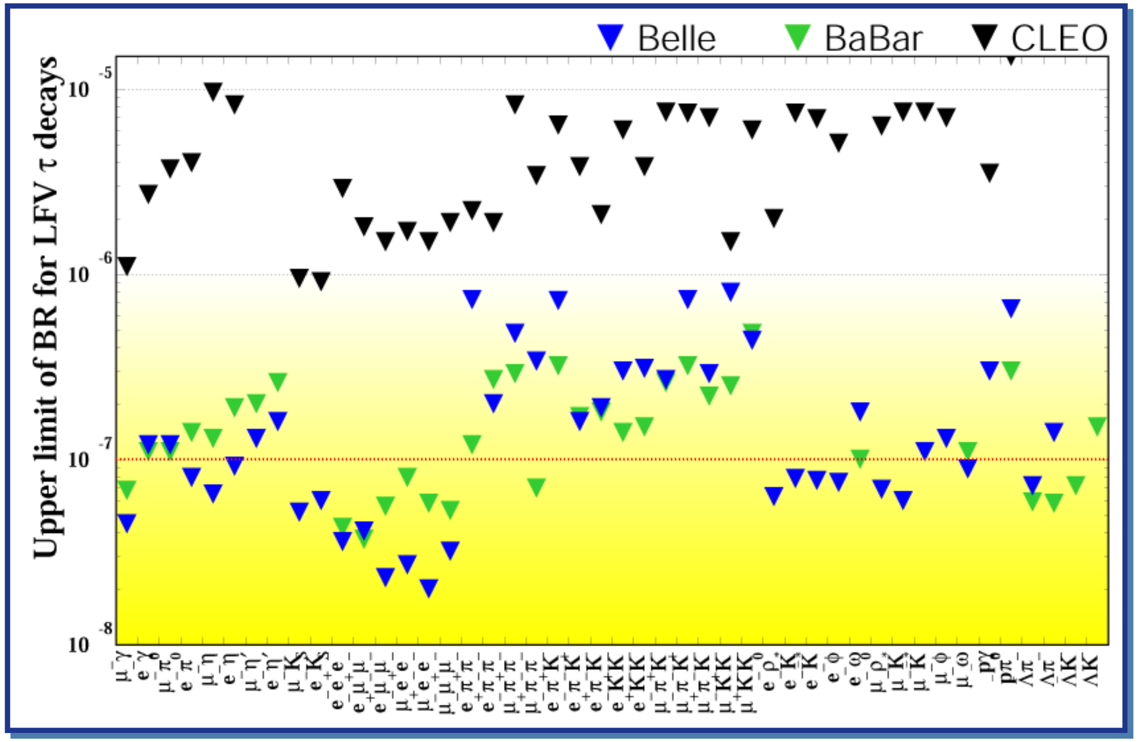




SUSY SO(10) + seesaw – Masiero et al., NJP 6 (2004) 202

Progress on LFV from B-Factories results





plots presented by K.Inami at PhiPsi08

Tau precision measurements and checks on the Standard Model

STANDARD MODEL

Lepton Universality Tests

- Standard Model (SM) predicts that leptons have same weak charged current couplings
- B-Factories can measure **several relatively less known ingredients** for LU tests below

$$\frac{\Gamma_{\tau\to e}}{\Gamma_{\mu\to e}} \propto \left(\frac{g_\tau}{g_\mu}\right)^2 = \frac{\tau_\mu}{\tau_\tau}\mathrm{BF}(\tau^- \to e^-\bar{\nu}_e\nu_\tau)\left(\frac{m_\mu}{m_\tau}\right)^5 \frac{f(m_e^2/m_\mu^2)r_{EW}^\mu}{f(m_e^2/m_\tau^2)r_{EW}^\tau}$$

$$\frac{\Gamma_{\tau\to \mu}}{\Gamma_{\mu\to e}} \propto \left(\frac{g_\tau}{g_e}\right)^2 = \frac{\tau_\mu}{\tau_\tau}\mathrm{BF}(\tau^- \to \mu^-\bar{\nu}_\mu\nu_\tau)\left(\frac{m_\mu}{m_\tau}\right)^5 \frac{f(m_e^2/m_\mu^2)r_{EW}^\mu}{f(m_\mu^2/m_\tau^2)r_{EW}^\tau}$$

$$\frac{\Gamma_{\tau\to e}}{\Gamma_{\tau\to \mu}} \propto \left(\frac{g_e}{g_\mu}\right)^2 = \frac{\mathrm{BF}(\tau^- \to e^-\bar{\nu}_\mu\nu_\tau)}{\mathrm{BF}(\tau^- \to \mu^-\bar{\nu}_\mu\nu_\tau)}\frac{f(m_\mu^2/m_\tau^2)}{f(m_e^2/m_\tau^2)}$$

$f(x) = 1 - 8x + 8x^3 - x^4 - 12x \ln x$ (approximating all $m_\nu = 0$)

$r_{EW}^\ell = 0.9960$ (EW radiative corrections, Marciano-Sirlin)

Precision measurements and Lepton universality

Tau mass BELLE $414\ \mathrm{fb}^{-1}$ PRL 99 (2007) 011801

m_τ = (1776.61 ± 0.13 ± 0.35) MeV **precision (0.021%) comparable to BES/KEDR (0.015%)**

