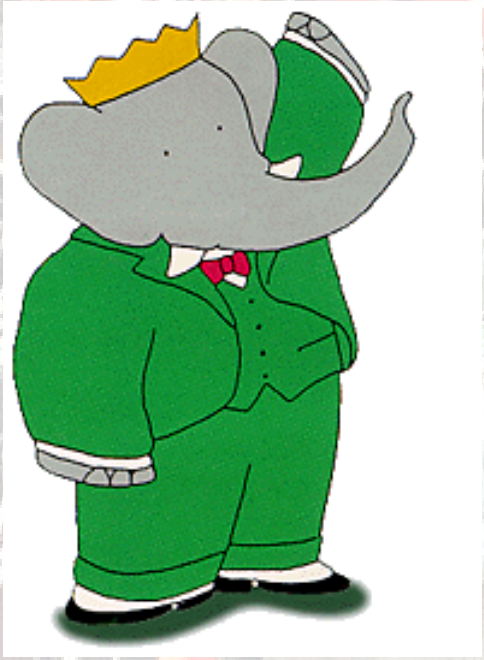
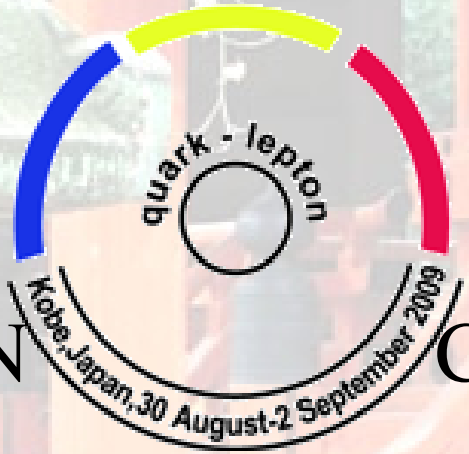
New physics searches at the B-factories





PHYSICS IN COLLISION

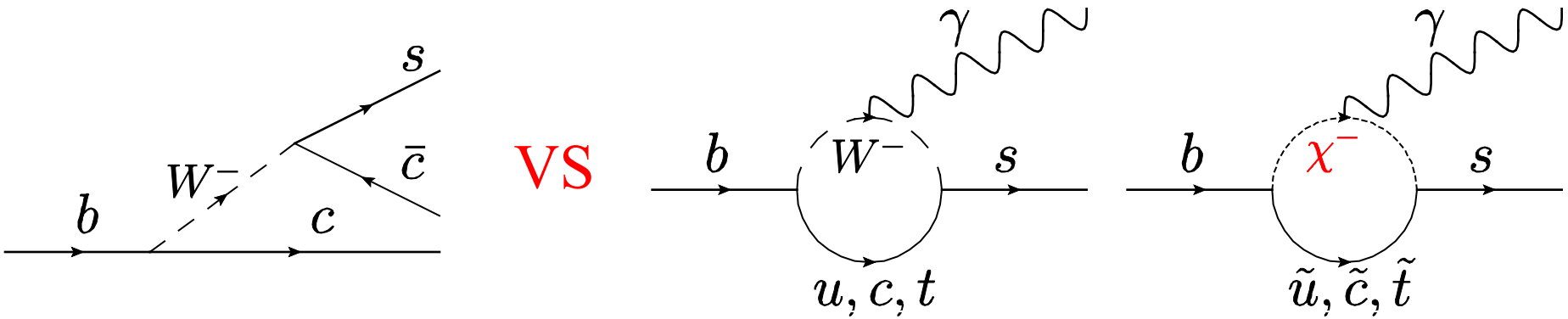
Pablo del Amo Sanchez (BaBar)

LPNHE (Univ. Paris VI et VII) – IN2P3 – CNRS

Now at LAPP (Université de Savoie)

Searching NP at B factories

- SM well tested at tree level
- Still room for NP in loop diagrams, where (virtual, high mass) NP particles could enter



→ Look for deviations from SM in loop-dominated processes

→ Look for SM-forbidden(suppressed) processes: observation would be due to NP → rare processes

Outline

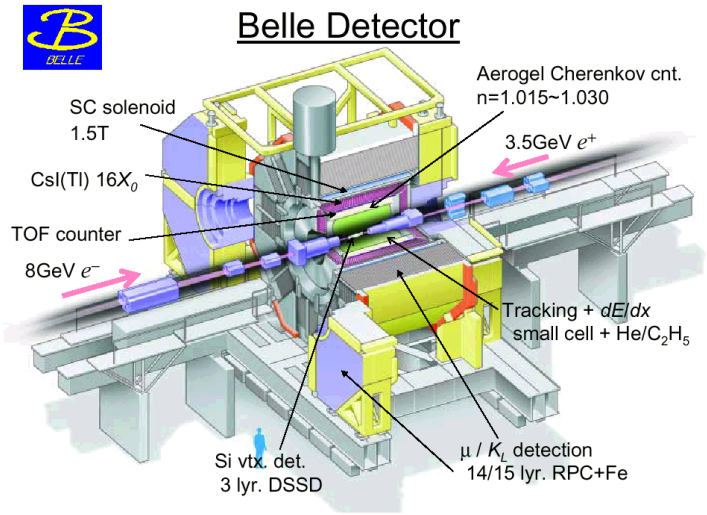
- B-factories: BaBar and Belle
- $b \to s\gamma$ and $b \to s\ell^+\ell^-$
- Leptonic and semi-leptonic B decays
- « $K\pi$ puzzle »
- LFV in τ decays
- Conclusions

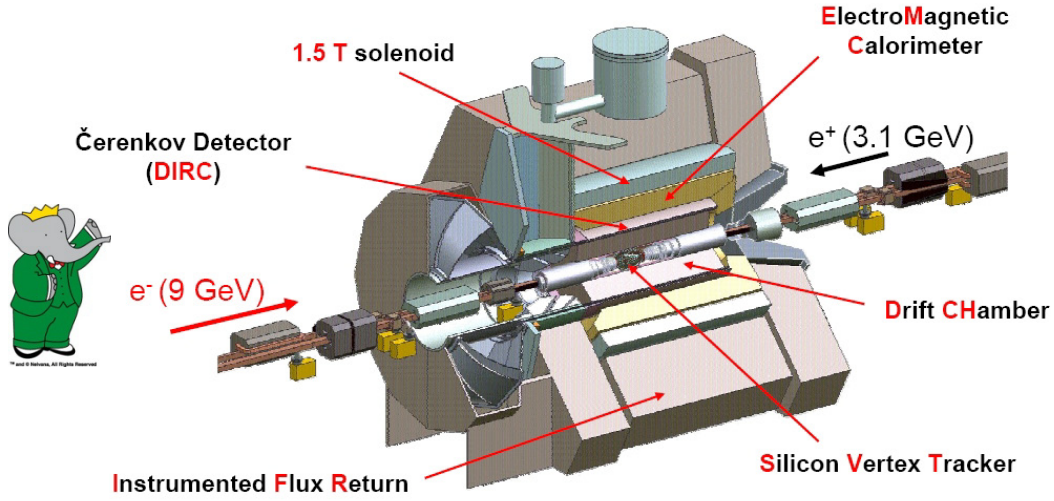
N.B.: will not talk about NP searches in Y(3S), Y(2S) or Y(1S) decays

B-factories

BaBar at PEP-II (SLAC) and Belle at KEKB

- Asymmetric e^+e^- colliders
- Centre-of-mass energy ~ $\Upsilon(4S) \to B\overline{B}$
  (also charm- and tau- factories)
- Excellent PID and vertex resolution





~710/fb @ Y(4S)

$2.1 \times 10^{34}/cm^2s$ (June 2009)

430/fb @ Y(4S)

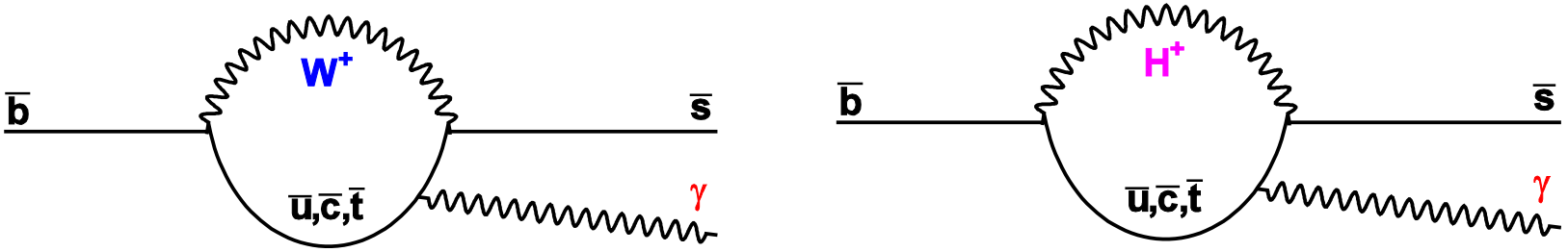
$1.2 \times 10^{34}/cm^2s$ (August 2006)

Record-breaking luminosities!

$b \to s\gamma$ and $b \to s\ell^+\ell^-$

b→sγ: motivation

- Radiative modes, clean probes of NP: limited hadronic theoretical uncertainties



- Inclusive b→sγ best example: BF known at NNLO in QCD
- Other path to avoid hadronic uncertainties: measuring asymetries. E.g. uncertainty of 30% in BF of B→K*γ due to form factors, A_{CP} and A_I known to 2%

$$A_{CP} = \frac{\Gamma(\overline{B} \to \bar{f}) - \Gamma(B \to f)}{\Gamma(\overline{B} \to \bar{f}) + \Gamma(B \to f)} \qquad A_I = \frac{\Gamma(\overline{B}^0 \to \bar{f}^0) - \Gamma(B^- \to f^-)}{\Gamma(\overline{B}^0 \to \bar{f}^0) + \Gamma(B^- \to f^-)}$$

$f = K^*\gamma,$
$K^*\ell^+\ell^-$

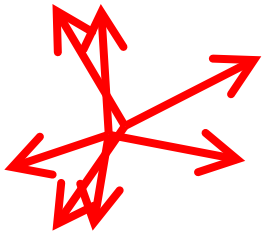
- Forbidden at tree level in SM, proceeds through loops where NP could appear
- Can describe NP effects in model independent way:

integrate out heavy d.o.f. (top, W) → effective theory characterized by Wilson coeffs.

- Experimentally, b→sγ constrains Wilson coeff $|C_7|$; b→sℓ⁺ℓ⁻ sensitive to C_7, C_9 & C_{10}

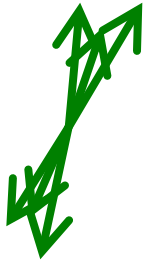
b→sγ: experiment

- Fully inclusive analysis only reconstructs high energy photon
  → Very large backgrounds
- Most high energy background photons come from boosted π^0, η
  → Reject high-energy photons consistent with π^0, η when paired with other photons of the event
  → Still need to remove lower E_γ events
- Can also impose event-shape requirements (*untagged sample*)



signal

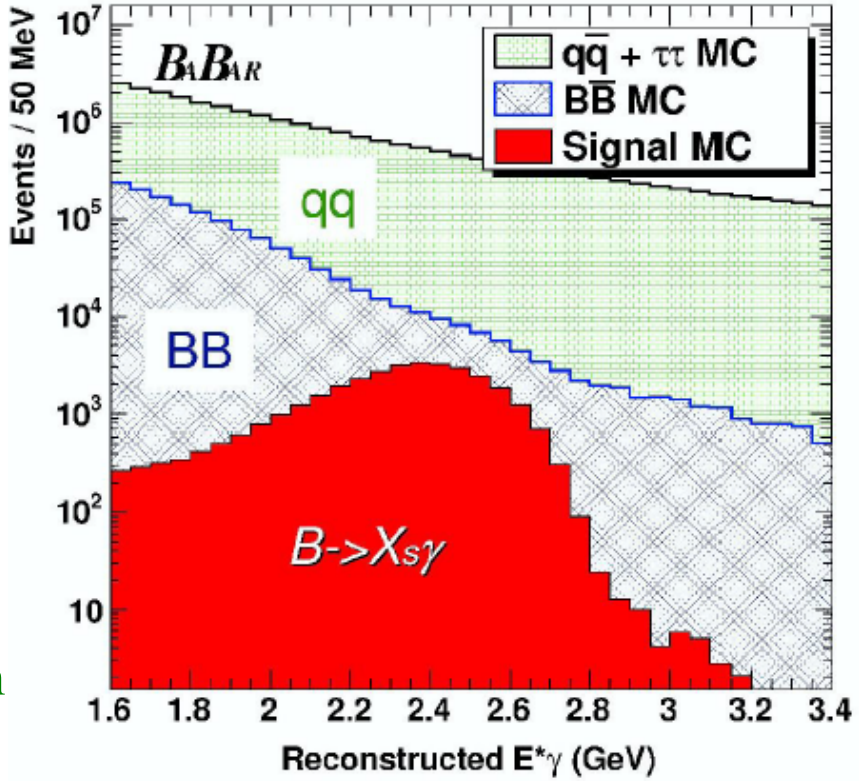
~spherical



continuum

jetty

or presence of high-energy lepton (from a semileptonic decay of other B, *lepton-tagged sample*)



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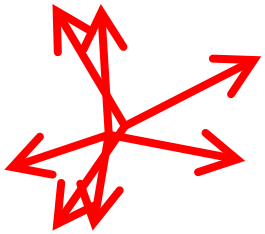

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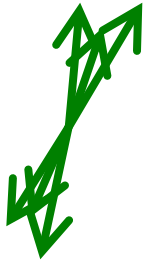

