Weak Decays, CP violation and CKM: Theoretical Status

Gino Isidori [*INFN - Frascati*]

- Introduction: flavour physics within & beyond the SM
- What we learned so far: the global picture
- Looking more closely: some *hints* of deviations from the SM
- What we could still hope to learn in the LHC era
- Conclusions

Introduction: flavour physics within & beyond the SM

Particle physics is described with good accuracy by a simple and *economical* theory:

$$\mathscr{L}_{\mathrm{SM}} = \mathscr{L}_{\mathrm{gauge}}(A_a, \psi_i) + \mathscr{L}_{\mathrm{Higgs}}(\phi, A_a, \psi_i)$$

(Symmetry Breaking)

- *Natural*
- Experimentally tested with high accuracy
- Stable with respect to quantum corrections
- Higly symmetric (*gauge & flavour symmetries*)

- *Ad hoc*
- Necessary to describe data (*clear indication of a non-symmetric vacuum*) but poorly tested in its dynamical form
- Not stable with respect to quantum corrections
- Determine the *flavour structure* of the model

Introduction: flavour physics within & beyond the SM

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$$\mathscr{L}_{\text{eff}} = \mathscr{L}_{\text{gauge}}(A_a, \psi_i) + \mathscr{L}_{\text{Higgs}}(\phi, A_a, \psi_i) + \sum_{d\geq 5} \frac{c_n}{\Lambda^{d-4}} O_n^{(d)}(\phi, A_a, \psi_i)$$

$\mathscr{L}_{\text{SM}}$ = renormalizable part of $\mathscr{L}_{\text{eff}}$
[= all possible operators with $d \leq 4$
compatible with the gauge symmetry]

operators of $d \geq 5$ containing SM fields only and compatible with the SM gauge symmetry

[=most general parameterization of the new (heavy) degrees of freedom, as long as we perform low-energy experiments]

Introduction: flavour physics within & beyond the SM

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new sources of flavour-symmtry breaking that we can explore only with low-energy exps.

Two key questions of particle physics today:

- Which is the energy scale of New Physics → High-energy experiments [*the high-energy frontier*]
- Which is the symmetry structure of the new degrees of freedom → High-precision low-energy exp. [*the high-intensity frontier*]

Introduction: flavour physics within & beyond the SM

Particle physics is described with good accuracy by a simple and *economical* theory. However, this is likely to be only the low-energy limit of a more fundamentaly theory:

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$\downarrow$

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Two key questions of particle physics today:

- Which is the energy scale of New Physics → High-energy experiments [*the high-energy frontier*]

Strong theoretical prejudice that some new degrees of freedom appear around or below 1 TeV to stabilise the electroweak symmetry breaking mechanism

Can we reconcile this expectation with the tight constraints of flavour physics ?

$$\mathscr{L}_{\rm eff} = \mathscr{L}_{\rm gauge}(A_a, \psi_i) + \mathscr{L}_{\rm Higgs}(\phi, A_a, \psi_i) + \sum_{d\geq 5} \frac{c_n}{\Lambda^{d-4}} O_n^{(d)}(\phi, A_a, \psi_i)$$

→ 3 identical replica of the basic fermion family [$\psi_i = Q_L, u_R, d_R, L_L, e_R$]

Large global
flavour symmetry: $U(1)_L \times U(2)_B \times SU(3)_Q \times SU(3)_U \times SU(3)_D \times \ldots$

→ Flavour-degeneracy broken the Yukawa interaction:

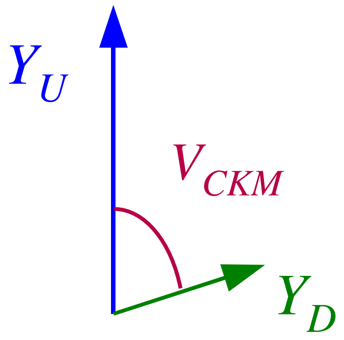
in the quark
sector:

$$\bar{Q}_L^{\,i}\, Y_D^{\,ik}\, d_R^{\,k}\, \phi \;\rightarrow\; \bar{Q}_L^{\,i}\, M_D^{\,ik}\, d_R^{\,k}$$

$$\bar{Q}_L^{\,i}\, Y_U^{\,ik}\, u_R^{\,k}\, \phi_c \;\rightarrow\; \bar{Q}_L^{\,i}\, M_U^{\,ik}\, u_R^{\,k}$$

$$M_D = \mathrm{diag}(m_d, m_s, m_b)$$

$$M_U = \underbrace{V}_{\text{The CKM matrix}} \times \mathrm{diag}(m_u, m_c, m_t)$$



$$\mathscr{L}_{\rm eff} = \mathscr{L}_{\rm gauge}(A_a, \psi_i) + \mathscr{L}_{\rm Higgs}(\phi, A_a, \psi_i) + \sum_{d\geq5} \frac{c_n}{\Lambda^{d-4}} O_n^{(d)}(\phi, A_a, \psi_i)$$

... while we still have a rather limited knowledge of the flavour structure of the new degrees of freedom (which hopefully will show up around the TeV scale)

We have some favourite scenarios, such as

MFV = *assumption that the SM Yukawa couplings are the only non-trivial flavour-breaking terms also beyond the SM*