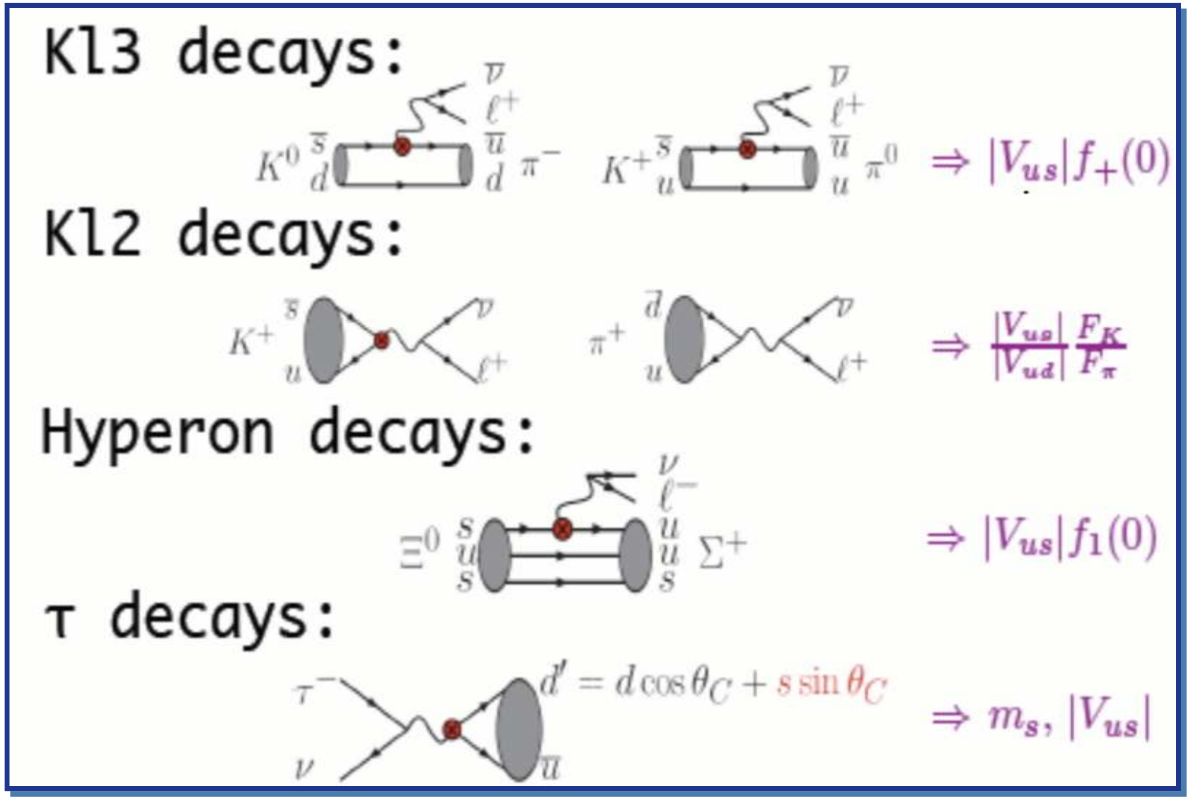
CPT test (not possible at threshold) **$(m_{\tau^+} - m_{\tau^-})/m_\tau < 2.8 \cdot 10^{-4}$ (PDG2006: $< 3 \cdot 10^{-3}$)**

Tau Lifetime BABAR preliminary $80\ \mathrm{fb}^{-1}$ Nucl.Phys. B (P.S.) 144 (2005) 105

τ_τ = 289.40 ± 0.91 ± 0.90 fs **$(\Delta\tau_\tau^{\mathrm{PDG2006}} = \pm 1.0\ \mathrm{fs})$** **$\Delta_{\mathrm{STAT}}\left(\frac{\tau_{\tau^-} - \tau_{\tau^+}}{\tau_{\tau^-} + \tau_{\tau^+}}\right) = 0.32\%$ (CPT test)**

- limited progress on lepton universality
- no improvement on leptonic branching fractions (hard job matching ALEPH systematics)

V_{us} measurements



(courtesy of S.Banerjee, Kaon07)

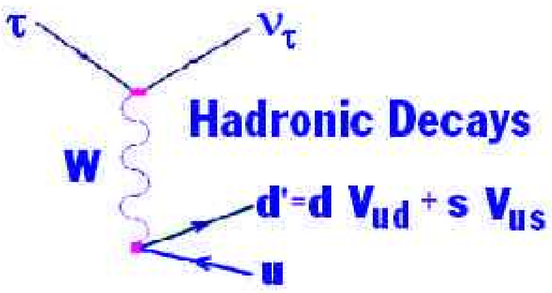
- kaon measurements limited by theory uncertainties (see e.g. arXiv:0802.3009 [hep-ex])
  - for K_{l3} decays $\Delta[f_+(0)] = 0.50\%$
  - for K_{l2} decays $\Delta(F_K/F_\pi) = 0.59\%$
- theory uncertainty on V_{us} from tau estimated to be 0.23% (arXiv:0709.0282v1 [hep-ph])

Tau Decays to final states with strangeness = 1

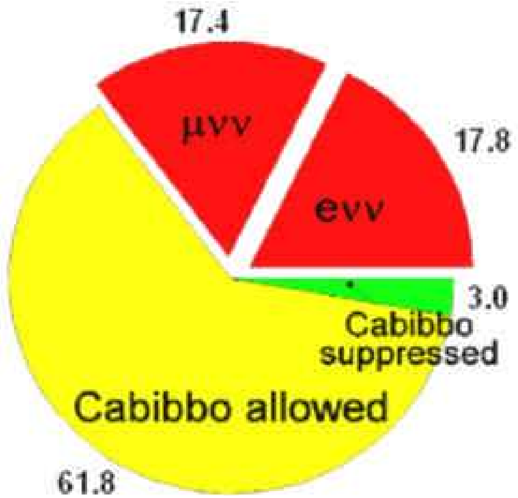
- inclusive BF($\tau \to s$) ⟶ potentially most precise/ clean V_{us} measurement
- if spectral functions are also measured ⟶ simultaneous fit of V_{us} and m_s
- otherwise, one can use m_s from lattice QCD (now $\Delta m_s \approx 10\,\text{MeV}$)
- $$R_\tau = \frac{\Gamma\left[\tau^- \to \nu_\tau \text{hadrons}(\gamma)\right]}{\Gamma\left[\tau^- \to e\nu_\tau\bar{\nu}_e(\gamma)\right]} \qquad |V_{us}|^2 = \frac{R_{\tau,\text{strange}}}{\left(R_{\tau,\text{non-strange}}/\,|V_{ud}|^2\right) - \delta R_{\tau,\text{theory}}}$$
  - $R_{\tau,\text{non-strange}}/\,|V_{ud}|^2 = 3.661 \pm 0.012$ (experiment)
  - $\delta R_{\tau,\text{theory}} = 0.216 \pm 0.016$ ($SU(3)$ breaking, arXiv:0709.0282v1 [hep-ph])
  - $\Delta\,|V_{us}|^2 \approx \dfrac{\Delta\delta R_{\tau,\text{theory}}}{\left(R_{\tau,\text{non-strange}}/\,|V_{ud}|^2\right)} \approx 2 \cdot 0.23\%$
- to fit for m_s simultaneously, must use also moments of the hadronic inv. mass distribution
  - $R_\tau^{kl} = \displaystyle\int_0^{m_\tau^2} ds \left(1 - \frac{s}{m_\tau^2}\right)^k \left(\frac{s}{m_\tau^2}\right)^l \frac{dR_\tau}{ds}$