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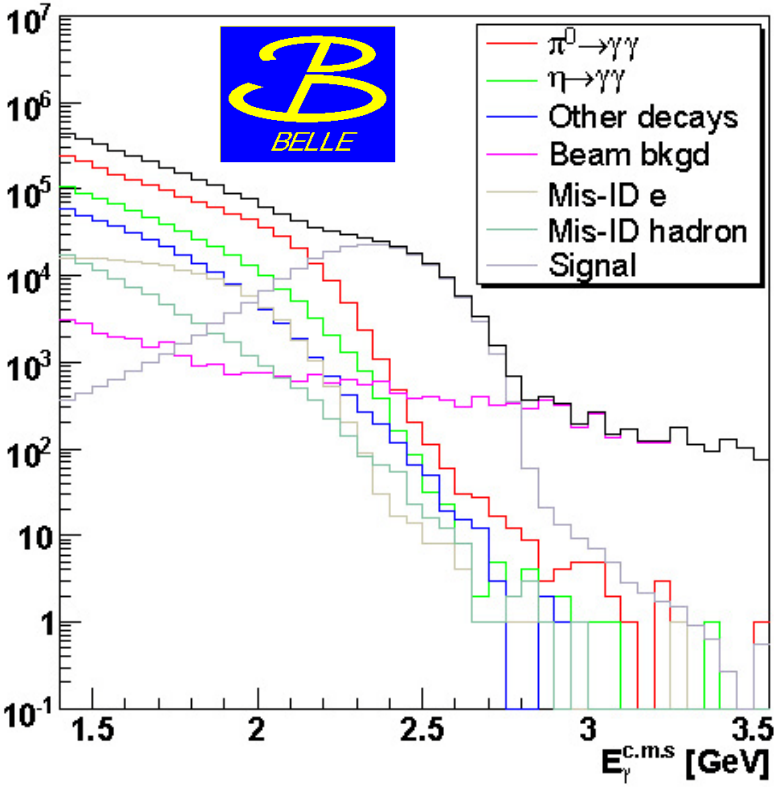
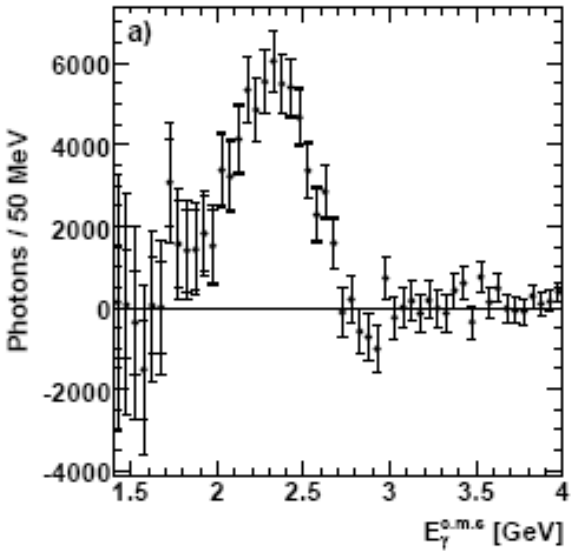


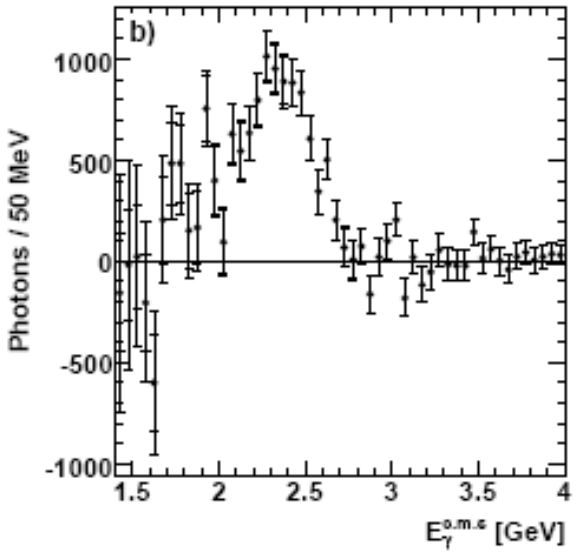
b→sγ: experiment

- Belle update (605/fb, arXiv:0907.1384 sub. to PRL). Bkg subtracted photon spectra:

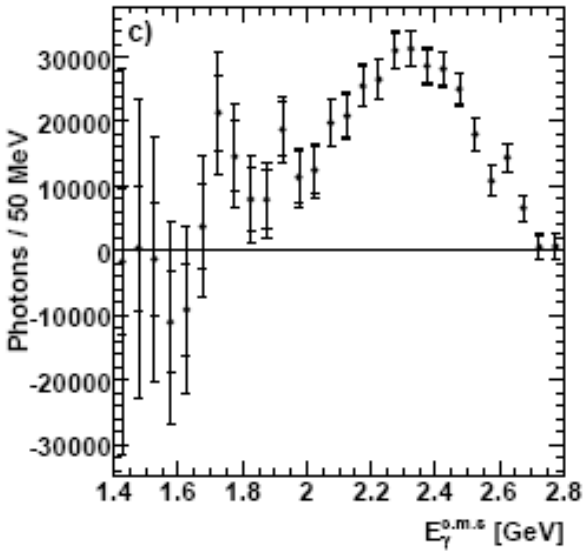
Untagged sample



Lepton-tagged sample



Eff. corrected average



NEW

	cut on E_γ^* (GeV)	BF
Belle (arXiv:0907.1384)	> 1.7	$(3.45 \pm 0.15 \pm 0.40)\times10^{-4}$
Previous HFAG w.a.	> 1.6	$(3.52 \pm 0.23 \pm 0.09)\times10^{-4}$
NNLO prediction (Misiak et al, Phys.Rev.Lett.98:022002)	> 1.6	$(3.15 \pm 0.23)\times10^{-4}$

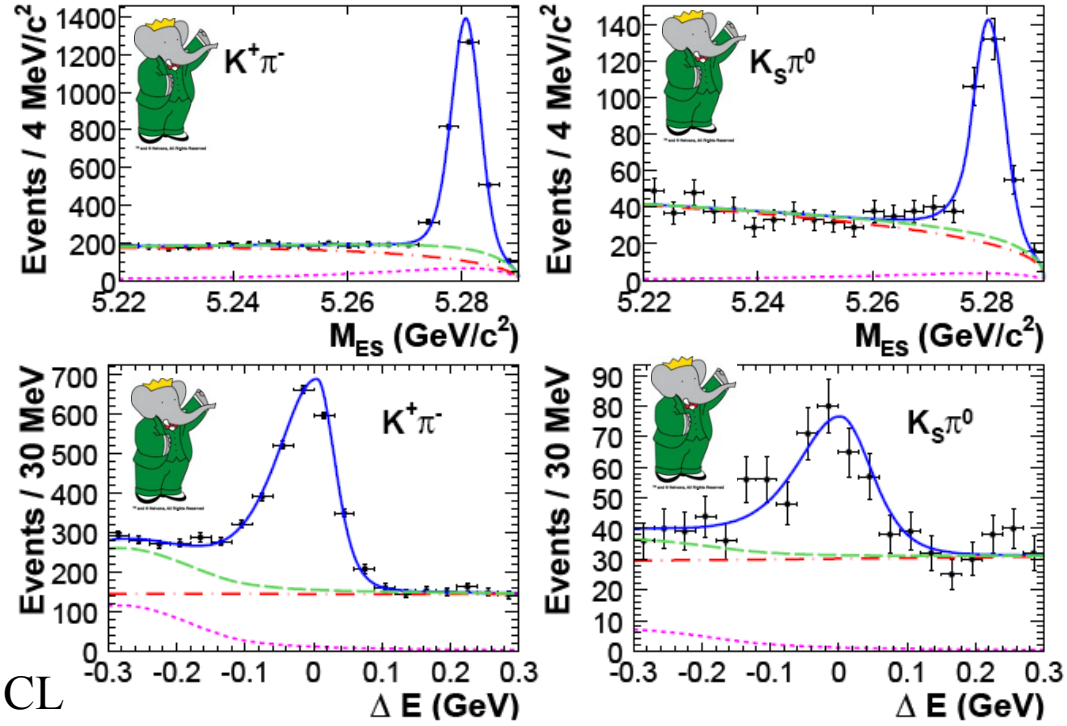
$B \to K^* \gamma$: experiment

Exclusive modes less challenging, affected by some hadronic theoretical uncertainties

- BaBar updates $B \to K^* \gamma$ ($K^* = K^+\pi^-, K_S\pi^0, K_S\pi^-, K^+\pi^0$, arXiv:0906.2177, sub. to PRL)

m_{ES} ~ B candidate mass constrained by (known) e^+e^- beam kinematics

$\Delta E = E_B^* - (E^*_{beam}/2)$



- Measured A_{CP} and A_I:

$-0.033 < A_{CP}(B \to K^* \gamma) < 0.028$

$0.017 < A_I(B \to K^* \gamma) < 0.116$

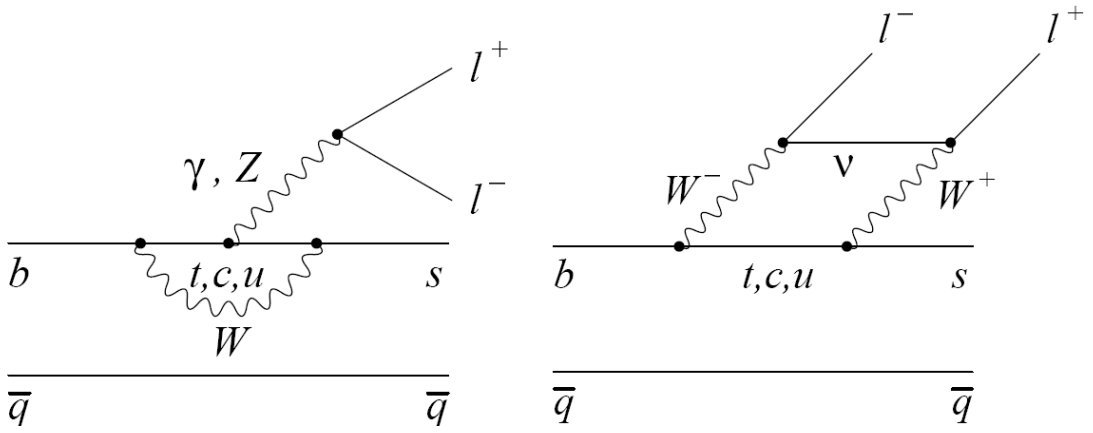
} at 90% CL

- Consistent with SM expectations: $A_{CP} < 1\%$, $-1\% < A_I < 3\%$ (Keum, Matsumori & Sanda Phys.Rev.D72:014013,2005)

$b \to s\ell^+\ell^-$: theory

$b \to s\ell^+\ell^-$ proceeds through loop diagrams. Sensitive to Wilson coeffs C_7, C_9, C_{10}

$q^2=m^2_{l+l-}$



Some clean observables for this channel:

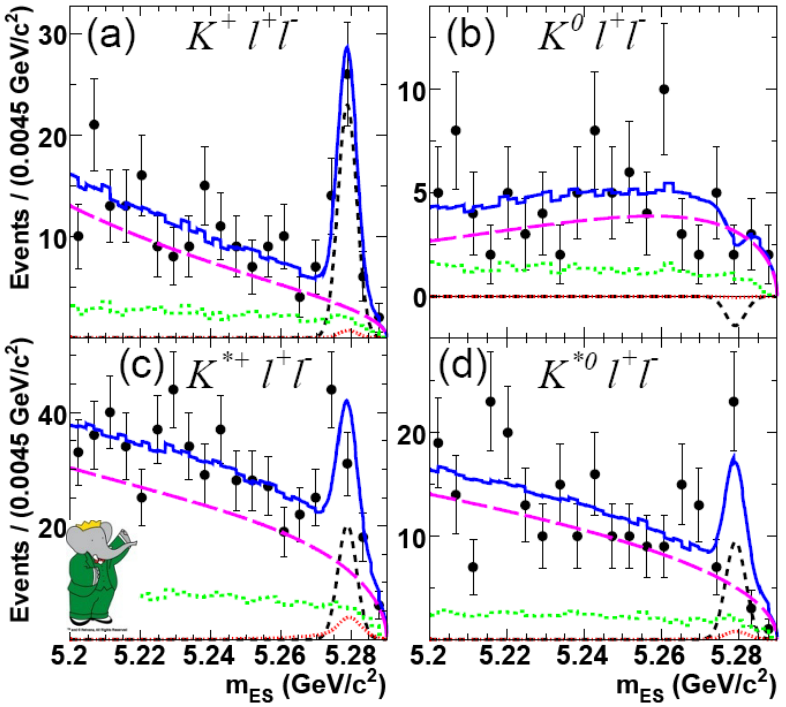
- Direct CP asymmetry A_{CP}, ~ zero in the SM
  (Bobeth, Hiller & Piranishvili, JHEP0807, 106(2008))
- Isospin asymmetry A_I, very small in SM, reaching at the most 10% at low q^2
- Lepton flavour ratio $R_{K(*)}$: in the SM, $R_K \sim 1$, $R_{K(*)} \sim 0.75$ (photon pole at $m_{\ell\ell}<2m_\mu$)

$$R_{K^{(*)}} \equiv \frac{\Gamma(B \to K^{(*)}\mu^+\mu^-)}{\Gamma(B \to K^{(*)}e^+e^-)}$$

$b \to s\ell^+\ell^-$: experimental results

Updates of $B \to K^{(*)}\ell^+\ell^-$ from BaBar (384×10^6 BB, PRD**79**:031102; PRL**102**:091803) and Belle (657×10^6 BB, arXiv:0904.0770)

- Exclusive reconstruction
- Reject $B \to c\bar{c}X_s$ by cutting on $q^2=m_{ll}^2$
  Bin resulting distribution in q^2



- A_{CP}s consistent with SM (zero)

A_{CP}	BaBar	Belle
$K^+l^+l^-$	–0.18±0.18±0.01	–0.10±0.10±0.01
$K^*l^+l^-$	0.01±0.16±0.01	0.04±0.10±0.02

- Measurements of lepton flavour ratio consistent with SM

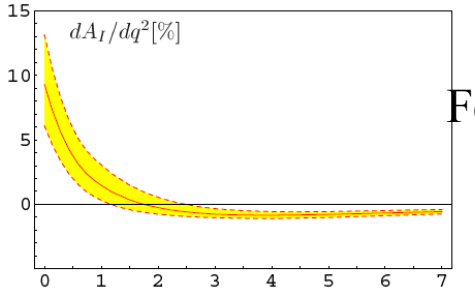
R	BaBar	Belle
R_K	0.96±0.40±0.05	1.03±0.19±0.06
R_{K*}	1.10±0.37±0.07	0.83±0.17±0.05

$b \to s \ell^+ \ell^-$: experimental results

- Both experiments see isospin asymmetries A_I consistent with SM (zero) at high q^2
- At low q^2, A_I could be slightly different from zero, but always positive
- BaBar sees a 3.9σ departure from zero

in negative direction (opposite from SM predicts)

(Belle, 2.2σ from zero)