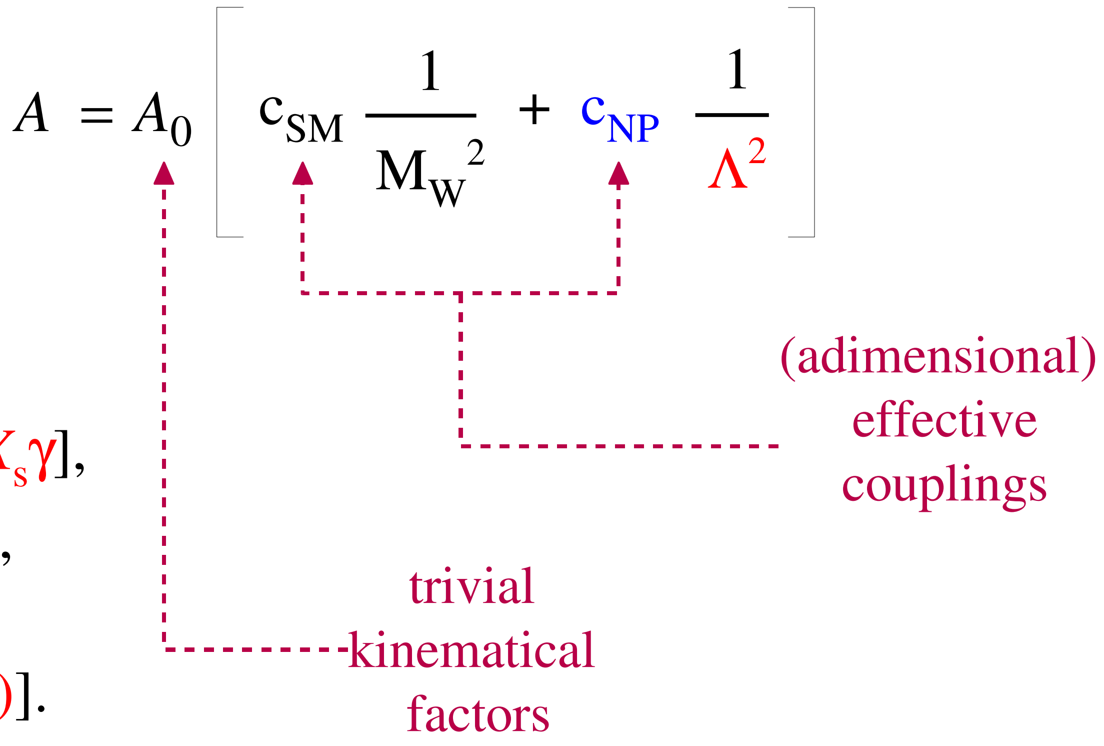
D'Ambrosio, Giudice,
G.I, Strumia, '02

However, at this stage these are still theoretical speculations, far from being clearly established from data

The main goal of flavour physics is trying to understand if there are additional non-trivial flavour breaking terms beside the SM Yukawas

$$\mathscr{L}_{\rm eff} = \mathscr{L}_{\rm gauge}(A_a, \psi_i) + \mathscr{L}_{\rm Higgs}(\phi, A_a, \psi_i) + \sum_{d\geq 5} \frac{c_n}{\Lambda^{d-4}} O_n^{(d)}(\phi, A_a, \psi_i)$$

N.B.: General decomposition of flavour-violating observables:



$$A = A_0 \left[c_{\rm SM} \frac{1}{M_W^{\,2}} + c_{\rm NP} \frac{1}{\Lambda^2} \right]$$

(adimensional) effective couplings

trivial kinematical factors

This decomposition is very general.
It holds for rare FCNC decays [B→$X_s\gamma$],
but also forbidden processes [μ→eγ],
charged currents [B→*l*ν],
and CPV observables [$A_{CP}(B_d \to \psi K)$].

It is based only on the assumption that the new degrees of freedom respect the $SU(2)_L \times U(1)$ gauge symmetry ⇒ no relevant d=5 effective ops

$$\mathcal{L}_{\rm eff} = \mathcal{L}_{\rm gauge}(A_a, \psi_i) + \mathcal{L}_{\rm Higgs}(\phi, A_a, \psi_i) + \sum_{d\geq5} \frac{c_n}{\Lambda^{d-4}} O_n^{(d)}(\phi, A_a, \psi_i)$$

N.B.: General decomposition of flavour-violating observables:

$$\Gamma \propto \left| c_{SM} \frac{1}{M_W^2} + c_{NP} \frac{1}{\Lambda^2} \right|^2$$