Inclusive BF($\tau \to s$) before B-Factories

$$B_{had} = 1 - B_e - B_\mu$$



$$R_{\tau,Strange} = R_\tau - R_{\tau,non-Strange}$$



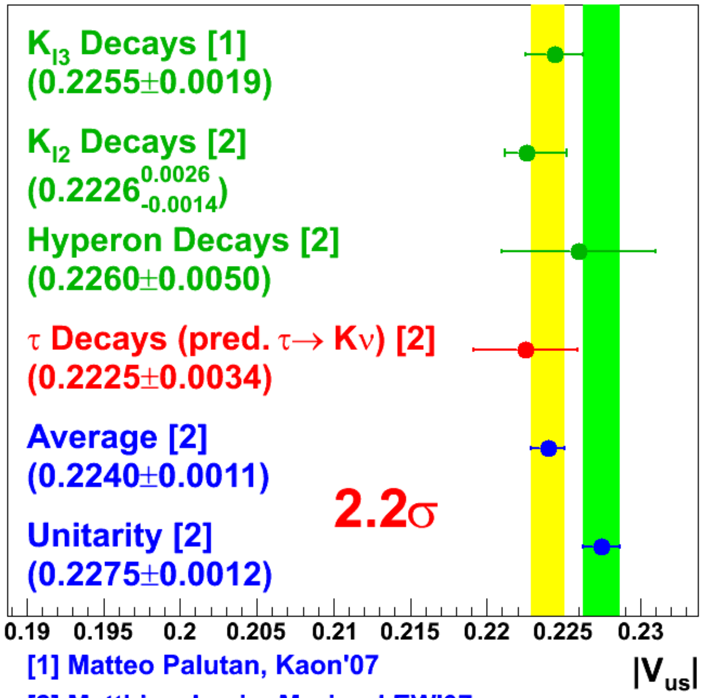
Strange τ Decays:

Mode	$\mathcal{B}(10^{-3})$
K^-	6.81 ± 0.23
$K^-\pi^0$	4.54 ± 0.30
$\bar{K}^0\pi^-$	8.78 ± 0.38
$K^-\pi^0\pi^0$	0.58 ± 0.24
$\bar{K}^0\pi^-\pi^0$	3.60 ± 0.40
$K^-\pi^+\pi^-$	3.30 ± 0.28
$K^-\eta$	0.27 ± 0.06
$(\bar{K}3\pi)^-$ (estimated)	0.74 ± 0.30
$K_1(1270)^- \to K^-\omega$	0.67 ± 0.21
$(\bar{K}4\pi)^-$ (estimated) and $K^{*-}\eta$	0.40 ± 0.12
Sum	29.69 ± 0.86

Davier, Hocker, Zhang(RMP 78, 1043, 2006)