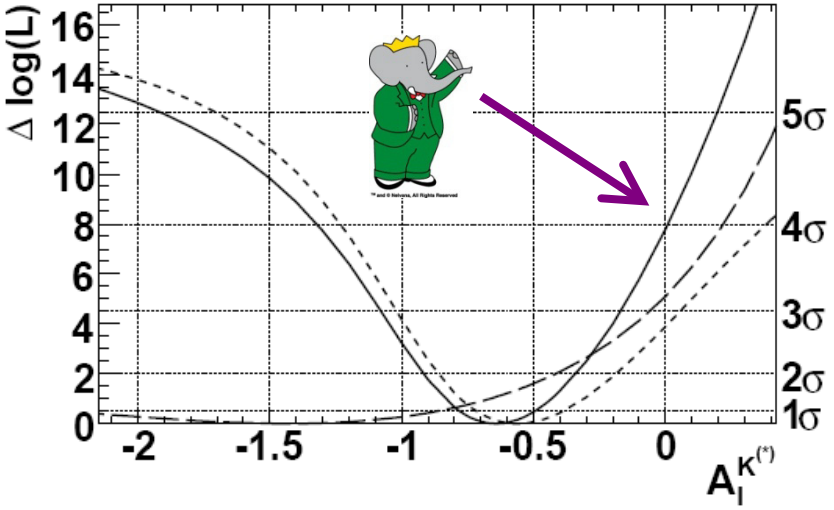


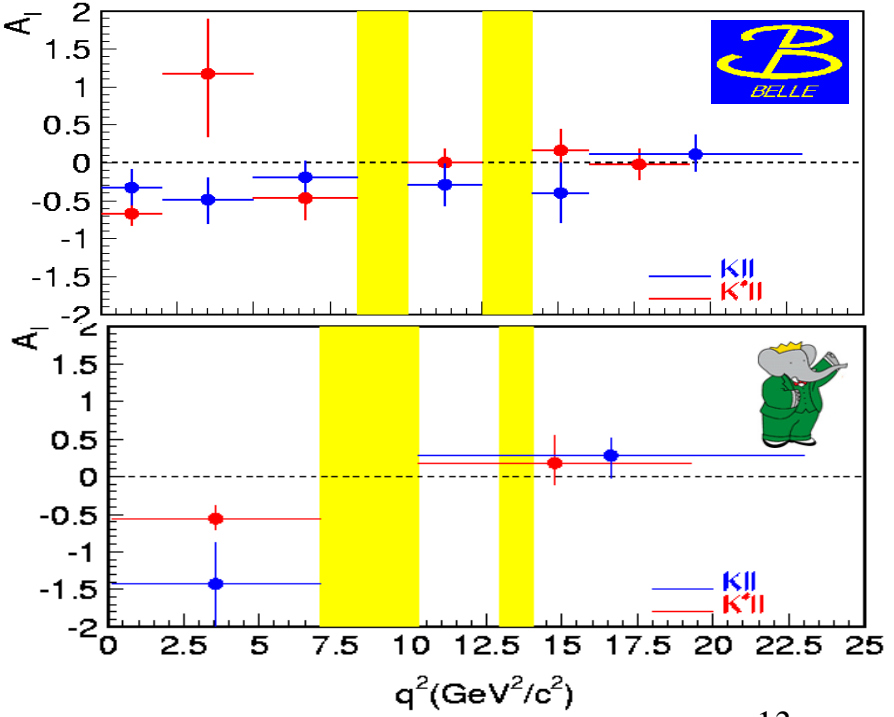
SM expectation

Feldmann & Matias

JHEP 0301, 074

A_I	BaBar	Belle
$K^+l^+l^-$	–1.43±0.55±0.04	–0.31±0.16±0.05
$K^*l^+l^-$	–0.56±0.16±0.03	–0.29±0.16±0.03





$b \to s \ell^+ \ell^-$: theory

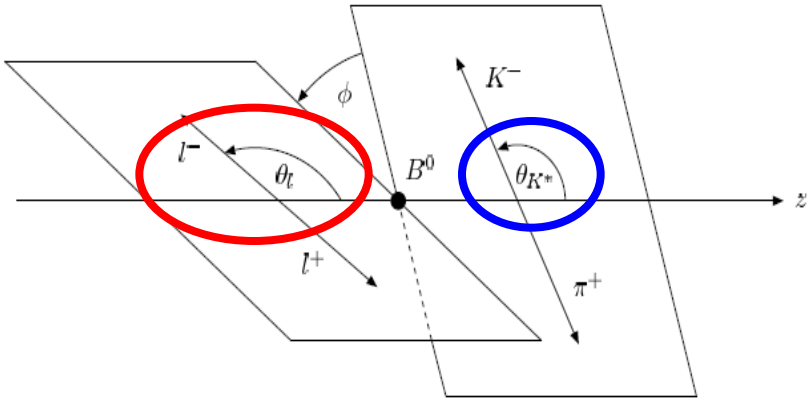
- $B \to K^* \ell^+ \ell^-$, a 4-body decay → Plenty of angular observables to constrain NP!

Just a few examples:

- F_L, longitudinal K^* polarization:

  ($\cos\theta_{K^*}$, angle between K and B in K^* rest frame)

$$\frac{3}{2} F_L \cos^2\theta_K + \frac{3}{4}(1 - F_L)(1 - \cos^2\theta_K)$$



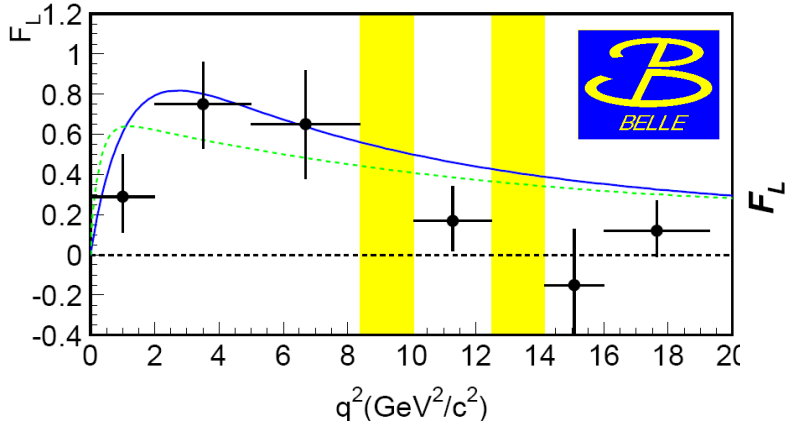
- Forward-backward asymmetry A_{FB}:

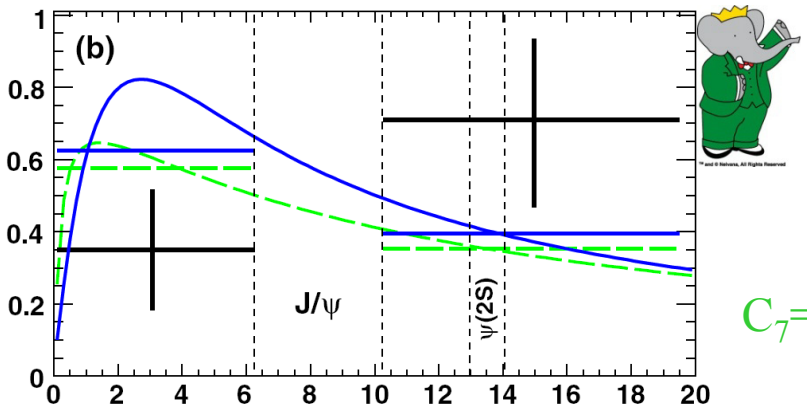
  ($\cos\theta_\ell$, angle between $\ell^+(\ell^-)$ and $B(\bar{B})$ in $\ell^+\ell^-$ rest frame)

$$A_{FB} = \frac{\Gamma(q^2, \cos\theta_{\ell-} > 0) - \Gamma(q^2, \cos\theta_{\ell-} < 0)}{\Gamma(q^2, \cos\theta_{\ell-} > 0) + \Gamma(q^2, \cos\theta_{\ell-} < 0)}$$

$b \to s \ell^+ \ell^-$: experimental results

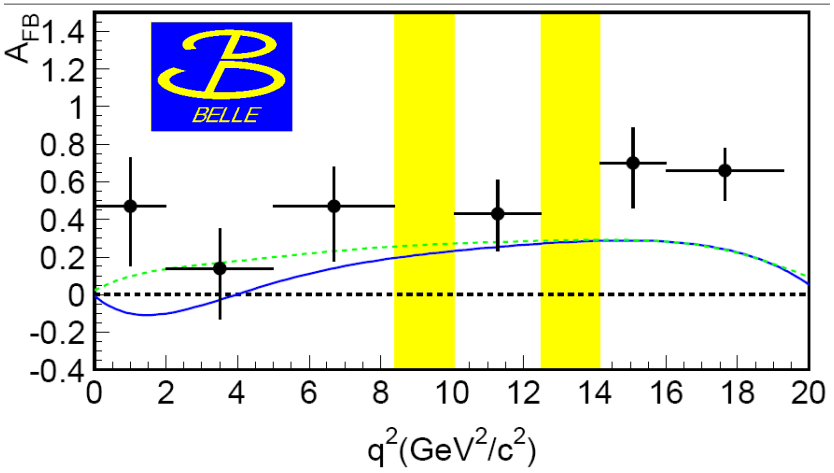
- Angular observables: measurements of F_L and A_{FB}
- Consistent with SM, but very much statistics-limited! A task for LHCb…

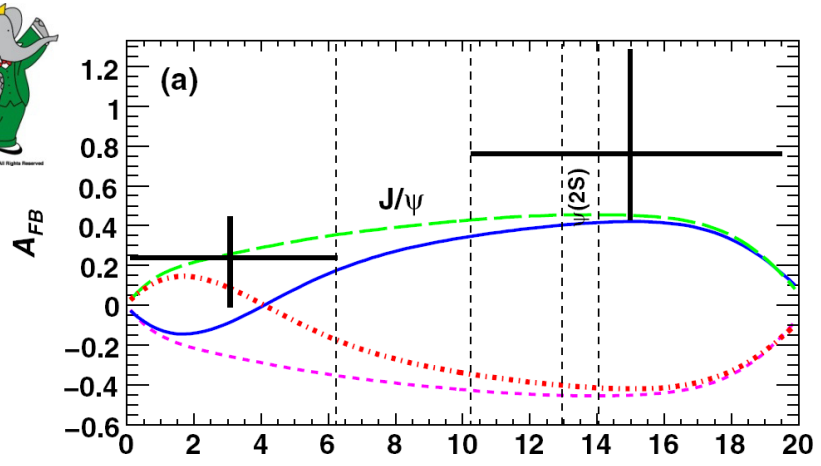




SM, blue

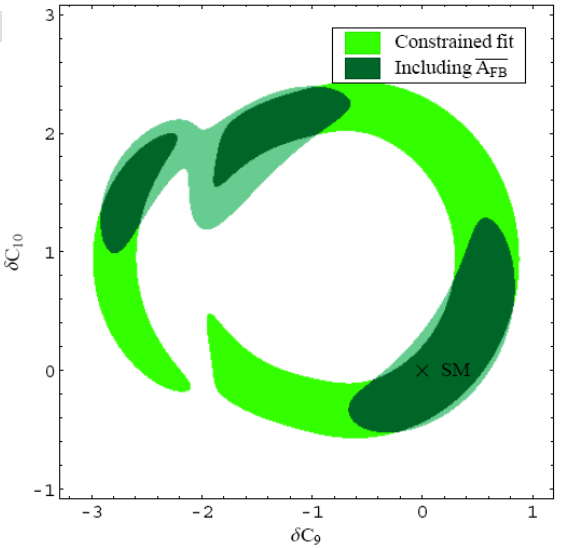
$C_7=-C_7^{SM}$, green





Constraints on NP

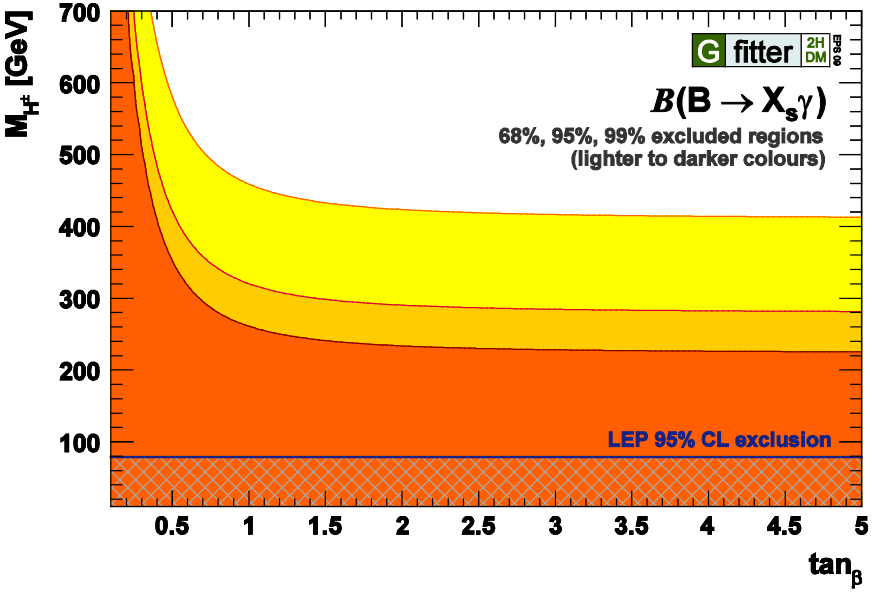
C_9, C_{10} in MFV (Hurth et al, Nucl.Phys.B808:326-346,2009)

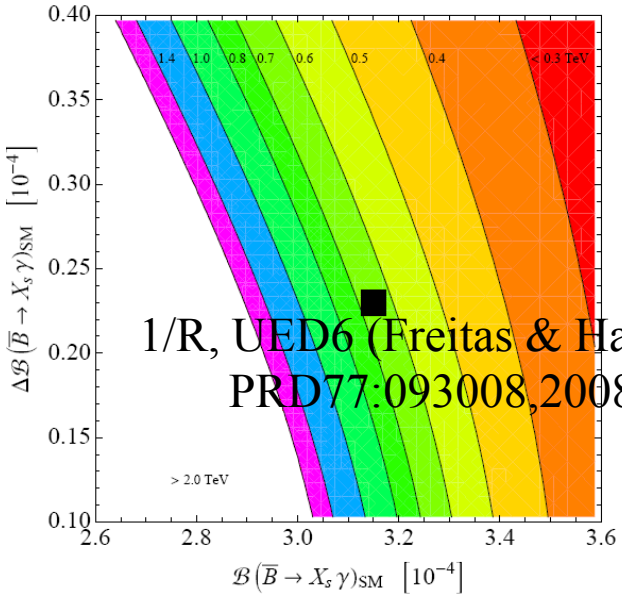


- Observables from radiative modes clean and very sensitive to NP.