↓

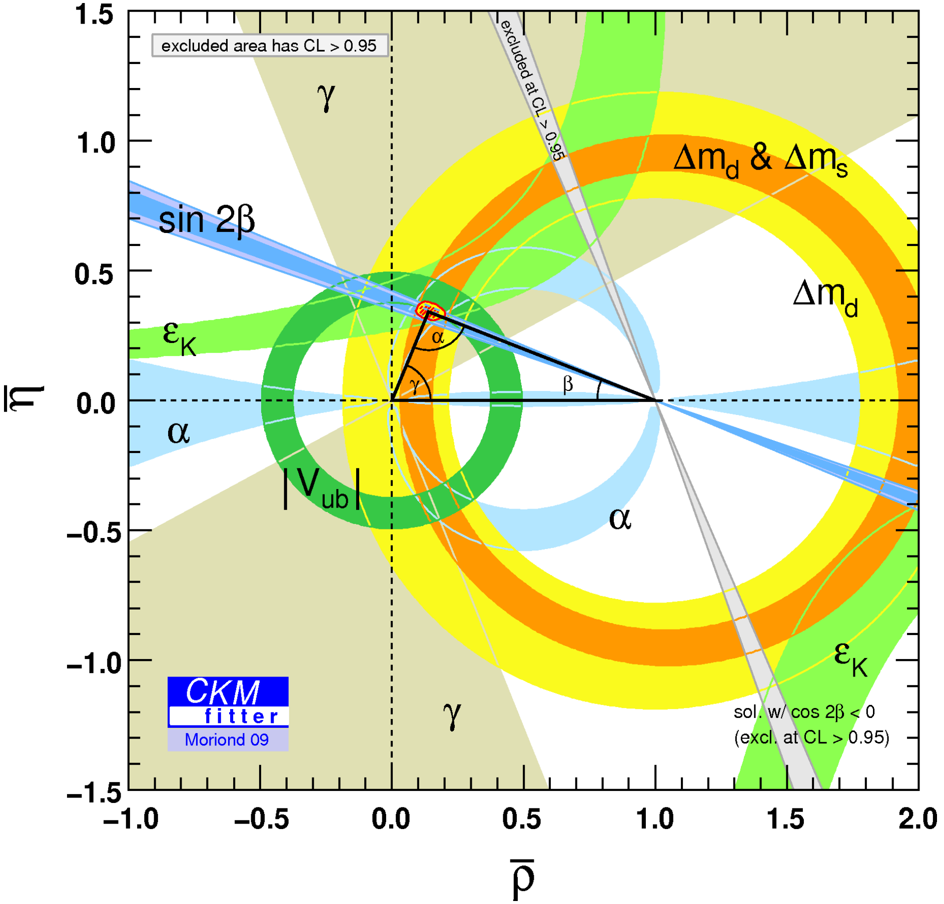
- The sensitivity to the energy scale grows slowly with the statistics or the luminosity of the experiment ($\sigma \sim 1/N^{1/4}$) ⇒ new exps. should be ambitious...
- The interest of a given flavour obs. depends on the magnitude of c_{SM} vs. c_{NP} and on the theoretical error of c_{SM} ⇒ ...concentrate on clean & rare processes...
- No way to disentangle Λ & c_{NP}, but the combined information which can be extracted is fully complementary to direct searches at high-p_T: flavour symmetry structure of NP ⇒ ...and should not worry too much about the LHC

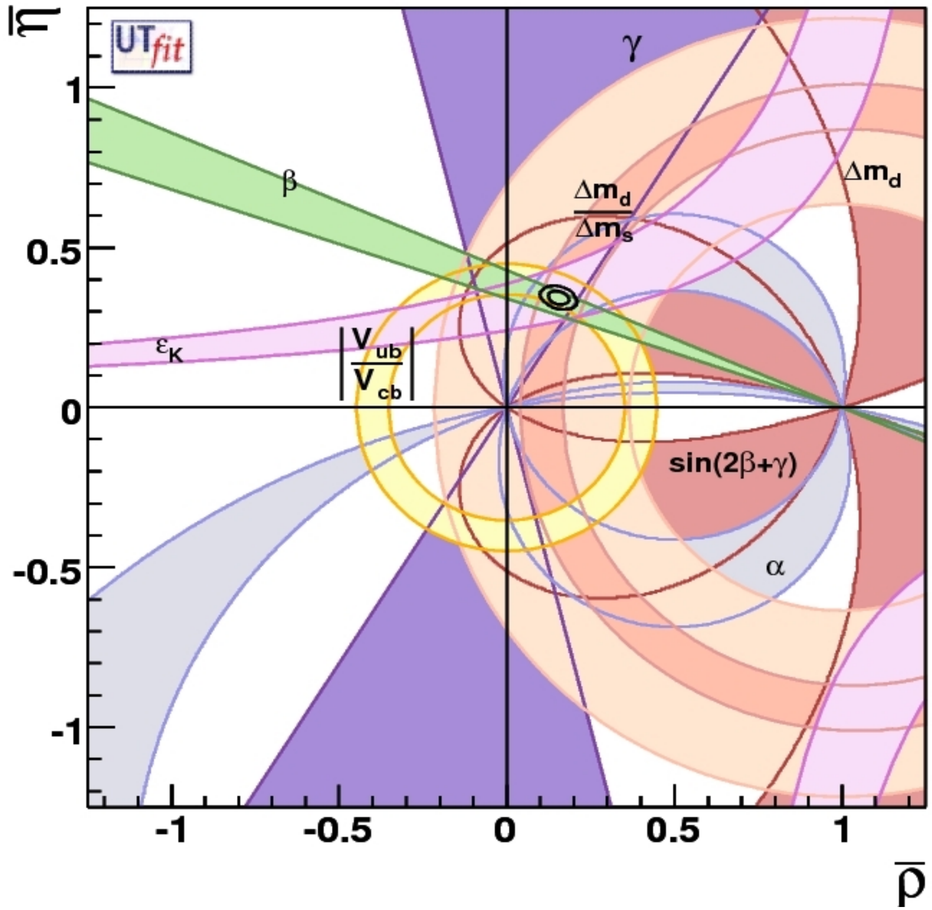
What we learned so far: the global picture

The SM is very successful in describing quark-flavour mixing !

Good consistency of the experimental constraints appearing in the so-called CKM fits [slight tension between sin(2β) and V_{ub} not very significant]

+ several observables not shown in such fits pointing in the same direction.