V_{us} and m_s determination before B-Factories

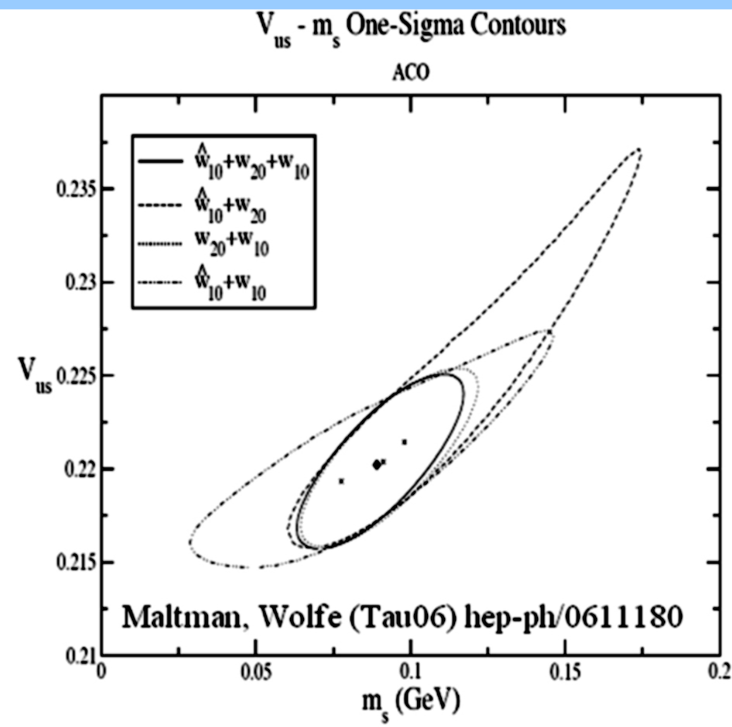
Extract |Vus| with Fixed m_s



[1] Matteo Palutan, Kaon'07

[2] Matthias Jamin, Moriond EW'07

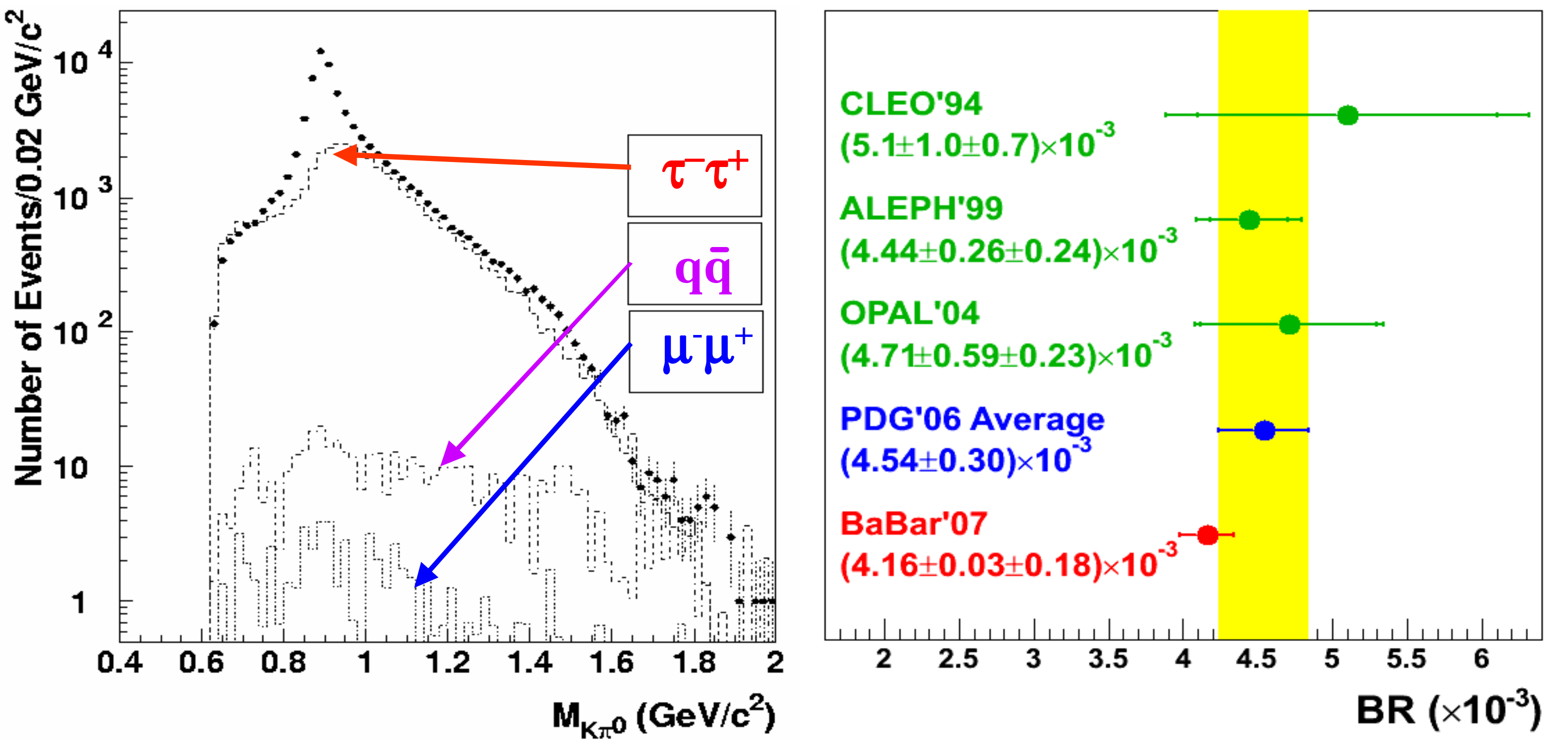
Simultaneously extract |Vus| and m_s



V_{us} precision: 1.53%

$\tau \rightarrow K\pi^0\nu$

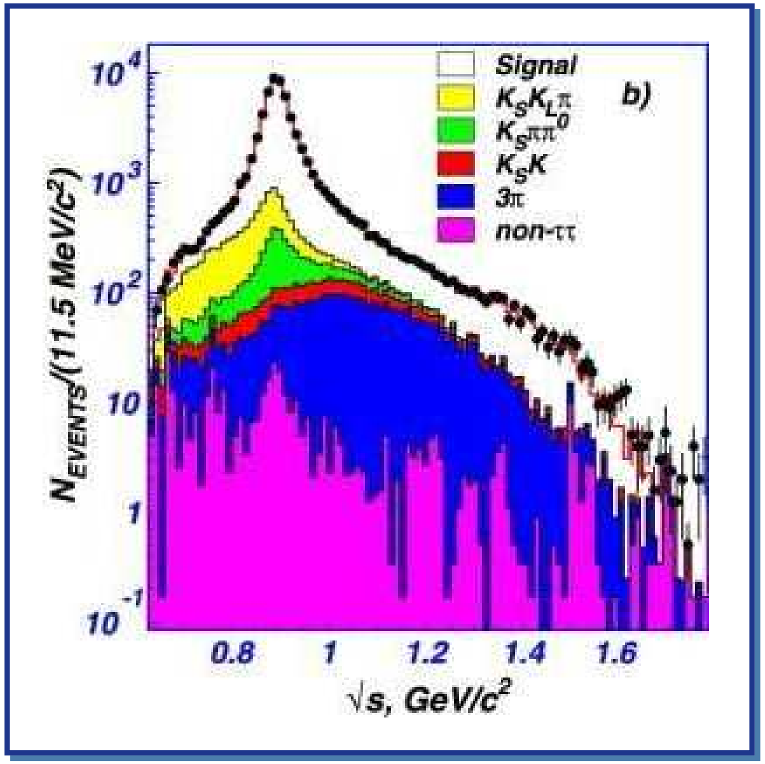
BABAR | $230\ \text{fb}^{-1}$ | PRD 76 051104 (2007)

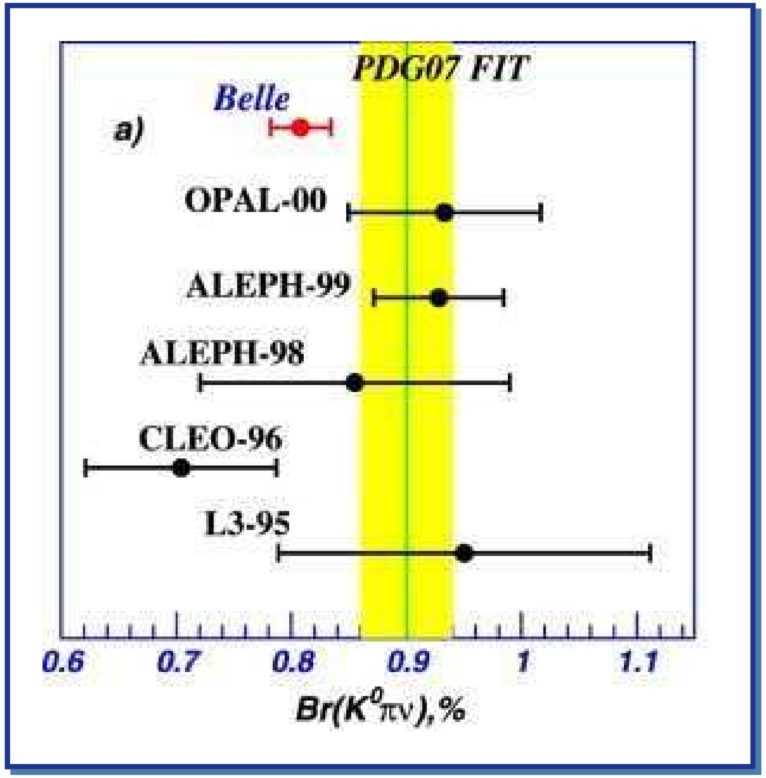


- 78k data candidates, 38k estimated bkg
- $\epsilon = (2.2267 \pm 0.008)\%$

- π^0 efficiency largest systematic
- **BF($\tau \rightarrow K\pi^0\nu$) = (0.416 ± 0.003 ± 0.018) %**