Just a few examples:

- $B \to X_s \gamma$ implies $m_{H^+} > 295$GeV (2HDM type II); scale of extra dimensions $R^{-1} > 650$GeV (UED6)
- $b \to s \ell^+ \ell^-$ constrains Wilson coeffs C_9, C_{10}, sign of C_7



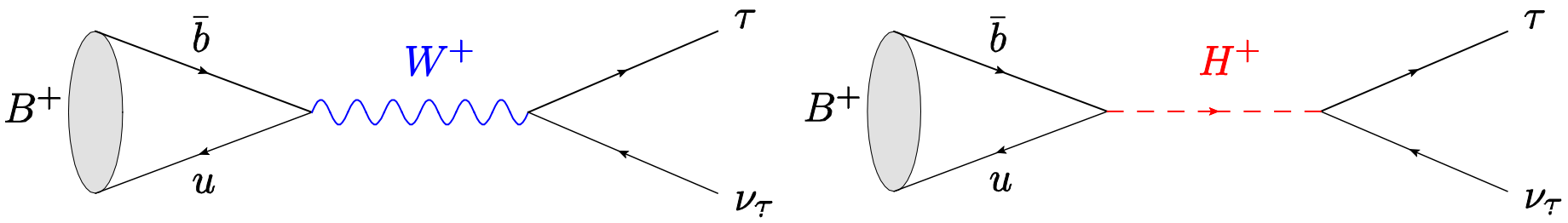


1/R, UED6 (Freitas & Haisch, PRD77:093008,2008)

Leptonic and semileptonic B decays

B→ℓu: theory

- Proceeds through annihilation diagram in SM. Other contributions (e.g. charged Higgs in 2HDM or SUSY) possible BSM.



$$BF(\mathrm{B} \to \ell \nu)_{\mathrm{SM}} = \frac{G_F^2 m_B}{8\pi} m_\ell^2 \left(1 - \frac{m_\ell^2}{m_B^2}\right)^2 f_B^2 \, |V_{ub}|^2 \, \tau_B$$

- Sensitive to V_{ub} and f_B
- Light leptons are helicity suppresed, tau channel ~ within reach of B factories:

  BF(B→τu) ~ 10^{-4}

  BF(B→eu) ~ 10^{-11}, BF(B→μu) ~ 10^{-7}

B→(e/μ)υ: experiment

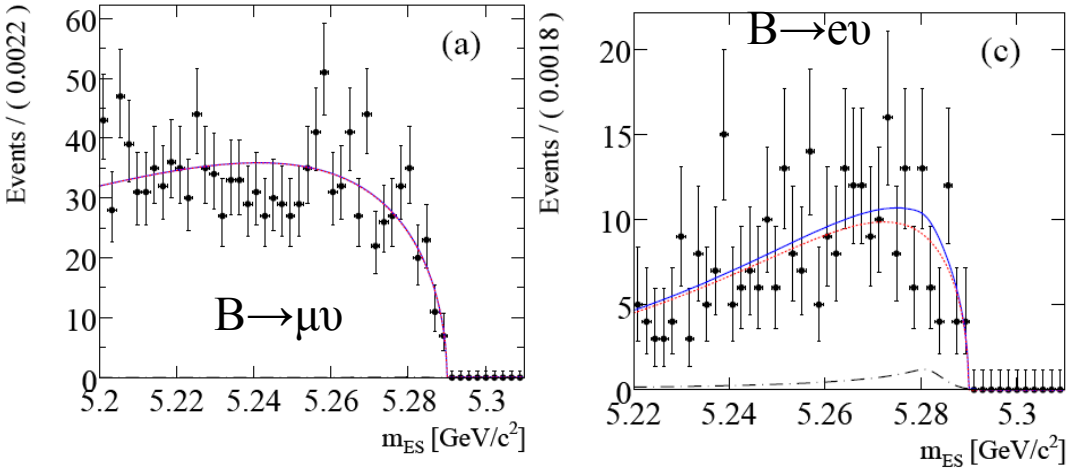
- BaBar has published search of B→(e/μ)υ with an inclusive approach.
- Select high momentum leptons as B candidates.

  Leptons monochromatic in B rest frame → boost to B rest frame with momentum inferred from rest of event. Fit m_{ES} and combination of event-shape variables.

NEW

	B→eυ	B→μυ
Sig. eff	(4.7±0.2)%	(6.1±0.2)%
Sig. yield	17.9±17.6	1.4 ± 17.2
BF UL @ 90% CL	<1.9 x 10^{-6}	<1.0 x 10^{-6}

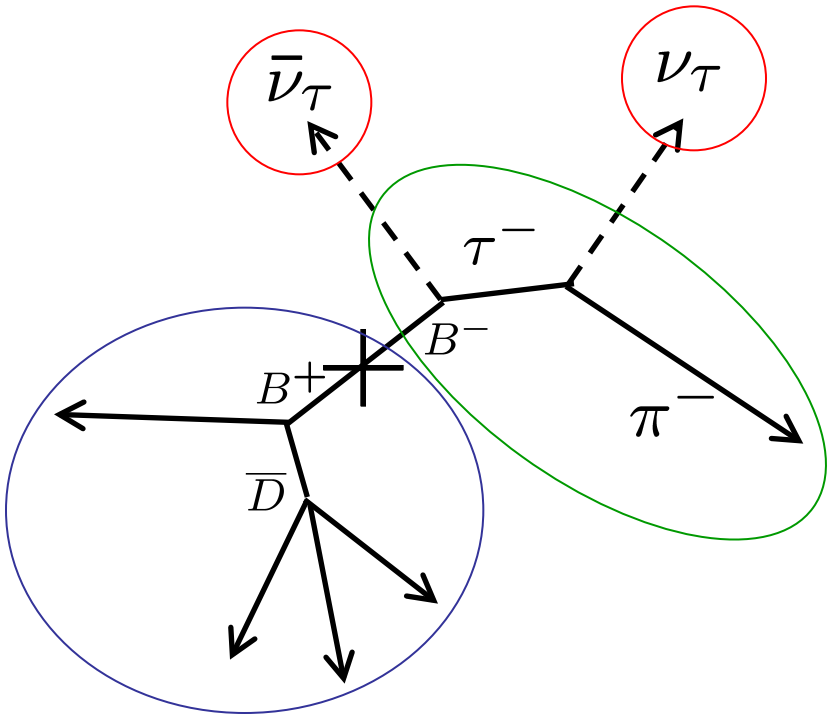
PRD**79**,091101 (2009)



c.f. Belle's BF(B→eυ) < 0.98 x 10^{-6}, BF(B→μυ) < 1.7 x 10^{-6} (Phys.Lett.B 647, 2006)

B→τυ: experiment

- Experimentally challenging due to presence of at least two neutrinos.
- Reconstruct both B mesons in the decay (signal and Btag), and require nothing else in the event (no other tracks and cal energy Eextra ≈ 0).

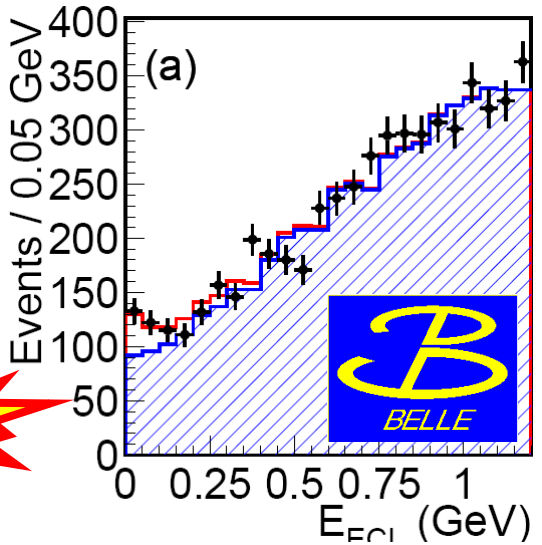


- Signal is reconstructed in τ→eυ, τ→μυ, τ→πυ, τ→ππυ, (71% of all tau decays)
- Btag can be reconstructed in semileptonic modes (*SL tag*), or in hadronic modes (*had tag*)
- SL tag more efficient (~1.5%) but less clean due to extra neutrino
- Had tag less efficient (~0.15%) but cleaner
- SL tag and Had tag samples uncorrelated

B→τυ: experiment

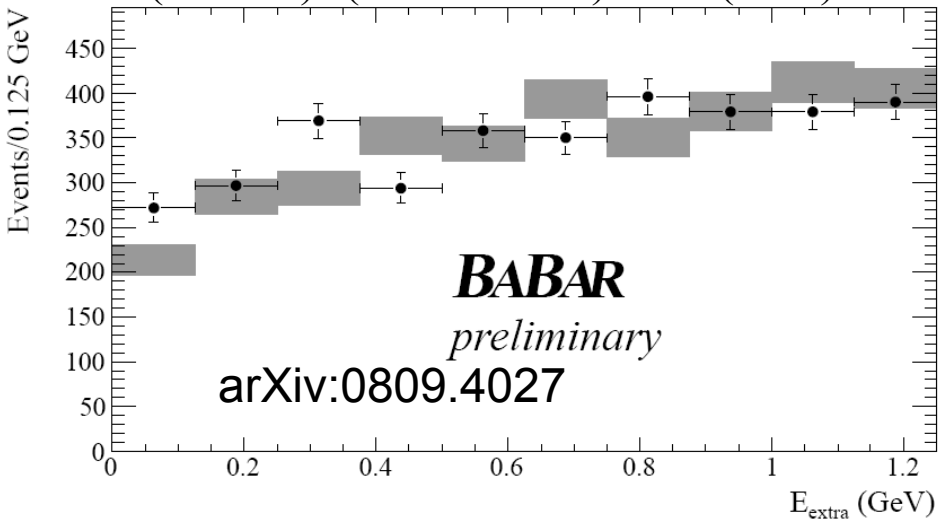
- Belle's SL tag analysis of 657x10^6 BB pairs
  Fit yields 154^{+36}_{-35} signal events.
  BF(B→τυ)=(1.65±0.38±0.36)x10^{-4} (2.8σ)

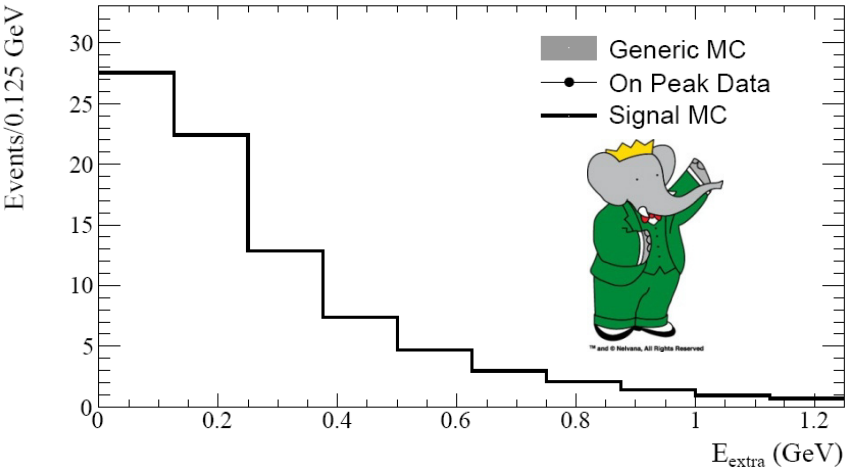
arXiv:0809.3834



NEW

- BaBar new SL tag analysis of full dataset
  Expected bkg: 521±31 Observed: 610
  BF(B→τυ)=(1.8±0.8±0.1)x10^{-4} (2.4σ)





B→τν: experiment

Agree with older Had tag analyses (independent samples)

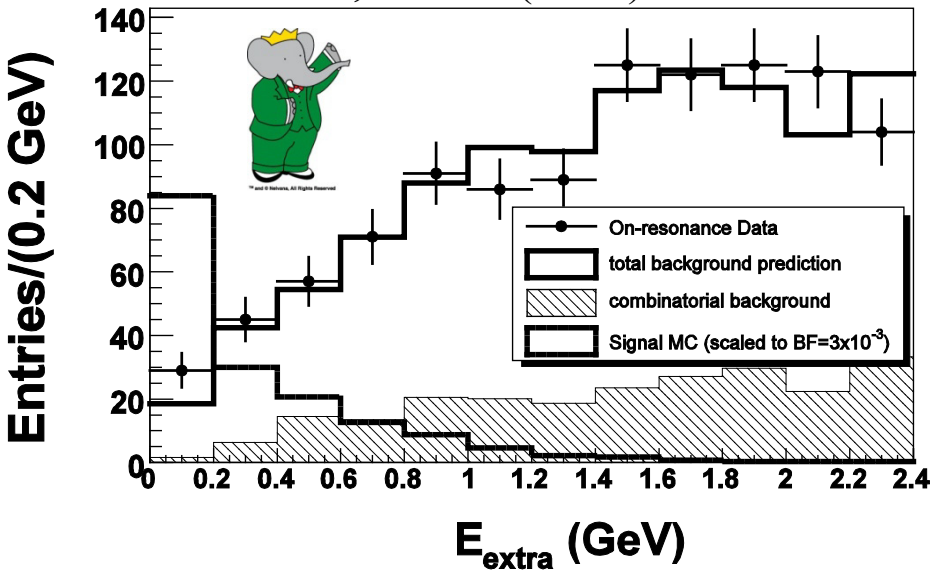
Belle (449×10^6 BB pairs):

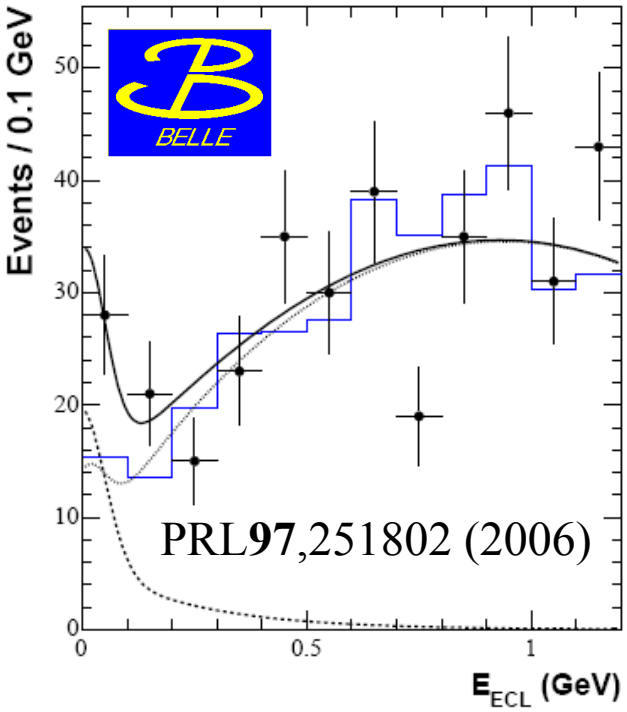
$BF(B\to\tau\nu)=(1.79^{+0.56}_{-0.49}{}^{+0.46}_{-0.51})\times10^{-4}$ (3.5σ)

Babar (383×10^6 BB pairs):

$BF(B\to\tau\nu)=(1.8^{+0.9}_{-0.8}\pm0.4\pm0.2)\times10^{-4}$ (2.2σ)

PRD**77**,011107 (2008)

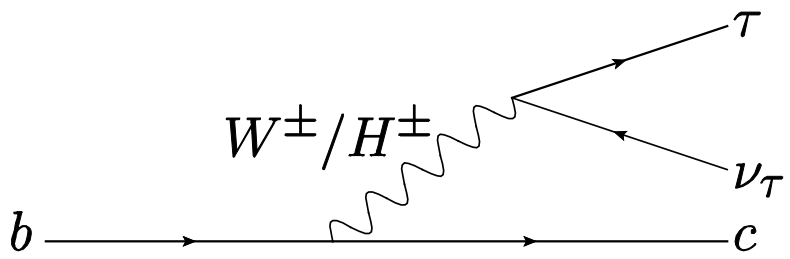




$BF(B\to\tau\nu)=(1.73\pm0.35)\times10^{-4}$

$B \to D^{(*)} \tau \nu$: theory

- $b \to c \tau \nu$, similar to $B \to \tau \nu$: sensitive to NP contributions such as charged Higgs
- Higher BFs than $B \to \tau \nu$: ~10^{-2} vs ~10^{-4}



Chen and Geng (2006), JHEP 0610,053	SM BF (%)
$B^0 \to D \tau \nu$	0.69±0.04
$B^0 \to D^{(*)} \tau \nu$	1.41±0.07

- Cleaner SM predictions than $B \to \tau \nu$ because V_{cb} better known than V_{ub}
- Spin zero of Higgs → charged Higgs affects D/D* differently.
  Tau polarization very sensitive.