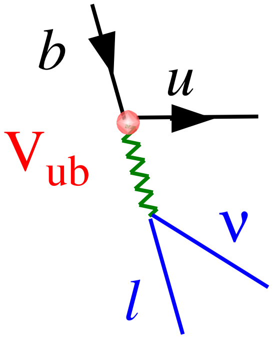




I. *The CKM fits* [constraints in the ρ-η plane]

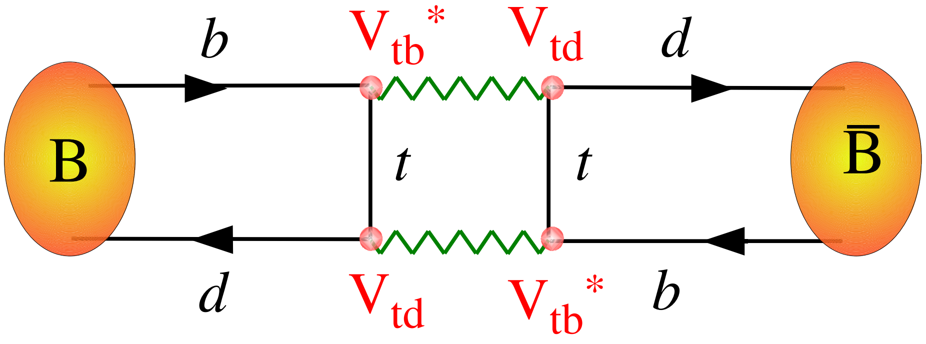
The most remarkable aspects of such fits is the consistency between tree-level constraints on the CKM matrix and those of ΔF=2 observables:

Tree-level semilptonic decays



vs.

ΔF =2 neutral-meson mixing

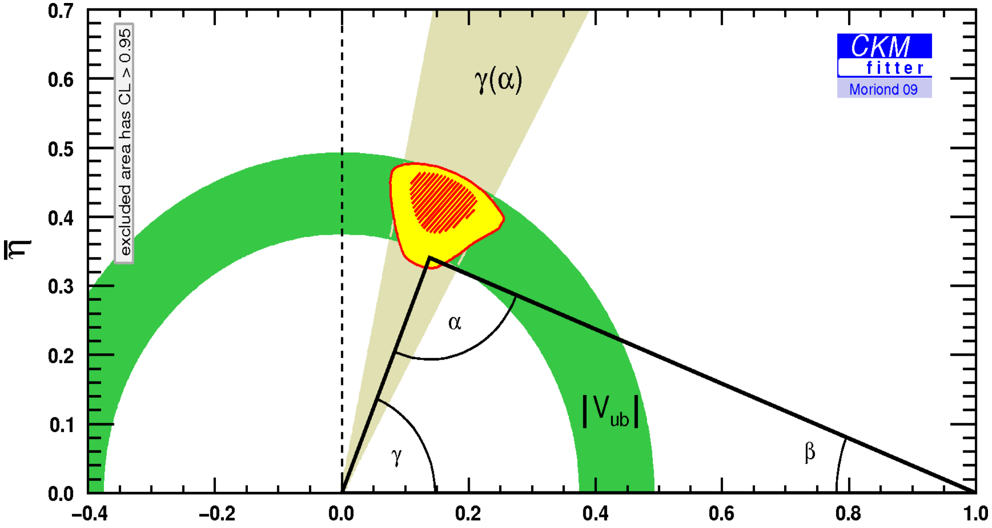


$$\Rightarrow \quad \frac{(y_t V_{tb}^* V_{td})^2}{16\,\pi^2 M_W^2}$$

Highly suppressed amplitude potentially more sensitive to New Physics

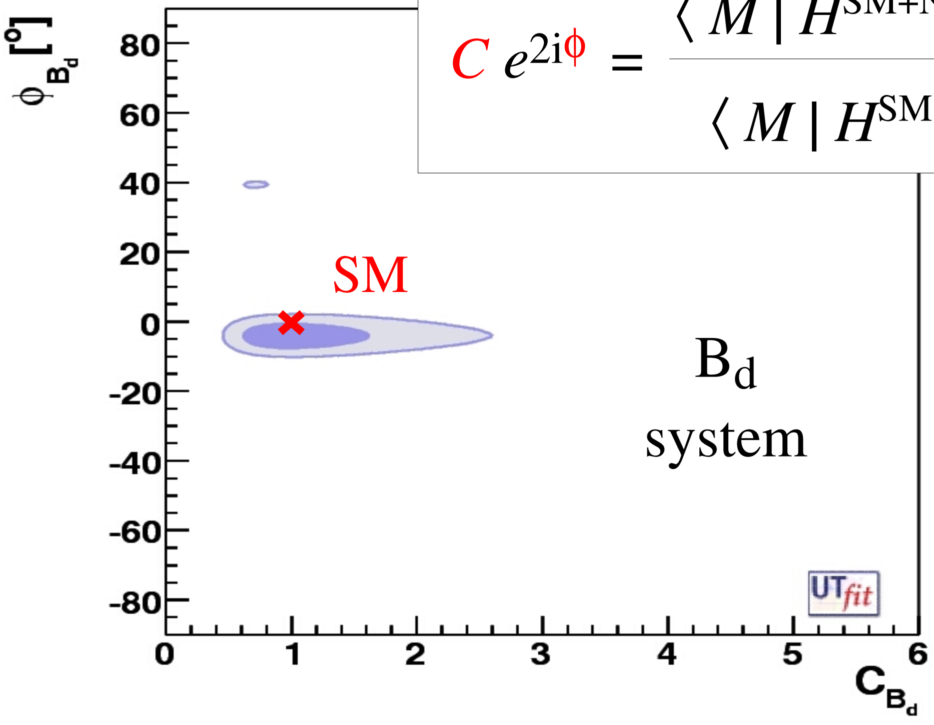
I. *The CKM fits* [constraints in the ρ-η plane]