$\tau \to K_S \pi \nu$ BELLE 351 fb^{-1} PLB 654 (2007) 65

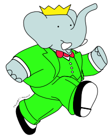




- 53k data candidates after bkg subtraction
  - smaller bkg w.r.t. $K\pi^0\nu$

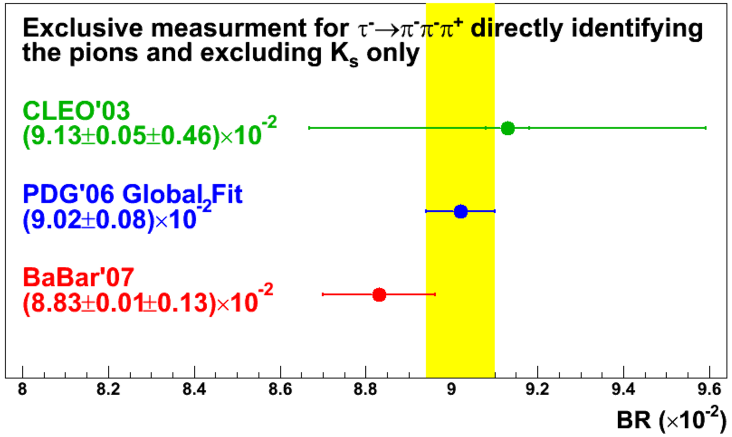
- K_S efficiency largest systematic
- **BF($\tau \to K_S \pi \nu$) = (0.404 ± 0.002 ± 0.013) %**