- Experimentally, same reconstruction techniques as $B \to \tau \nu$ → very low eff ~ 10^{-5}
- Extract BF ratio of $B \to D^{(*)} \ell \nu$ and $B \to D^{(*)} \tau (\to \ell \nu) \nu$
- Fit e.g. unobserved particles mass (m_{miss}^2) and tau daughter momentum (p_l)

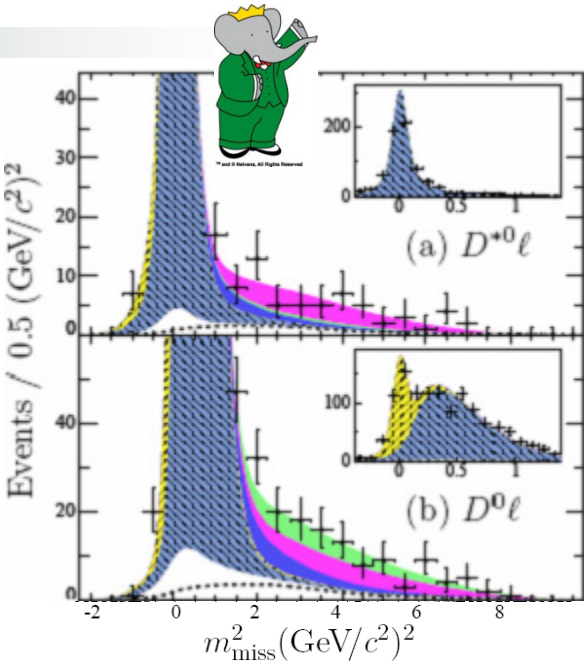
$B \to D^{(*)} \tau \nu$: experiment

- Had tag analyses. BaBar (232/fb, PRD**79**,092002)

NEW

Mode	$\mathcal{B}$ [%]	$\sigma_{\rm tot}$ ($\sigma_{\rm stat}$)
$B^- \to D^0 \tau^- \overline{\nu}_\tau$	$0.67 \pm 0.37 \pm 0.11 \pm 0.07$	1.8 (1.8)
$B^- \to D^{*0} \tau^- \overline{\nu}_\tau$	$2.25 \pm 0.48 \pm 0.22 \pm 0.17$	5.3 (5.8)
$\overline{B}^0 \to D^+ \tau^- \overline{\nu}_\tau$	$1.04 \pm 0.35 \pm 0.15 \pm 0.10$	3.3 (3.6)
$\overline{B}^0 \to D^{*+} \tau^- \overline{\nu}_\tau$	$1.11 \pm 0.51 \pm 0.04 \pm 0.04$	2.7 (2.7)
$B \to D \tau^- \overline{\nu}_\tau$	$0.86 \pm 0.24 \pm 0.11 \pm 0.06$	3.6 (4.0)
$B \to D^* \tau^- \overline{\nu}_\tau$	$1.62 \pm 0.31 \pm 0.10 \pm 0.05$	6.2 (6.5)

Agree with SM, dominated by stat errors



and Belle (605/fb, W. Dungel @ EPS09)

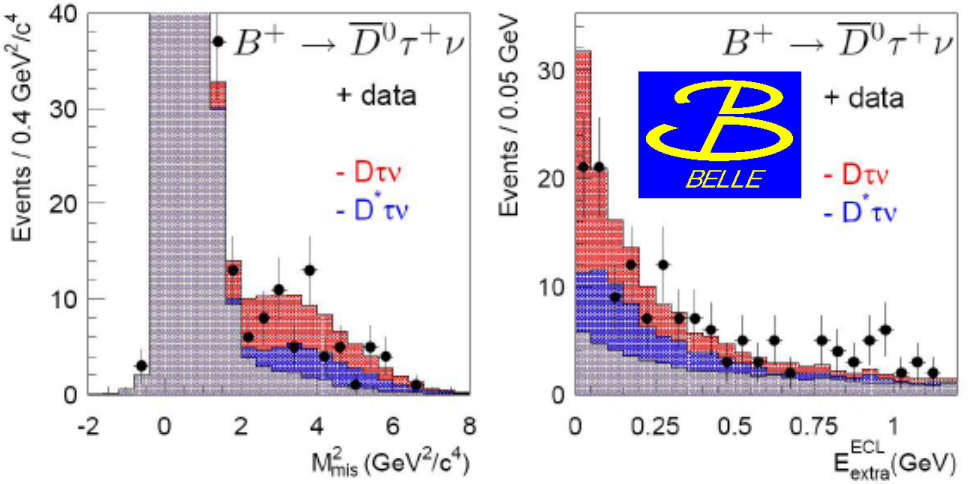
NEW

$\mathcal{B}(B^+ \to \bar{D}^0 \tau^+ \nu) = 1.51^{+0.41}_{-0.39}(stat)^{+0.24}_{-0.19}(syst) \pm 0.15(norm)\%$ 3.8σ

$\mathcal{B}(B^+ \to \bar{D}^{*0} \tau^+ \nu) = 3.04^{+0.69}_{-0.66}(stat)^{+0.40}_{-0.47}(syst) \pm 0.22(norm)\%$ 3.9σ

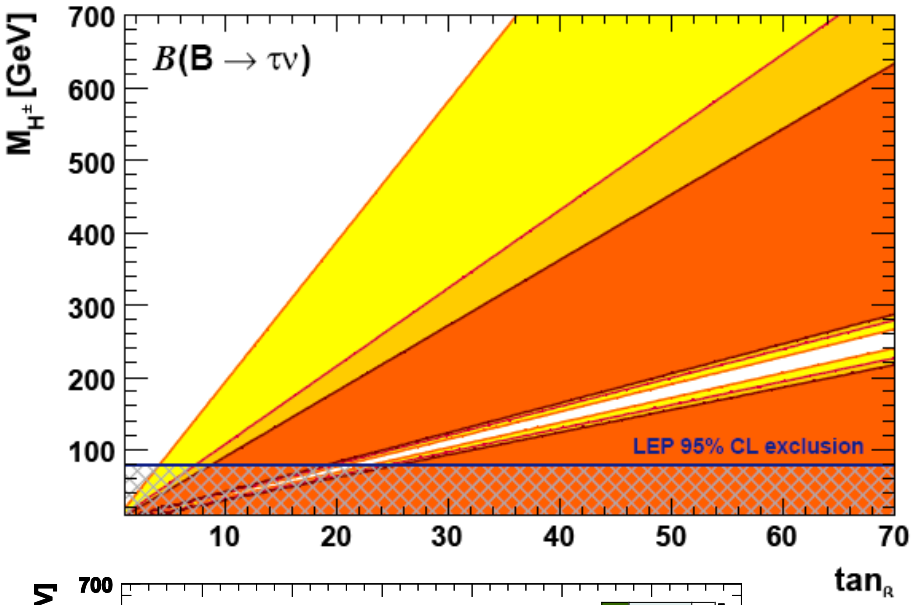
$\mathcal{B}(B^0 \to D^- \tau^+ \nu) = 1.01^{+0.46}_{-0.41}(stat)^{+0.13}_{-0.11}(syst) \pm 0.10(norm)\%$ 2.6σ

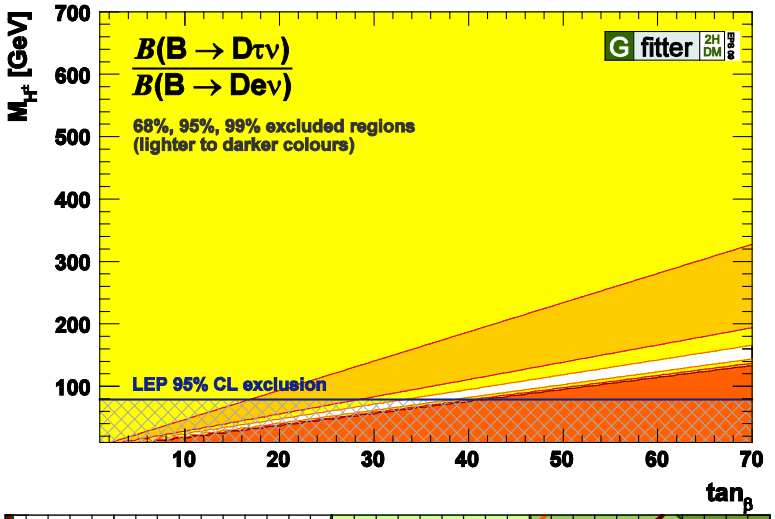
$\mathcal{B}(B^0 \to D^{*-} \tau^+ \nu) = 2.56^{+0.75}_{-0.66}(stat)^{+0.31}_{-0.22}(syst) \pm 0.10(norm)\%$ 4.7σ

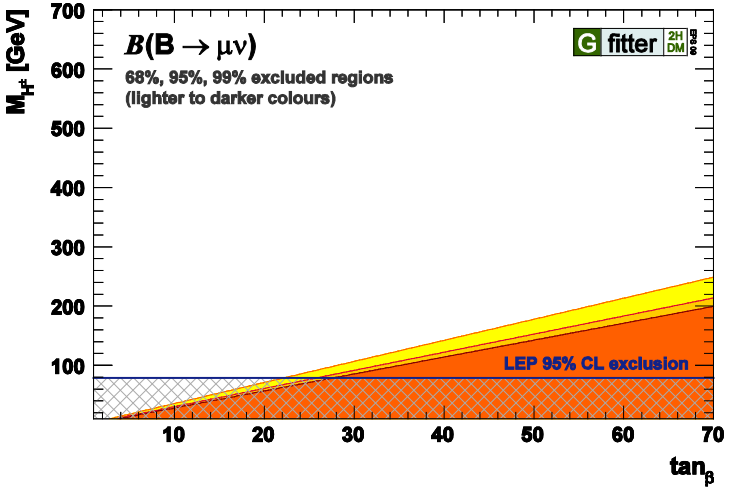


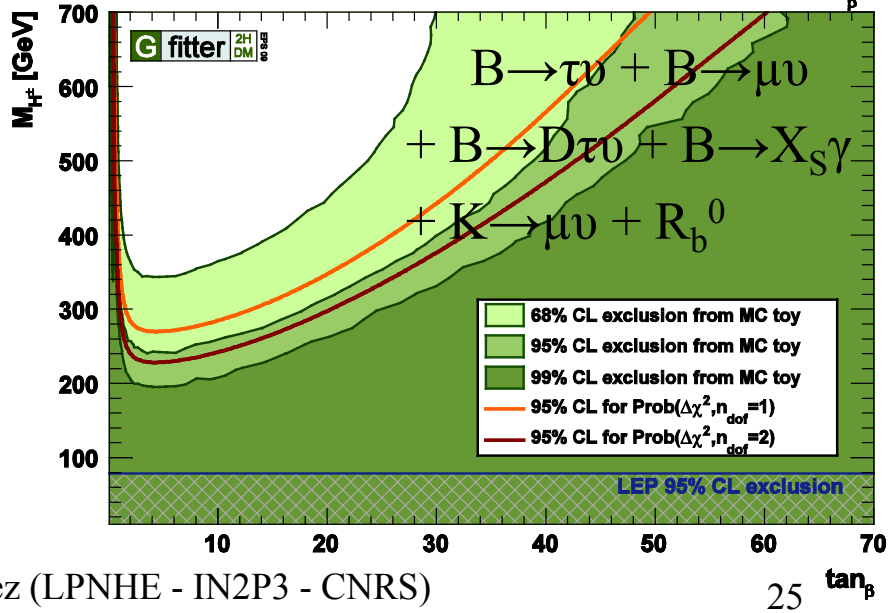
Contraints on NP from (semi)leptonic

Ex: constraints on 2HDM Type II. Plots from Gfitter (Eur. Phys. J. C **60**, 543 (2009))