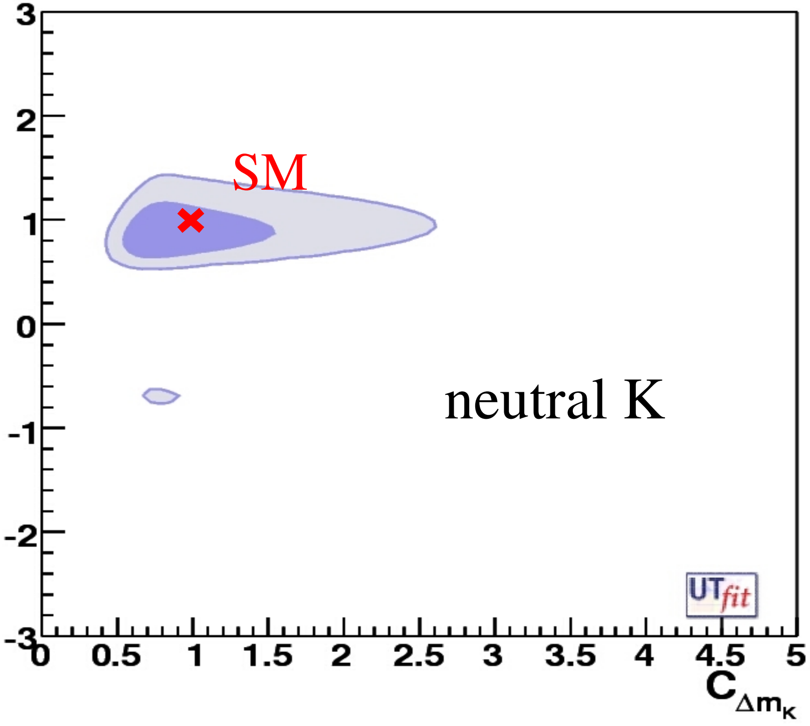
CKM unitarity triangle using only tree-level dominated amplitudes →



General fit of NP in ΔF=2 amplitudes

$$C\,e^{2i\phi} = \frac{\langle M \,|\, H^{\rm SM+NP} \,|\, \bar{M} \rangle}{\langle M \,|\, H^{\rm SM} \,|\, \bar{M} \rangle}$$





I. The CKM fits [constraints in the ρ-η plane]

These results are quite instructive if interpreted as bounds on the scale of new physics:

$$M(B_d\text{-}\bar{B}_d) \sim \frac{(V_{tb}{}^{*}V_{td})^2}{16\,\pi^2\,M_w{}^2} + \boxed{c_{NP}\,\frac{1}{\Lambda^2}}$$

contrbution of the new heavy degrees of freedom

$$\begin{tikzcd}[column sep=small]
 & \sim 1 \arrow[r, "\text{tree/strong + generic flavour}"] & \Lambda \gtrsim 2\times10^4\ \text{TeV [K]} \\
 & \sim 1/(16\,\pi^2) \arrow[r, "\text{loop + generic flavour}"] & \Lambda \gtrsim 2\times10^3\ \text{TeV [K]} \\
c_{NP} \arrow[ruu] \arrow[ru] \arrow[r] \arrow[rd] & \sim (V_{ti}{}^{*}V_{tj})^2 \arrow[r, "\text{tree/strong + MFV}"] & \Lambda \gtrsim 5\ \text{TeV [K \& B]} \\
 & \sim (V_{ti}{}^{*}V_{tj})^2/(16\,\pi^2) \arrow[r, "\text{loop + MFV}"] & \Lambda \gtrsim 0.5\ \text{TeV [K \& B]}
\end{tikzcd}$$

MFV (or something very similar at least for *s→d* & *b→d*), is mandatory if we want to keep Λ in the TeV range

II. *Rare decays*

Good agreement with SM expectations is found also in rare FCNC ΔF=1 decays. Most remarkable example: $B \to X_s \gamma$

Most accurate SM th. estimate:

$$B(B \to X_s\gamma) = (3.15 \pm 0.23) \times 10^{-4}$$

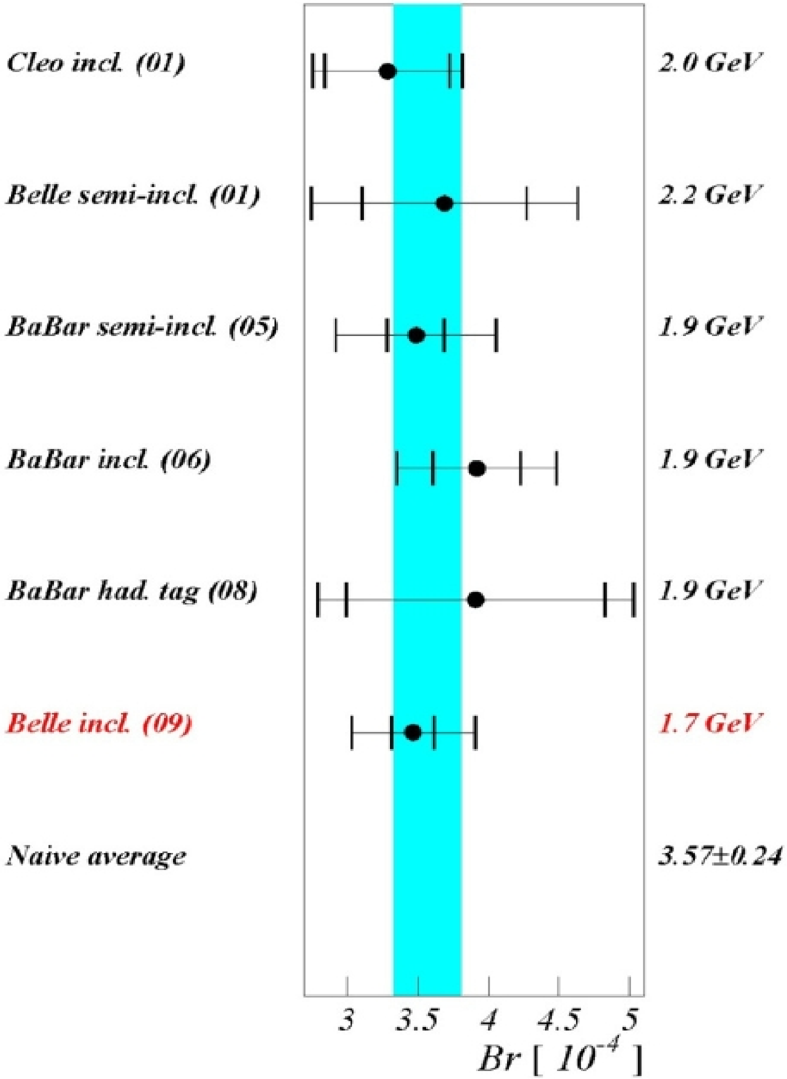
[Misiak *et al.* '07]

- NNLO perturbative calculation
- Inclusive non-pert. effects using HQET
- E_γ cut controlled by shape-function analysis
- Hard (impossible ?) to improve further in the near future...

To be compared with:

$$B(B \to X_s\gamma) = (3.57 \pm 0.24) \times 10^{-4}$$

[2009 exp. WA]



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[Misiak *et al.* '07]

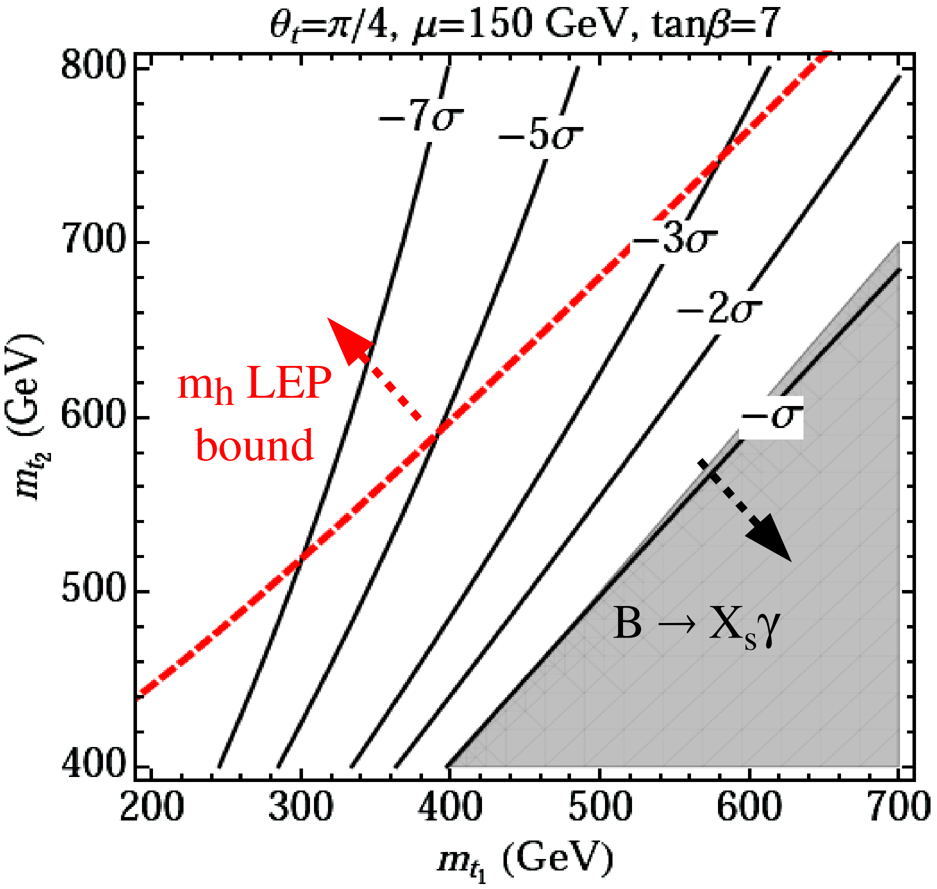
One of the most significant constraint in many SM extensions (*with MFV as stringent as EW precision observables*)

To be compared with:

$$\mathcal{B}(B \to X_s\gamma) = (3.57 \pm 0.24)\times 10^{-4}$$

[2009 exp. WA]

E.g.: *contraints on the stop sector of the MSSM*
[with MFV & heavy gauginos]