$\tau \to 3h\nu$

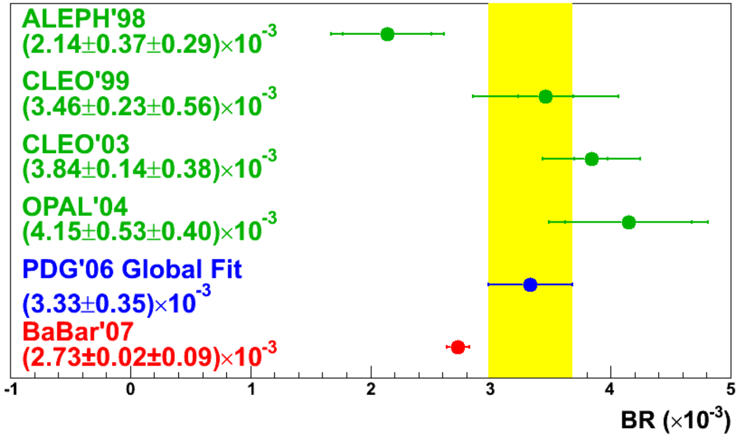


BABAR | 342 fb^{-1} | PRL 100 011801

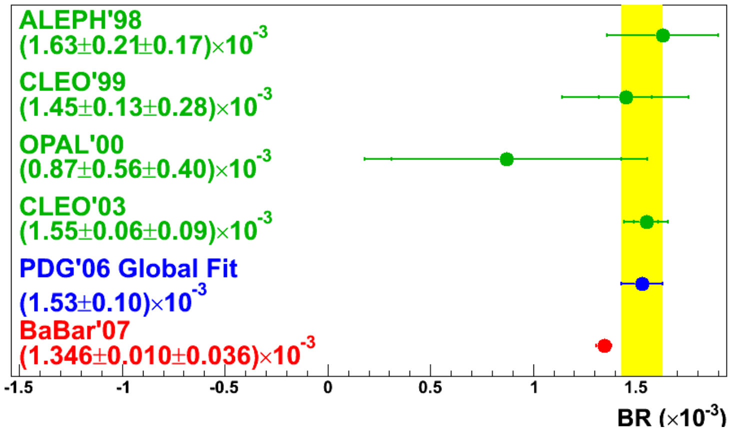
$\pi^-\pi^-\pi^+$



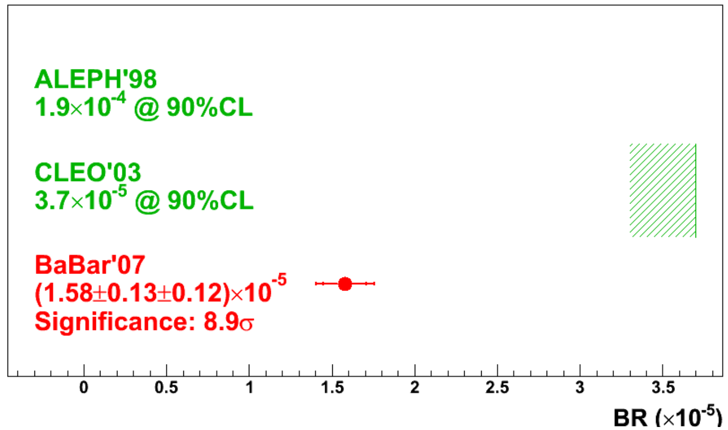
$K^-\pi^-\pi^+$



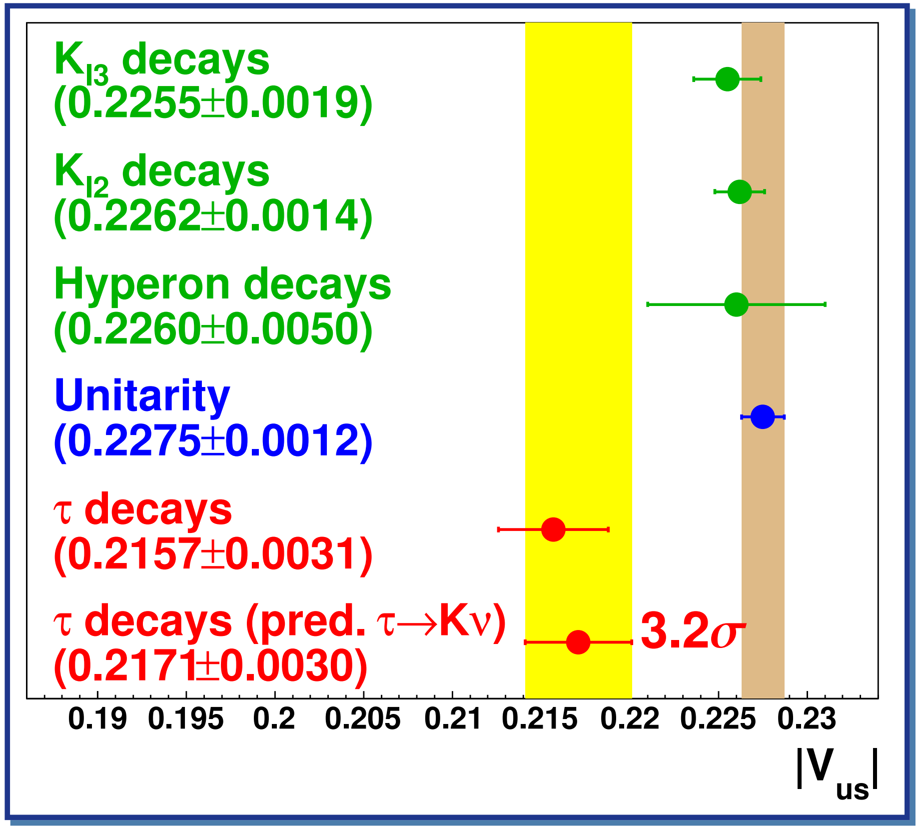
$K^-\pi^-K^+$



$K^-K^-K^+$



V_{us} update using BABAR and Belle results



- S.Banerjee, arXiv:0707.3058v4 [hep-ex]
- **V_{us} precision: 1.38%**

Updated $\tau \to s$ results

BABAR

- $\tau \to K\pi^0\nu$ PRD 76 051104 (2007)
- $\tau \to K\pi\pi\nu$ PRL 100 011801

BELLE

- $\tau \to K^0\pi\nu$ PLB 654 65-73 (2007)

- **universality improved V_{us} determination**:
  assume $\mu - \tau$ universality to predict
  BF[$\tau \to K\nu(\gamma)$] from BF[$K \to \mu\nu(\gamma)$]
  Rev.Mod.Phys. 78 1043 (2006)

Tau V_{us} status and prospects

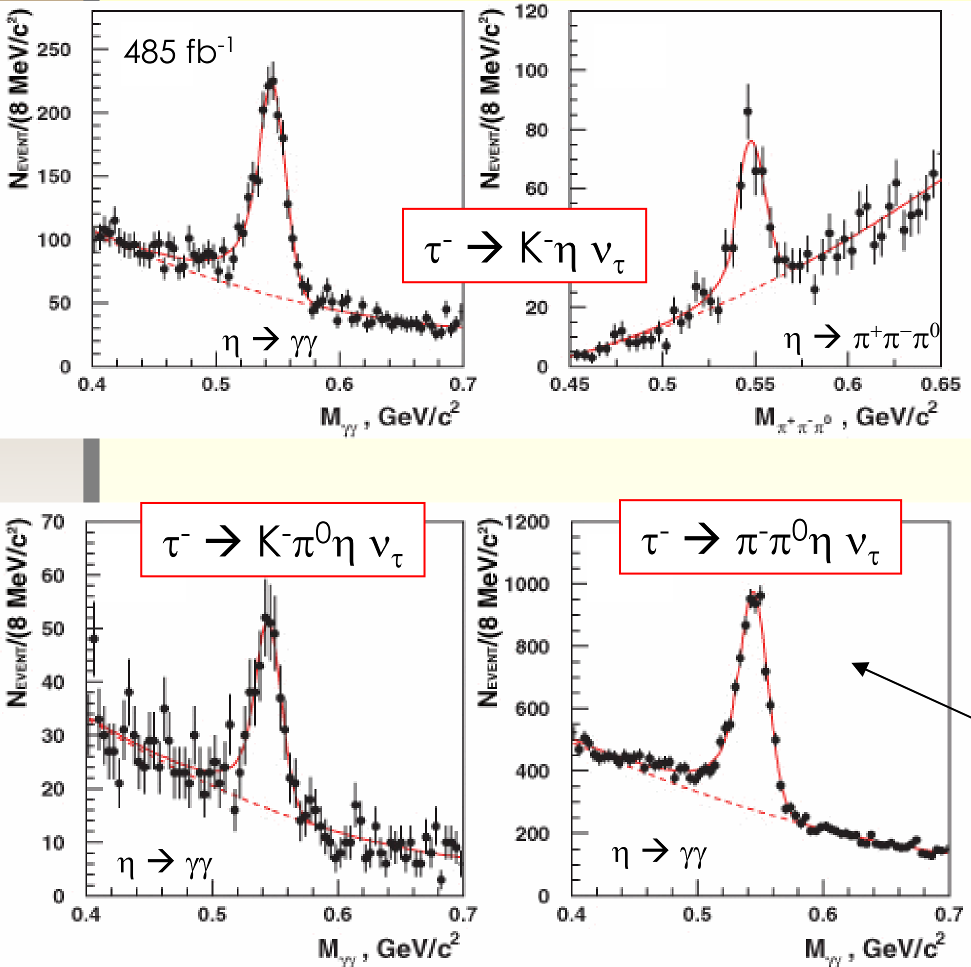
- $V_{us}(\tau) = 0.2171 \pm 0.0030$ universality improved V_{us} from $\tau \to s$ inclusive
  - uses V_{ud} = 97377(27) from PDG2006, however negligible change using updated V_{ud}
- $V_{us}(\text{unitarity}) = 0.2258 \pm 0.0011$ using V_{ud} = 0.97418(26) [Hardy-Towner, nucl-th 0710.3181]
  - moved by 1.5σ w.r.t. PDG 2006 → 2007 (isospin breaking Coulomb corrections)
  - V_{ud} from neutron decays differs by up to 4.5σ [0.97092(68) – 0.9786(19)]
    (also, recent measurement of neutron lifetime is 6.5σ away from PDG2006 value)
- $V_{us} = 0.2246 \pm 0.0012$ from $K_{\ell 3}$ P.Massarotti HQL08 (FlaviaNet)
- $V_{us} = 0.2261 \pm 0.0014$ from $K_{\mu 2}$ P.Massarotti HQL08 (FlaviaNet) (my elaboration using above V_{ud})
- **$|V_{us}(\tau) - V_{us}(\text{unitarity})| = 2.7\sigma$**
- experimentally, it is useful to improve on V_{us} from $\tau \to$ **s inclusive** and also from $\dfrac{\mathbf{BF}(\tau \to K\nu)}{\mathbf{BF}(\tau \to \pi\nu)}$

Tau decays modes with η meson

BELLE

485 fb^{-1} preliminary

arXiv:0708.0733v1[hep-ex])