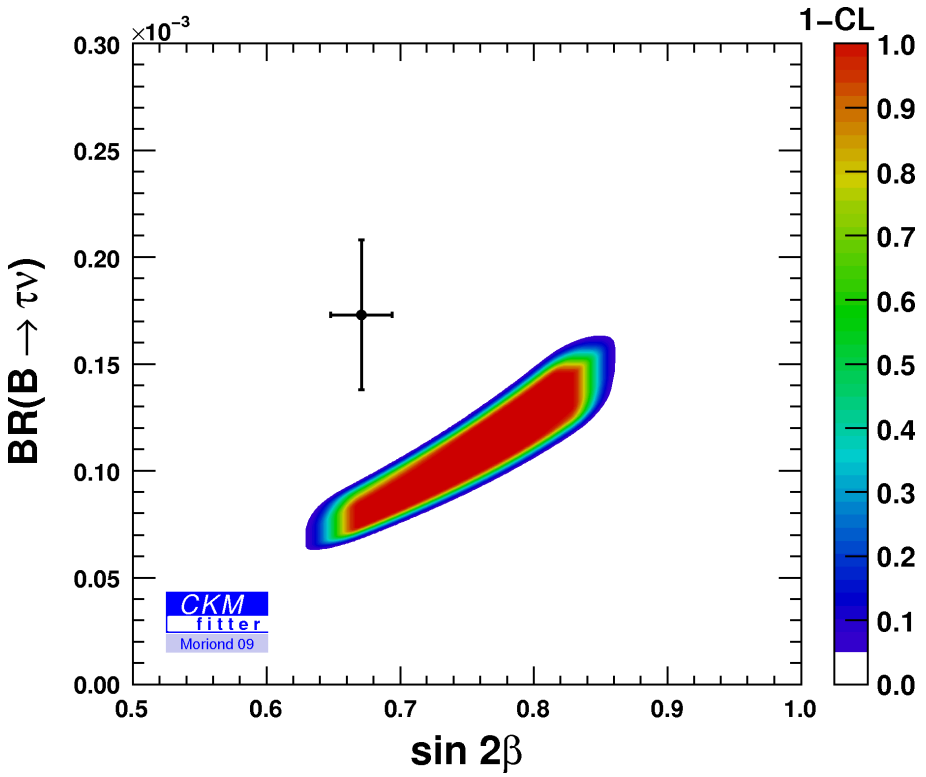


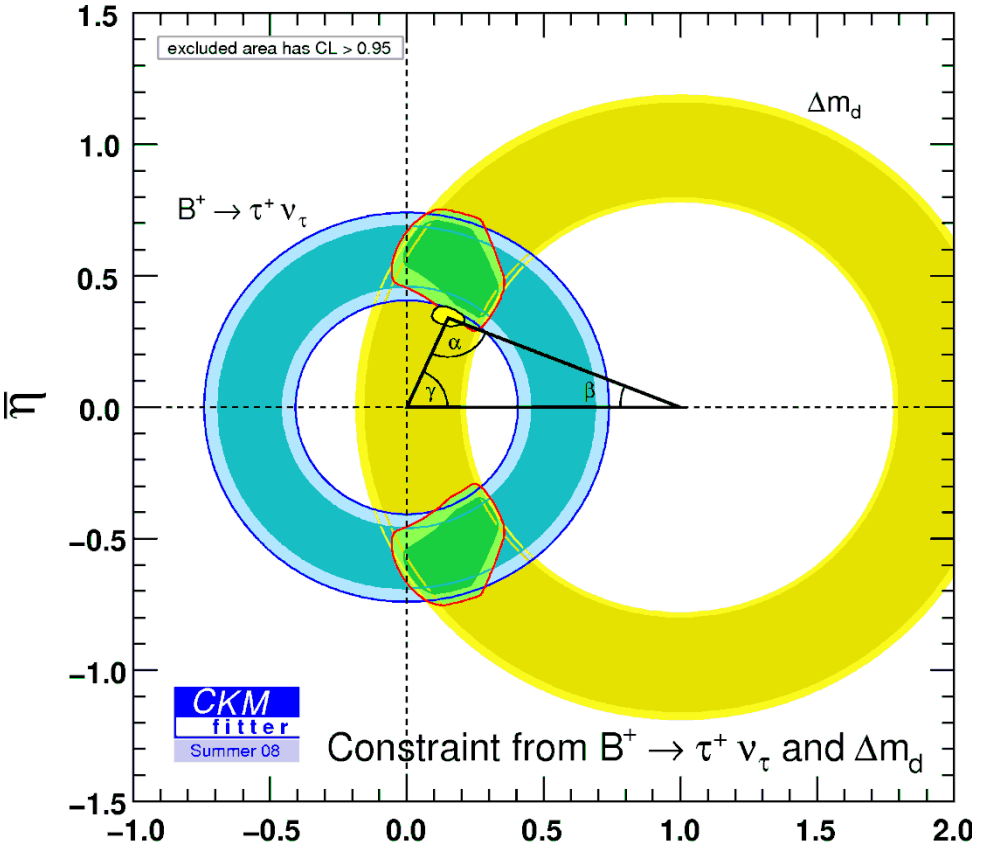


$B \to \tau\nu$: tensions in CKM fit

- Worth pointing out: tensions in SM regarding $\sin 2\beta$ and $B \to \tau\nu$
- $(B \to \tau\nu + \Delta m_d)$ and $\sin 2\beta$ predict different (ρ, η):

  $B \to \tau\nu$ too high or $\sin 2\beta$ too low!



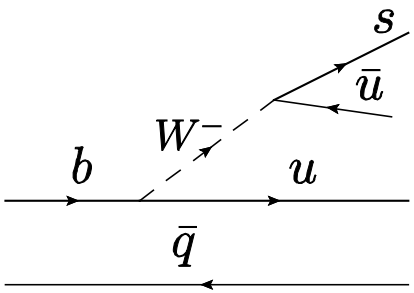


Kπ puzzle

B→Kπ: naïve theoretical expectacions

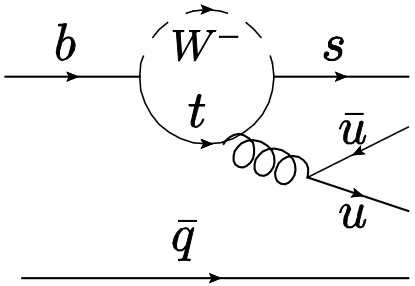
- Four contributions: (gluonic) Penguin, Tree, Colour-suppressed tree and EW penguin
- Naïve theoretical assumption: can neglect colour-suppressed tree and EW penguin

$$\rightarrow A_{CP}(K^+\pi^-) \approx A_{CP}(K^+\pi^0)$$



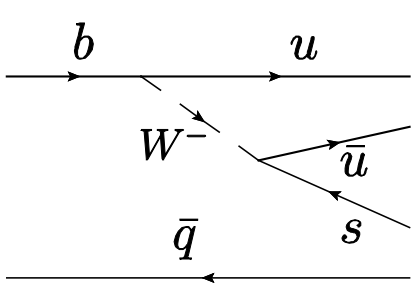
Tree

$K^+\pi^-$ $K^+\pi^0$



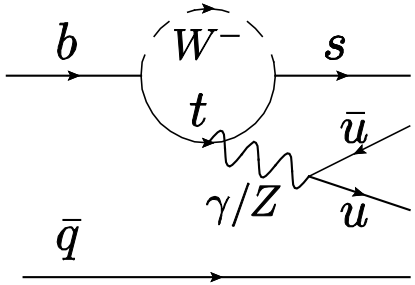
(gluonic) Penguin

$K^+\pi^-$ $K^+\pi^0$



Color-supressed tree

$K^+\pi^0$



EW penguin

$K^+\pi^0$

- Independent sum rule holds in SM and relates A_{CP}s of $K^+\pi^-$, $K^0\pi^+$, $K^+\pi^0$, $K^0\pi^0$ (M. Gronau, PLB 627,82 (2005)):

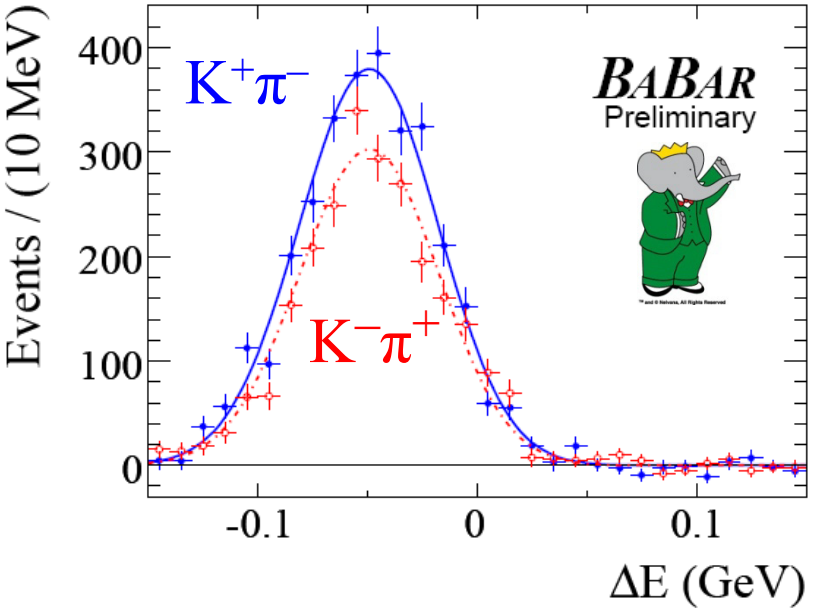
$$A_{CP}(K^+\pi^-) + A_{CP}(K^0\pi^+) \approx A_{CP}(K^+\pi^0) + A_{CP}(K^0\pi^0)$$

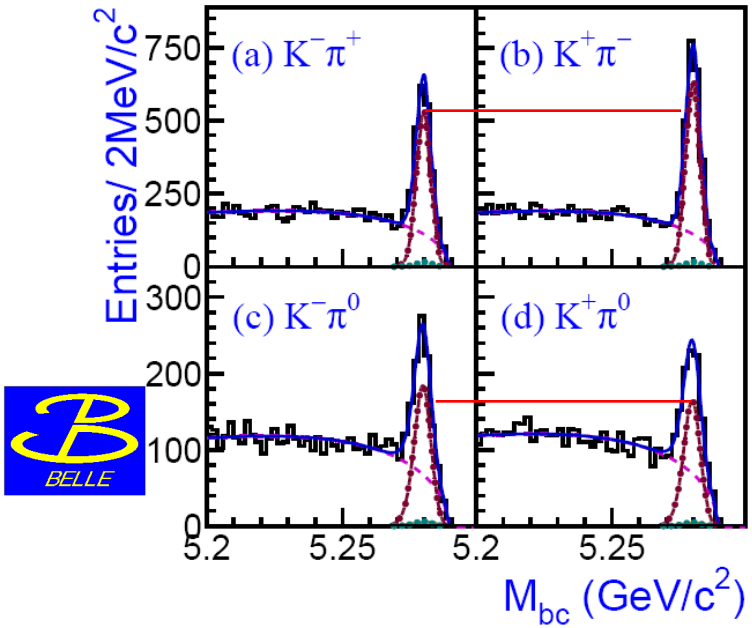
$B \to K\pi$: ΔA_{CP}

$$\Delta A_{CP} = A_{CP}(K^+\pi^-) - A_{CP}(K^+\pi^0) \neq 0$$

(BaBar, arXiv:0807.4226 and Belle, Nature 452, 332 (2008))

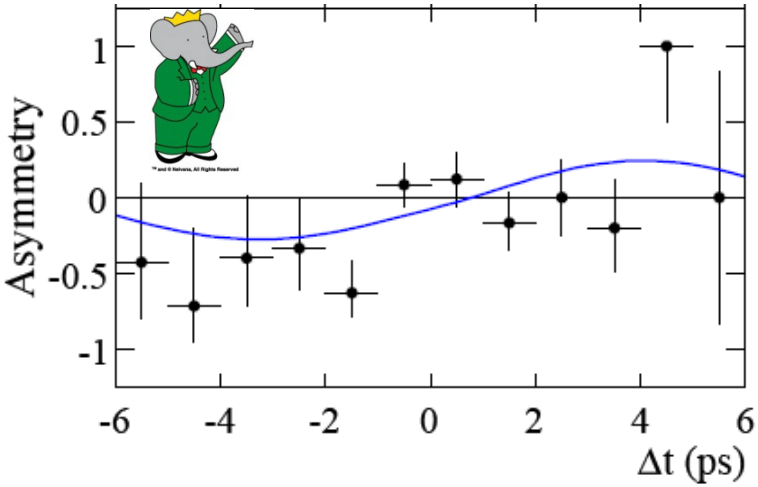
A_{CP}	BaBar	Belle	HFAG average
$K^+\pi^-$	–0.107±0.016±0.006	–0.094±0.018±0.08	–0.098±0.012
$K^+\pi^0$	0.030±0.039±0.010	0.07±0.03±0.01	0.050±0.025

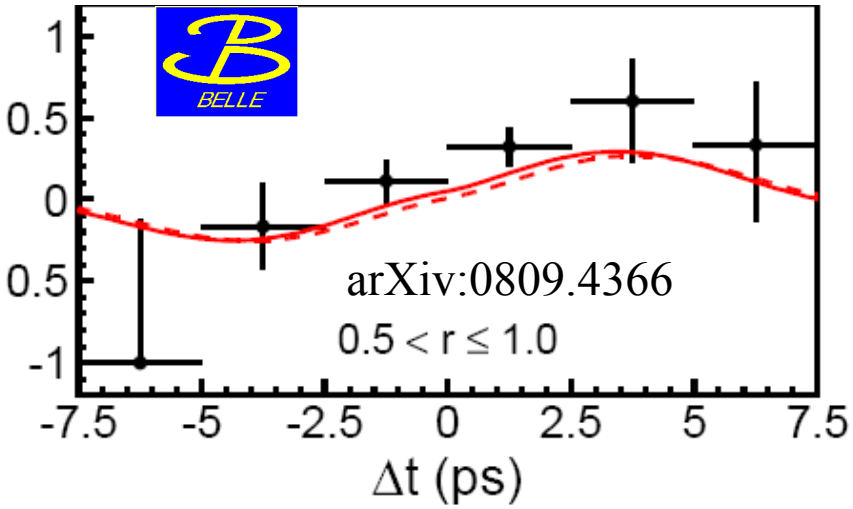


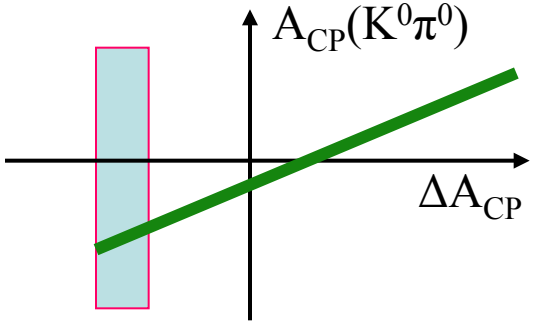


$B \to K\pi$: time-dep. $K^0\pi^0$

BaBar recent update: time-dependent (TD) analysis of $B \to K^0\pi^0$ (PRD79:052003,2009)







Sum rule predicts

$A_{CP}(K^0\pi^0) = -0.151 \pm 0.043$

TDCP $K^0\pi^0$	BaBar	Belle
S	$0.55 \pm 0.20 \pm 0.03$	$0.67 \pm 0.31 \pm 0.08$
A_{CP}	$-0.13 \pm 0.13 \pm 0.03$	$0.14 \pm 0.13 \pm 0.06$