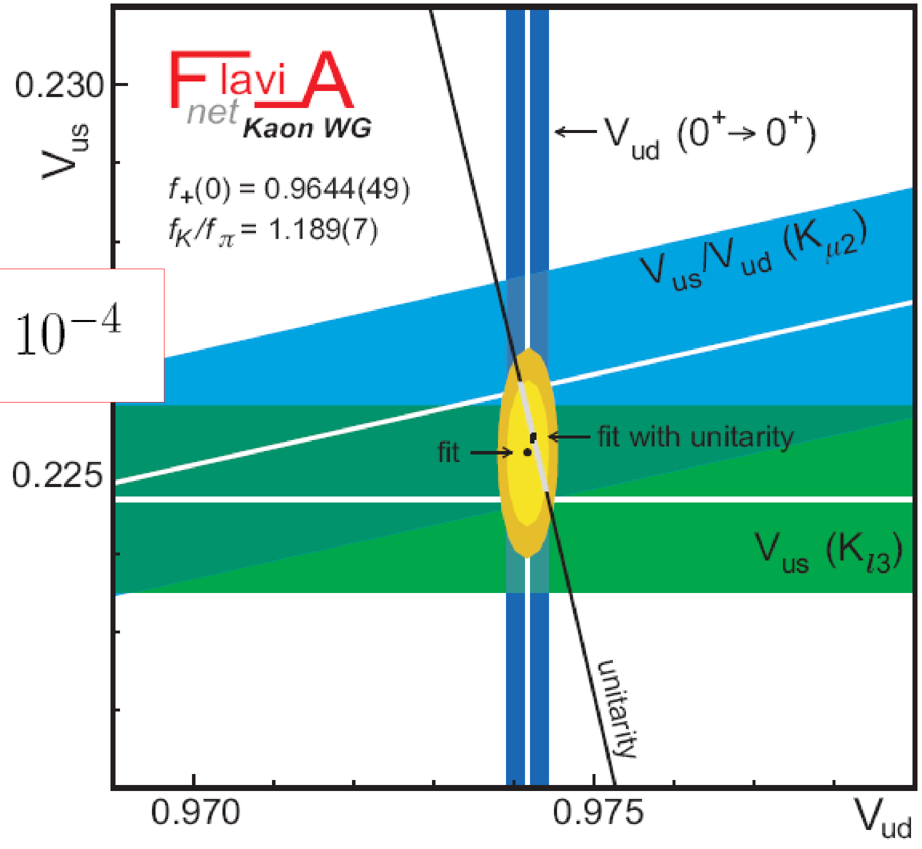
Barbieri & Pappadopulo '09

III. *Vus & CKM Unitarity*

An impressive progress has been obtained also in testsing charged-current interactions:

$$|V_{ud}|^2 + |V_{us}|^2 + \cancel{|V_{ub}|^2} - 1 \; = \; (-1 \pm 6) \times 10^{-4}$$

few 0.1% error !



See talk by M. Moulson tomorrow

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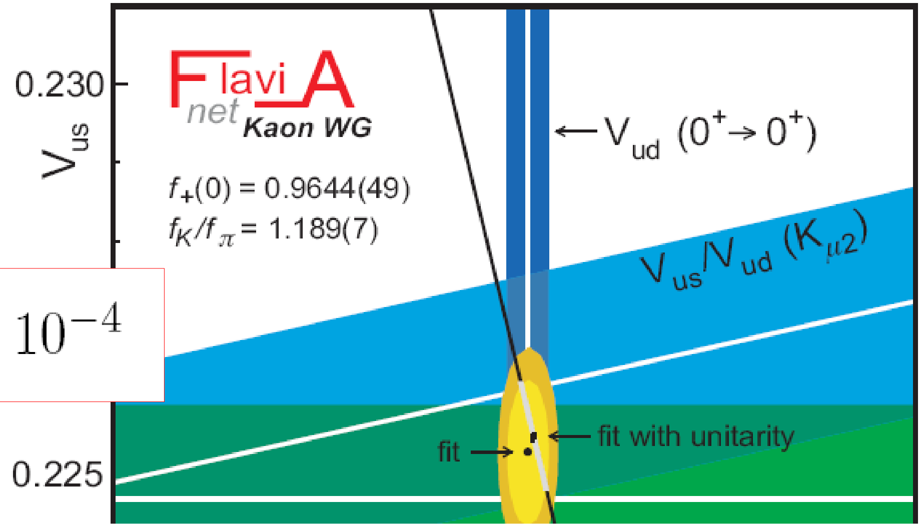


$$|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2 - 1 \;=\; (-1 \pm 6) \times 10^{-4}$$

Very challenging for all extensions of the SM predicting some breaking of universality between quarks & leptons (*strong e.w. symm. breaking*, *extra dim....*)

$$\mathscr{L}_{\text{c.c.-eff.}} = G_F^{CKM}\,(\bar{U}_L \gamma_\mu D_L)\,(\bar{l}_L \gamma_\mu \nu_L) \;+\; G_F^{(\mu)}\,(\bar{\nu}_L \gamma_\mu l_L)\,(\bar{l}_L \gamma_\mu \nu_L) \;+ \dots$$

$$G_F^{CKM} = G_F^{(\mu)}\,[\,|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2\,]^{(1/2)}$$

$$G_F^{CKM} - G_F^{(\mu)} = \frac{c^{(i)}}{\Lambda^2}$$

bounds on Λ of several TeV

See e.g. Cirigliano *et al.* '09

Looking more closely: some hints of deviations from the SM

Looking more closely, there are also a few observables where the agreement with the SM is not so good, such as

- $A_{FB}(B \to K^* l^+ l^-)$, CPV in B_s mixing, $B \to \tau \nu$
- Non-leptonic direct CPV ($B^\pm \to K^\pm \pi^0$ vs. $B^\pm \to K^0 \pi^\pm$)
- Time-dependent CPV in b→s penguin modes

But we are still far from claiming serious discrepancies either because of limited statistics, or because of uncontrolled/underestimated theory errors, or because of both...