Improved accuracy in BF by factor 4-8 wrt previous measurements

$\mathcal{B}(\tau^- \to K^-\eta\,\nu_\tau)$	$(1.62 \pm 0.05 \pm 0.09)\times10^{-4}$
$\mathcal{B}(\tau^- \to K^-\pi^0\eta\,\nu_\tau)$	$(4.7 \pm 1.1 \pm 0.4)\times10^{-5}$
$\mathcal{B}(\tau^- \to K^*(892)^-\eta\,\nu_\tau)$	$(1.13 \pm 0.19 \pm 0.07)\times10^{-4}$
$\mathcal{B}(\tau^- \to \pi^-\pi^0\eta\,\nu_\tau)$	$(1.39 \pm 0.03 \pm 0.07)\times10^{-3}$

Fit $\gamma\gamma$ distribution using Crystal Ball + polynomial for bg

arXiv:0708.0733v1[hep-ex])

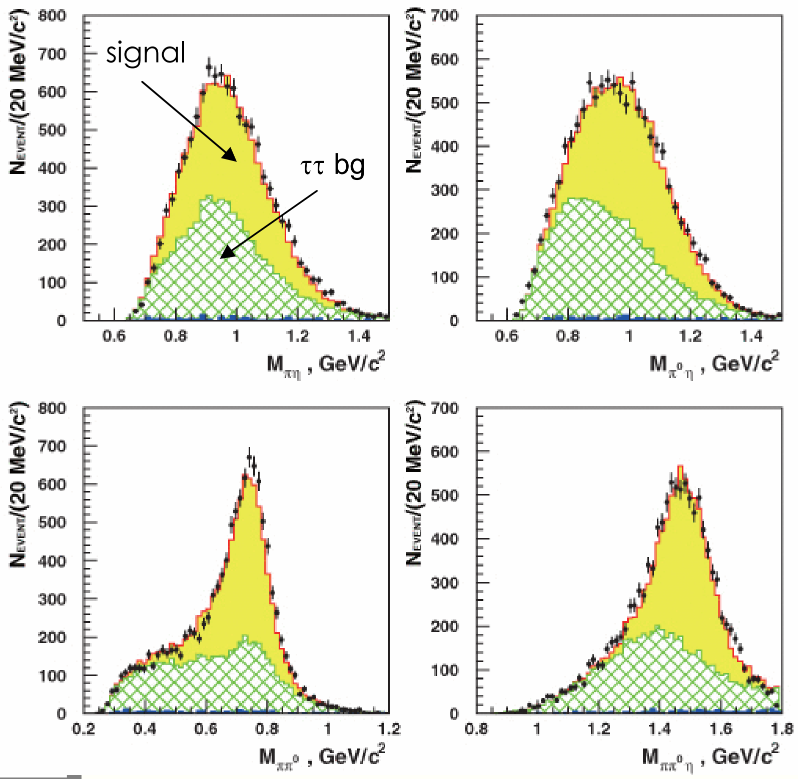
Tau decays modes with η meson

BELLE

485 fb^{-1} preliminary

arXiv:0708.0733v1[hep-ex])

Comparison with predictions



arXiv:0708.0733v1[hep-ex])

- $\mathcal{B}(\tau^- \to \pi^-\pi^0\eta\,\nu_\tau)$ consistent with prediction based on CVC and experimentally measured $e^+e^- \to \pi+\pi-\eta$ cross section
  - Good agreement between data and MC (TAUOLA)
- Central value of $\mathcal{B}(\tau^- \to K^-\eta\,\nu_\tau)$ and $\mathcal{B}(\tau^- \to K^-\pi^0\eta\,\nu_\tau)$ slightly different from chiral theory prediction (Phys. Rev. D 55 (1997) 1436)
  - More tuning of MC needed
  - Further studies of final state dynamics and resonance formation in progress