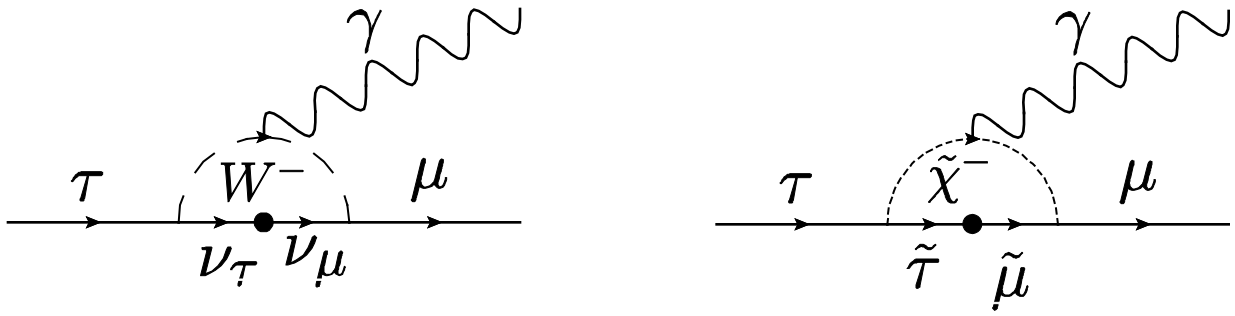
Agreement of A_{CP} average and sum rule prediction at 1.5σ

Stat errors with full BaBar dataset too large…

Lepton Flavour Violation (LFV) in τ decays

LFV in τ decays : introduction

- Neutrino mixing introduces LFV in SM at levels many orders of magnitudes below our present experimental reach



→ Any LFV experimental detection due to New Physics

	A. Cervelli CIPANP 09	τ→μγ	τ→lll
SM + ν mixing	Lee, Shrock, PRD 16 (1977) 1444 Cheng, Li, PRD 45 (1980) 1908	10^{-54} - 10^{-40}	10^{-40}
SUSY Higgs	Dedes, Ellis, Raidal, PLB 549 (2002) 159 Brignole, Rossi, PLB 566 (2003) 517	10^{-10}	10^{-7}
SM + heavy Maj ν_R	Cvetic, Dib, Kim, Kim , PRD66 (2002) 034008	10^{-9}	10^{-10}
Non-universal Z'	Yue, Zhang, Liu, PLB 547 (2002) 252	10^{-9}	10^{-8}
SUSY SO(10)	Masiero, Vempati, Vives, NPB 649 (2003) 189 Fukuyama, Kikuchi, Okada, PRD 68 (2003) 033012	10^{-8}	10^{-10}
mSUGRA + Seesaw	Ellis, Gomez, Leontaris, Lola, Nanopoulos, EPJ C14 (2002) 319 Ellis, Hisano, Raidal, Shimizu, PRD 66 (2002) 115013	10^{-7}	10^{-9}

E.g. $\tau \to \mu\gamma$,

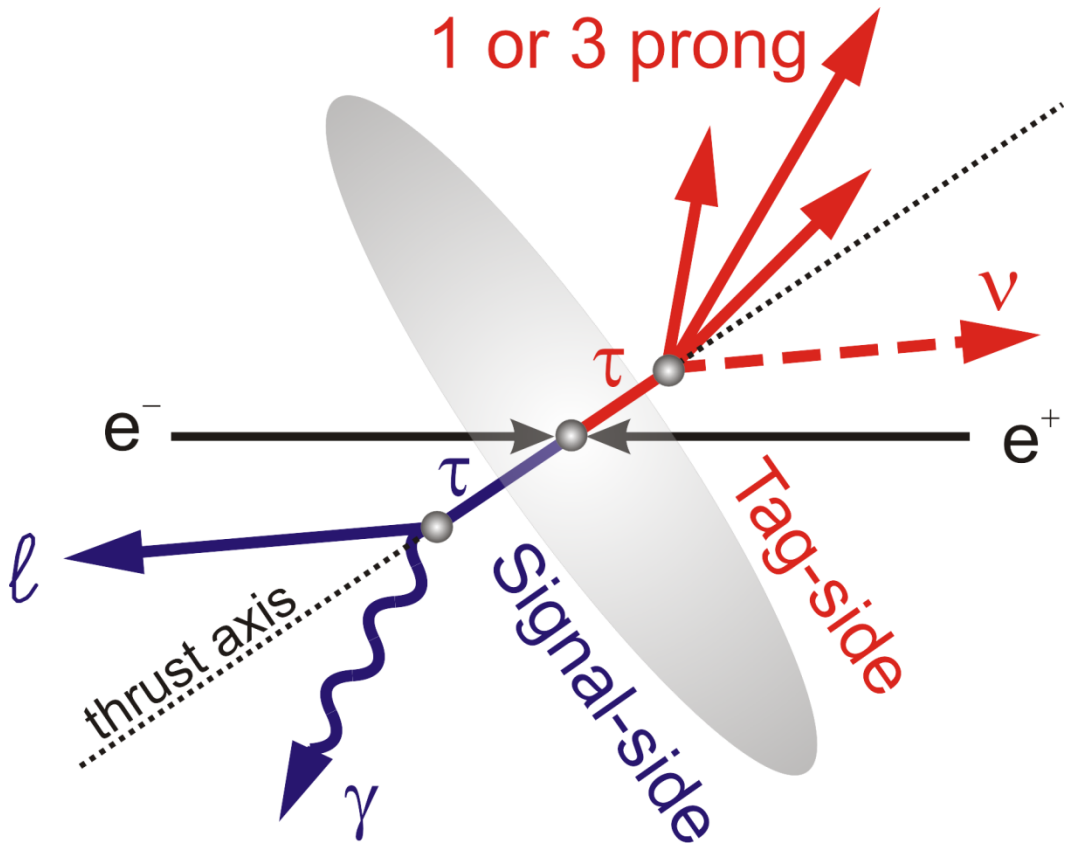
$BF_{SM} \sim 10^{-54} \to BF_{NP} \sim 10^{-7}$

$\tau \to \ell\ell\ell$,

$BF_{SM} \sim 10^{-40} \to BF_{NP} \sim 10^{-7}$

LFV in τ decays: exp. approach

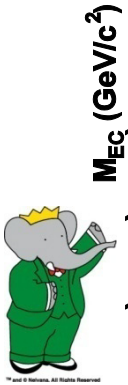
- Separate signal and tag hemispheres in CM system
- Require 1-prong tau decays (~85%) on tag side, fully reconstruct signal side (no missing energy e.g. $\tau \to \ell\ell\ell$) → use usual m_{ES}, ΔE variables
- Define (blind) signal region, estimate backgrounds from sidebands
- Count/fit events in signal region, estimate upper limits

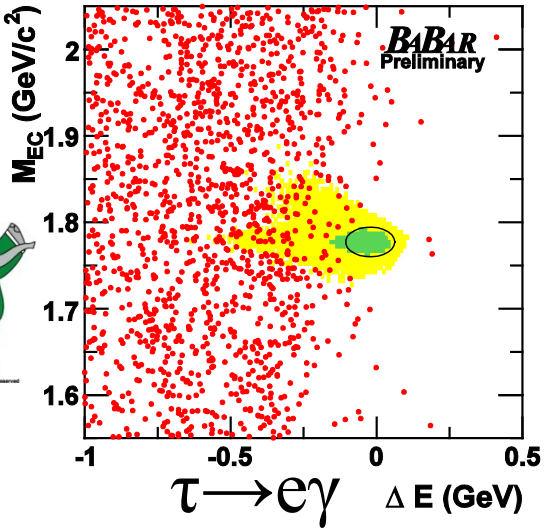


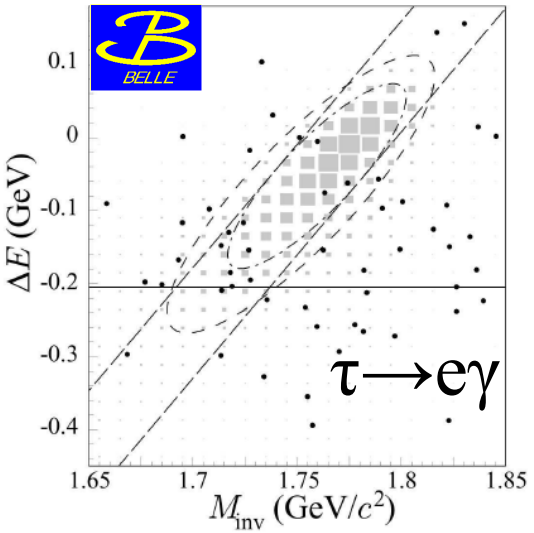
LFV in τ decays: τ→ℓγ

- BaBar (515/fb, sub. to PRL, arXiv:0908.2381) and Belle (535/fb, Phys.Lett.B666:16) results

- Number of events found in signal boxes consistent with background estimations



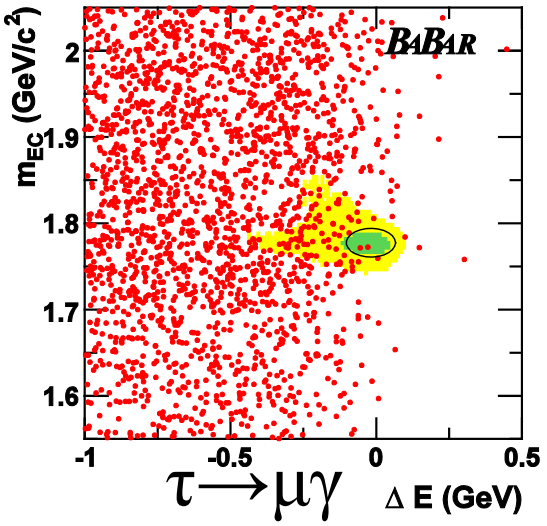


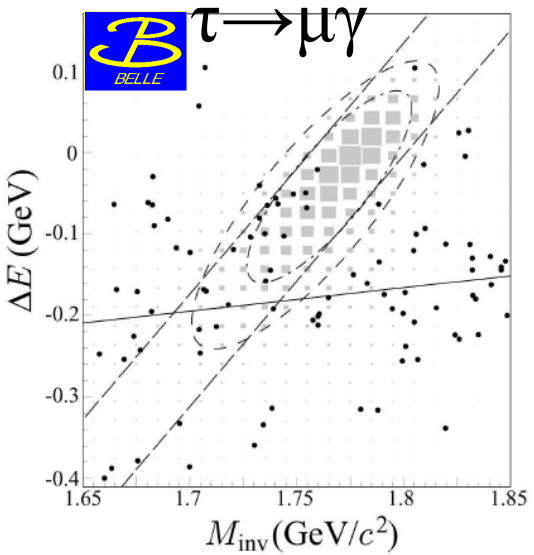


NEW

Mode	BaBar BF	Belle BF
τ→eγ	< 3.3x10^{-8}	< 1.2x10^{-7}
τ→μγ	< 4.4x10^{-8}	< 4.5x10^{-8}

(all ULs at 90% CL)

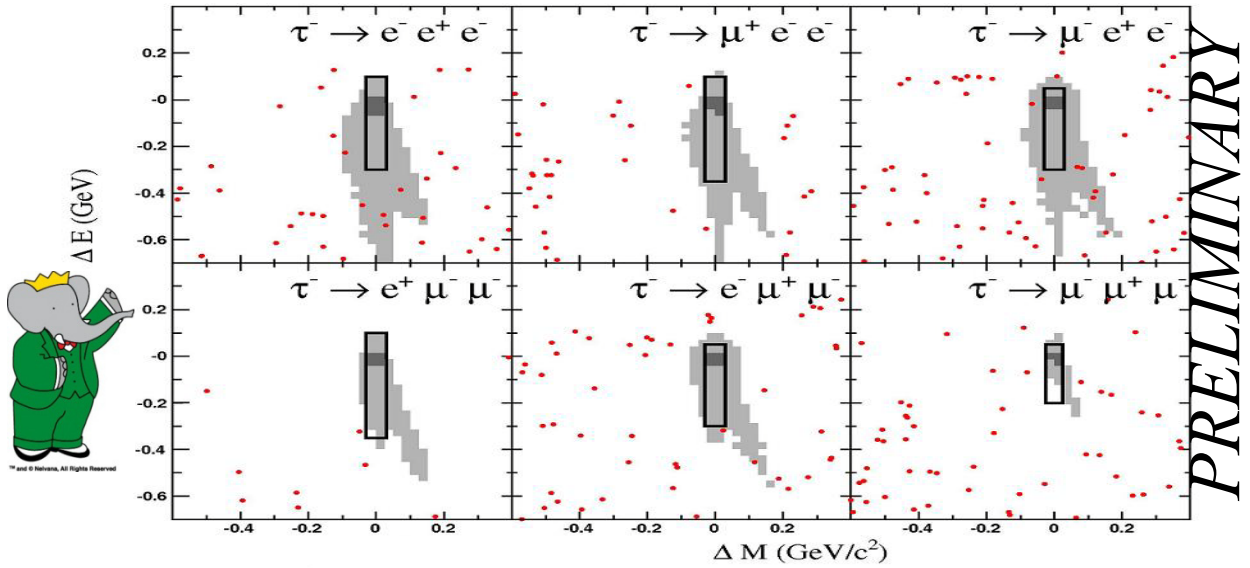




LFV in τ decays: τ→ℓℓℓ

- BaBar (472/fb, *preliminary*, CIPANP'09) and Belle (Phys.Lett.B660:154, 782/fb)

- No events seen by any experiment in signal regions



- Results start to constrain several NP models

Mode	ϵ [%] *BABAR* (Belle)	UL [$\times 10^{-8}$] *BABAR* (Belle)
$e^+e^-e^+$	8.6 (6.0)	2.9 (2.7)
$e^+e^-\mu^+$	8.8 (9.3)	2.2 (1.8)
$e^+e^+\mu^-$	12.6 (11.5)	1.8 (1.5)
$e^+\mu^-\mu^+$	6.4 (6.1)	3.2 (2.7)
$e^-\mu^+\mu^+$	10.2 (10.1)	2.6 (1.7)
$\mu^+\mu^-\mu^+$	6.6 (7.6)	3.3 (2.1)

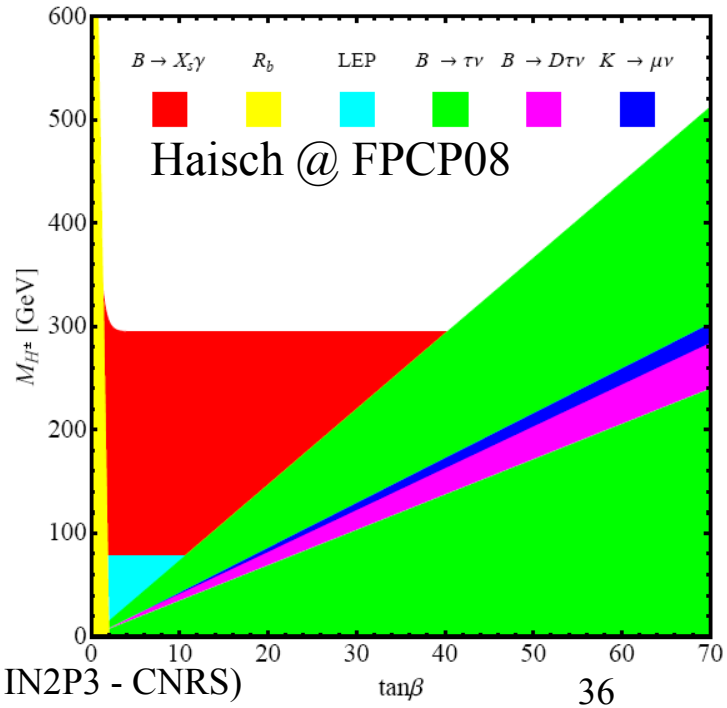
	τ→μγ	τ→lll
SM + ν mixing	10^{-54} - 10^{-40}	10^{-40}
SUSY Higgs	10^{-10}	10^{-7}
SM + heavy Maj ν_R	10^{-9}	10^{-10}
Non-universal Z'	10^{-9}	10^{-8}
SUSY SO(10)	10^{-8}	10^{-10}
mSUGRA + Seesaw	10^{-7}	10^{-9}

Conclusions

B factories developping rich programme searching for BSM physics that already constrains most popular NP models: MSSM, 2HDM, UED, RS...