$\tau^- \to \eta\pi^-\pi^+\pi^-\nu_\tau$ with $\eta \to \gamma\gamma$

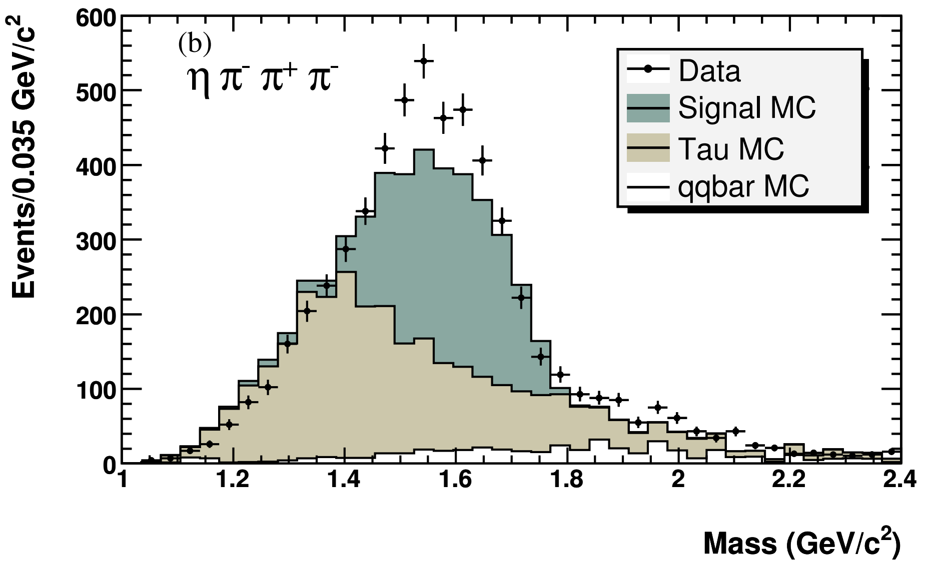
BABAR 384 fb^{-1} accepted by PRD

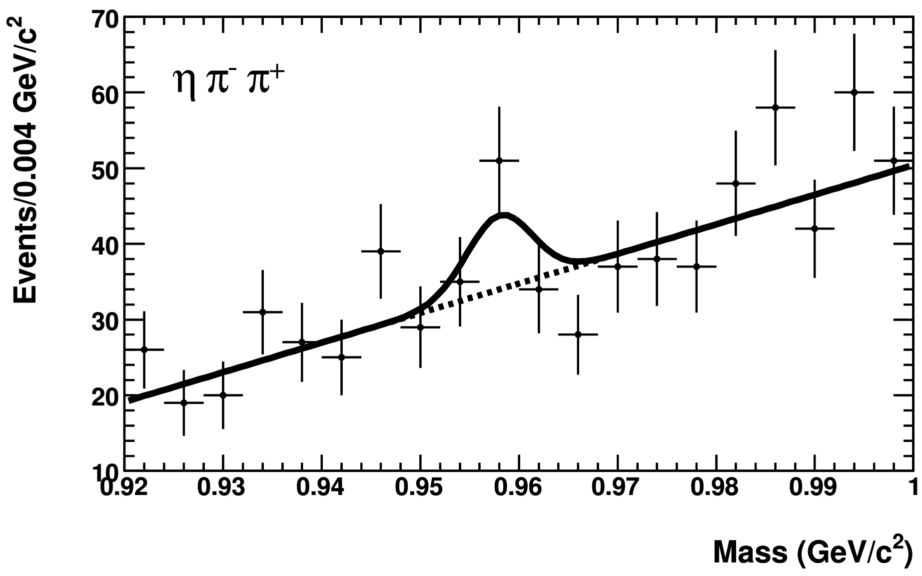
BF($\tau^- \to \eta\pi^-\pi^+\pi^-\nu_\tau$) = $(1.60 \pm 0.05 \pm 0.11)\cdot 10^{-4}$

BF($\tau^- \to f_1(1285)\pi^-\nu$) = $(1.11 \pm 0.06 \pm 0.05)\cdot 10^{-4}$

BF($\tau^- \to \eta'(985)\pi^-\nu_\tau$) < $7.2\cdot 10^{-6}$ 90% CL 2nd class current, suppressed by isospin conservation

arXiv:0803.0772 [hep-ex]



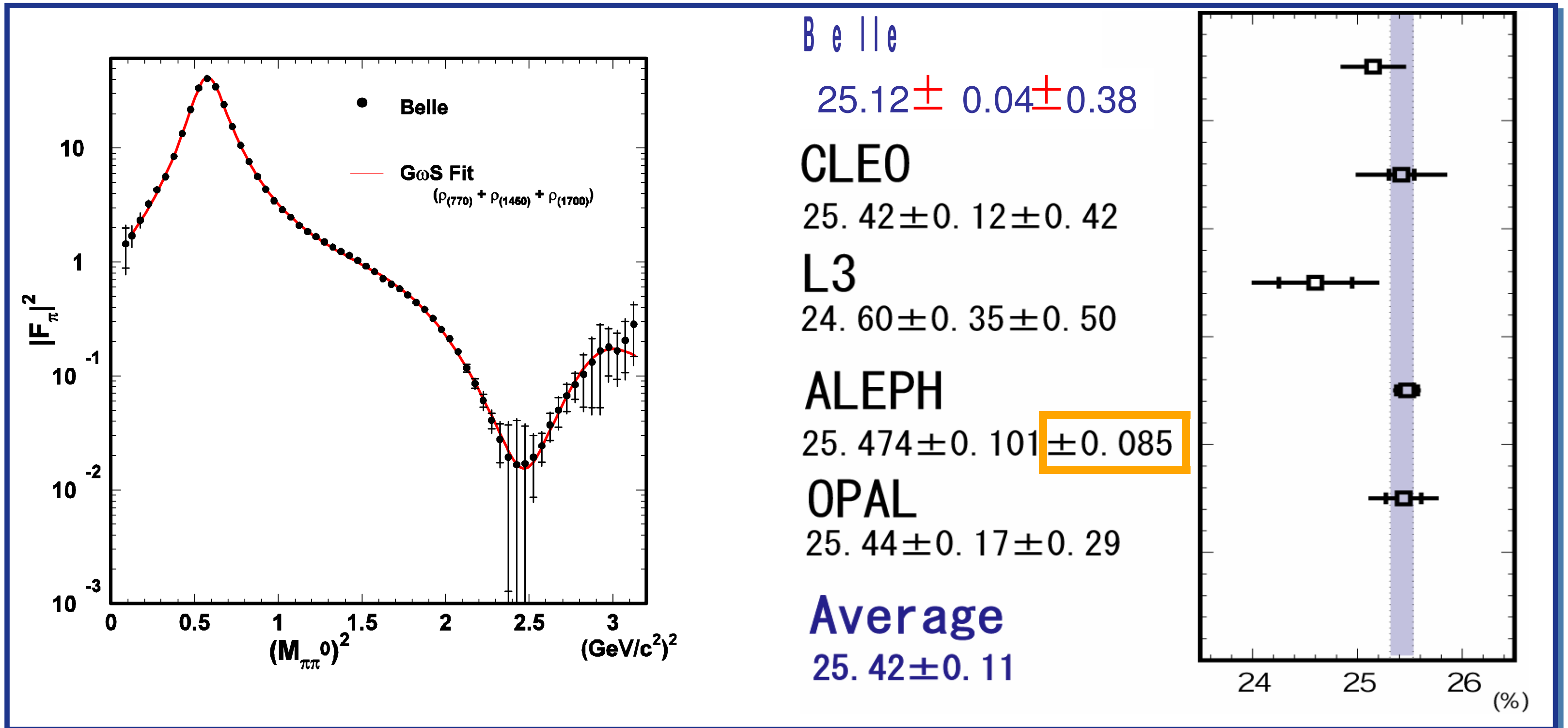


BF and spectrum of $\tau \to \pi\pi^0\nu$

BELLE

23M tau pairs
preliminary

H.Hayashii, PhiPhi08/FPCP08



- 5.4M candidates fitted
- largest systematic: π^0 efficiency
- **BF($\tau \to \pi\pi^0\nu$) = (25.12 ± 0.04 ± 0.38) %**

- **improved spectrum (larger stat. than LEP)**
- $a_\mu^{\pi\pi}$ close to previous existing tau estimates
  see H.Hayashii@FPCP08 for details

Conclusions

LFV Searches

- good experimental coverage
- recent new/updated results
- expect further improvements

V_{us} from $\tau \to s$ inclusive

- results on several BF, V_{us} updated
- $3.2\sigma \to 2.7\sigma$ discrepancy w.r.t. K/unitarity

(semi-)hadronic decays

- Precision improved on several small BF
- first 2nd class searches results
- $\tau \to \pi\pi^0\nu$ BF and spectrum for $\Delta_{HAD}(g{-}2)_\mu$

Lepton universality and precision meas.

- tau lifetime, tau mass
- CPT tests
- improving mass and leptonic BF is hard

Future prospects

- **B-Factories**
  - many new/updated results to come
- **KEDR, BES-III**
  - Tau Mass
- **Tau Physics at Super B-Factories**
  - LFV searches to probe NP
  - Tau EDM, $g-2$, CPV