A few examples discussed today:

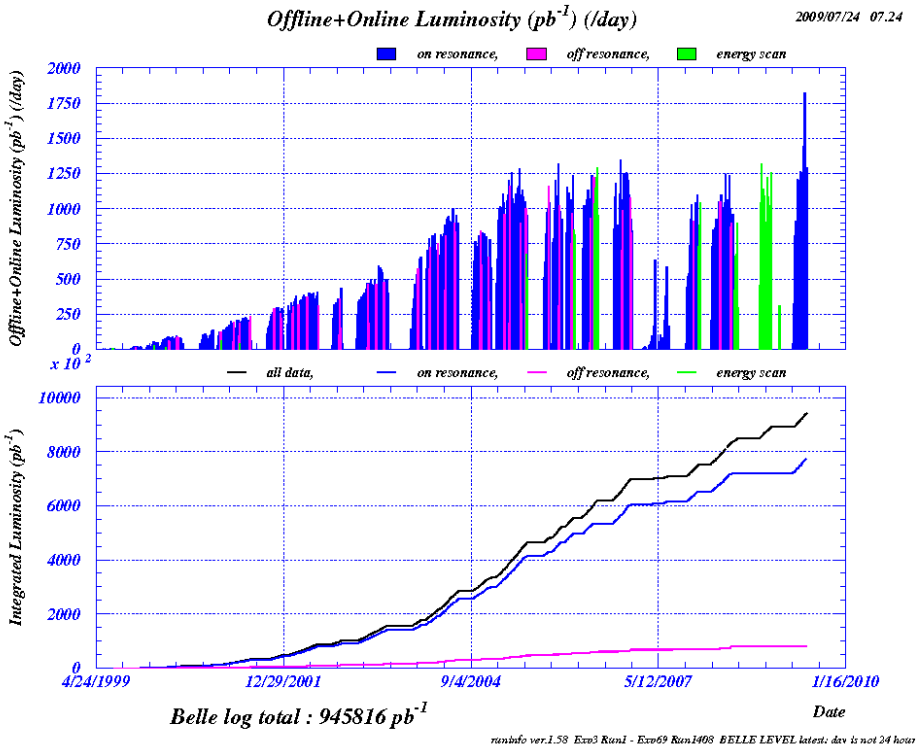
- strong limits on charged Higgs mass from $b \to s\gamma$, $B \to \tau\nu$ and $B \to D^{(*)}\tau\nu$
- Model-indepedent constraints derived from $b \to s\ell^+\ell^-$ based on Wilson coeffs C_7, C_9, C_{10}
- $K\pi$ puzzle still an open issue
- Searches of LFV τ-decays reaching NP-enhanced predictions

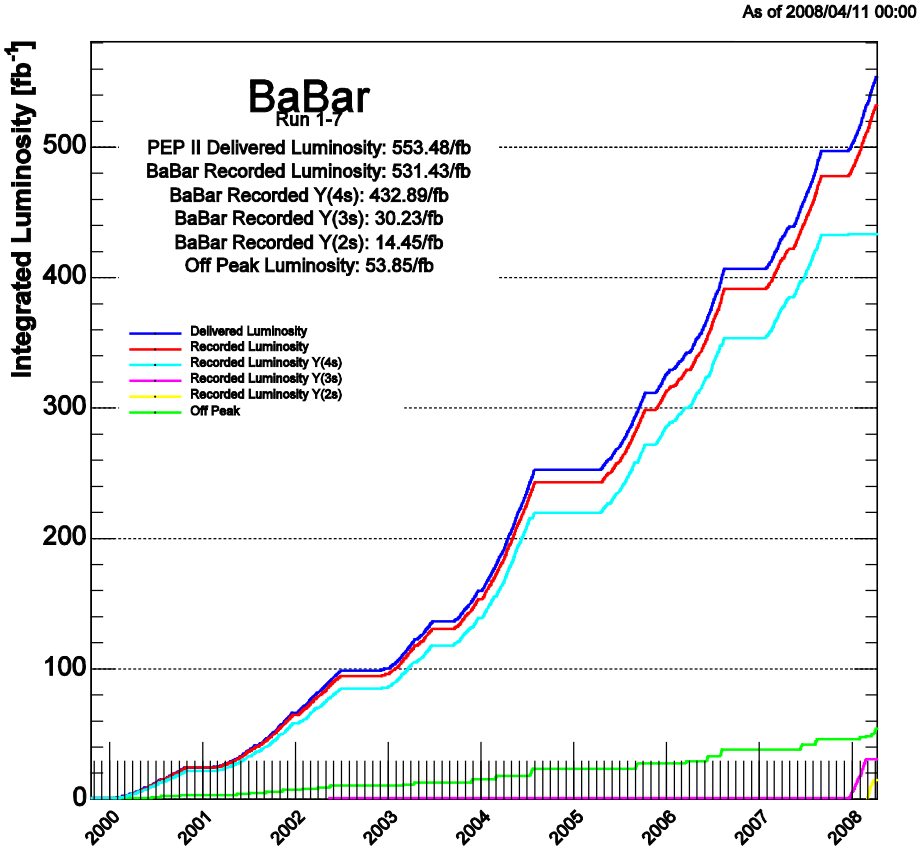


All of measurements discussed stats-limited: looking forward to LHCb and/or SuperB(elle) sheding further light on these issues!

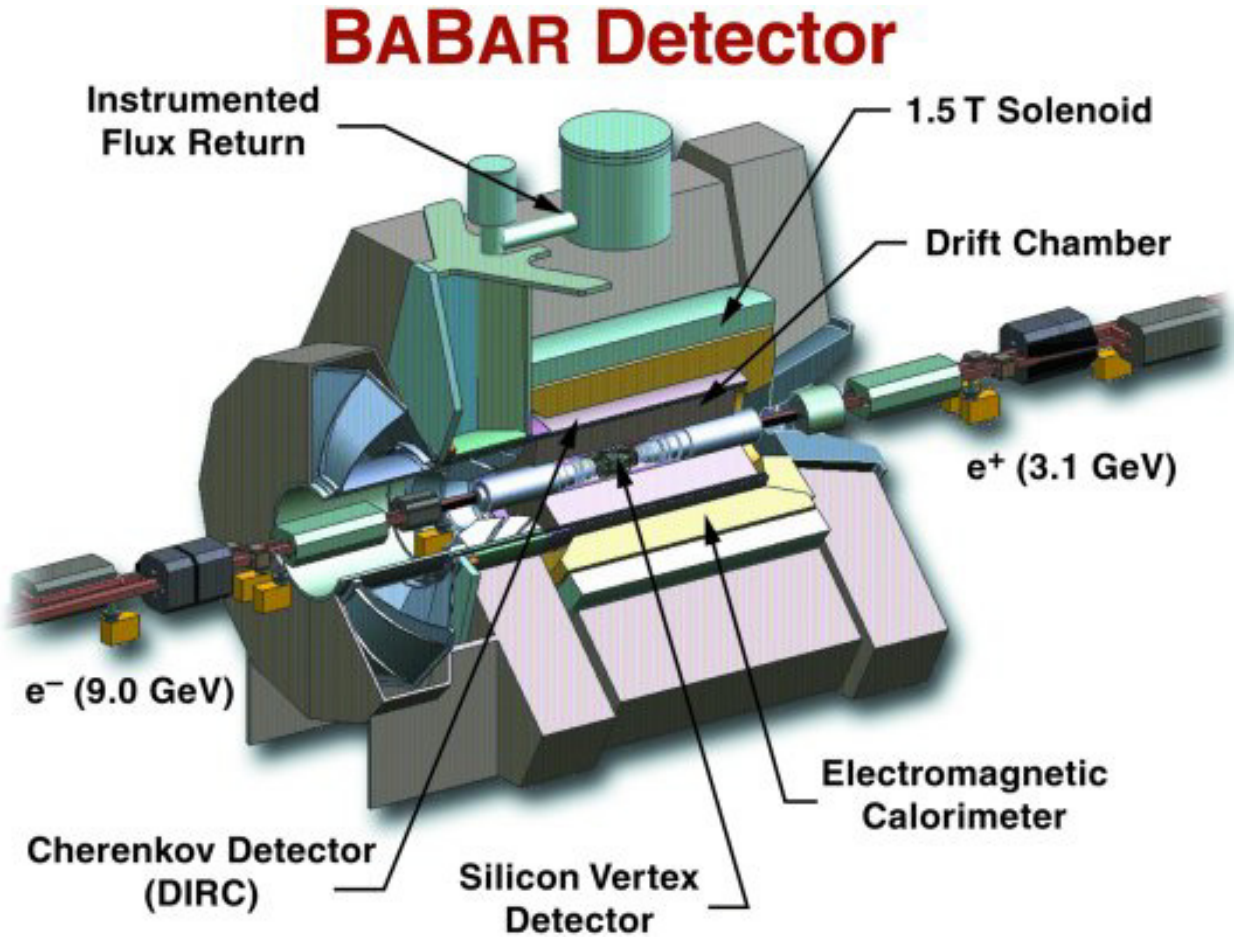
BACK UP SLIDES

Collected data





The BaBar experiment



- Asymmetric energies: boost $\beta\gamma = 0.56$
- $\sqrt{s}$ = 10.58 GeV = m(Y(4S)) ≈ 2 m(B^0) so $e^+e^- \rightarrow Y(4S) \rightarrow B\bar{B}$
- SVT: 100μm resolution in $\Delta z \sim \beta\gamma c\tau = 250$ μm
- SVT: good eff for low p_t tracks
- PID from DIRC essential for tagging
- Belle experiment similar

$b \to s\gamma$

- SM: BF = $(3.15 \pm 0.23) \times 10^{-4}$ (Misiak et al)

  BF = $(2.98 \pm 0.26) \times 10^{-4}$ (Becher & Neubert)

- 2HDM Type II: constructive interference in $b \to s\gamma$, destructive in $B \to \tau\nu$

Outline

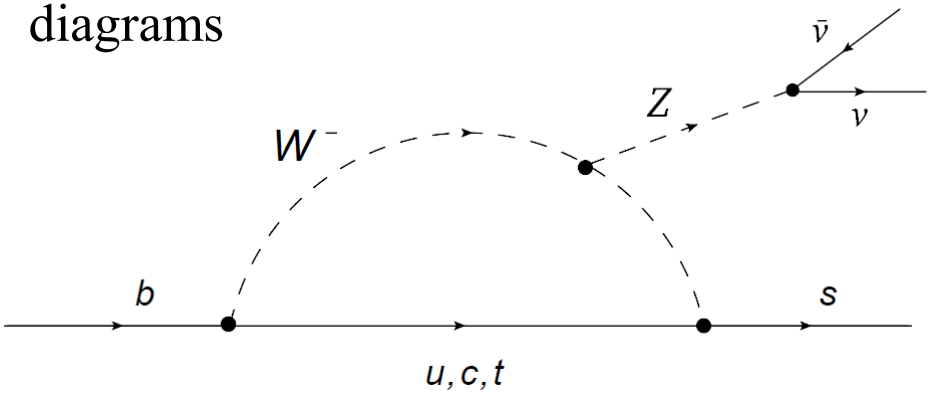
- B-factories: BaBar and Belle
- $b \to s\gamma$ and $b \to s\ell^+\ell^-$
- Leptonic and semi-leptonic B decays
- $b \to s\nu\bar{\nu}$
- « $K\pi$ puzzle »
- LFV in τ decays
- Conclusions

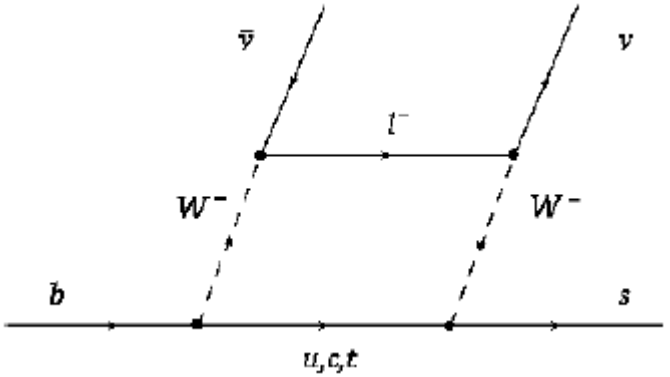
N.B.: will not talk about NP searches in Y(3S), Y(2S) or Y(1S) decays

$b \to s\nu\bar{\nu}$

$b \to s\nu\bar{\nu}$

- Another theoretically very clean mode: also due to electroweak loop diagrams





- Possible NP: MSSM, dark matter models, UED1, unparticle physics…
- Experimentally, same method as $B^+ \to \tau^+\nu$. Discriminating variables: Eextra, m_{miss}^2

Mode	BaBar UL @ 90%CL	Belle UL @ 90%CL	Theory BF
$B^+ \to K^+\nu\nu$	$< 4.5 \times 10^{-6}$	$< 14 \times 10^{-6}$	$(4.5 \pm 0.7) \times 10^{-6}$
$B^+ \to K^{*+}\nu\nu$	$< 8 \times 10^{-5}$	$< 14 \times 10^{-5}$	$(1.3\ ^{+0.4}_{-0.3}) \times 10^{-5}$
$B^0 \to K^{*0}\nu\nu$	$< 12 \times 10^{-5}$	$< 34 \times 10^{-5}$	

NEW