I. $A_{FB}(B\to K^* l^+ l^-)$

$$A_{FB} = \int \frac{d^2 B(B\to K^* \mu^+ \mu^-)}{ds\, d\cos\theta}\, sgn(\cos\theta) \quad \propto \quad \Re\left\{C_{10}^*\left[s C_9 + r(s) C_7\right]\right\}$$

θ = angle between μ^+ & B momenta
in the dilepton rest frame

q^2 = dilepton inv. mass
$s = q^2/M_B^2$

- Direct access to the *relative phases* of the Wilson coeff.
- Proportional to C_{10} (interf. of axial & vector currents)
- Uncertainties of hadronic form factors under control in the low-q^2 region (pQCD, sum-rules)

Beneke, Feldmann, Seidel '01

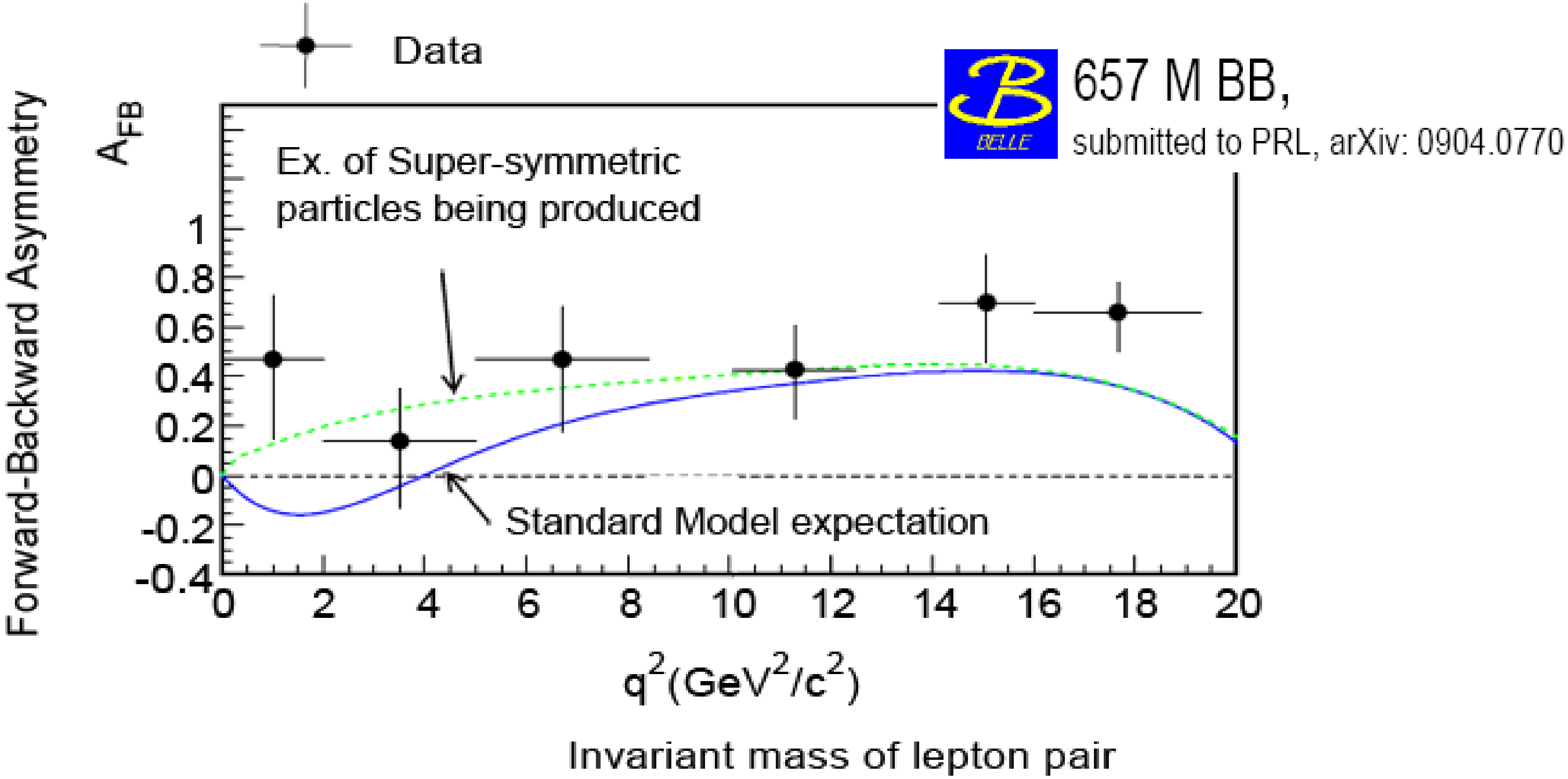
⬇

Sensitive test of various realistic extensions of the SM
(e.g. non-standard Zbs effective coupling)

Ali *et al.* '00; Buchalla *et al.* '01
[...] Altmannshofer *et al.* '09

I. $A_{FB}(B\to K^* l^+ l^-)$

Belle has just reached an interesting sensitivity on this observable:



Ex. of Super-symmetric particles being produced

Standard Model expectation

Invariant mass of lepton pair

657 M BB,

submitted to PRL, arXiv: 0904.0770

I. $A_{FB}(B\to K^{*}l^{+}l^{-})$

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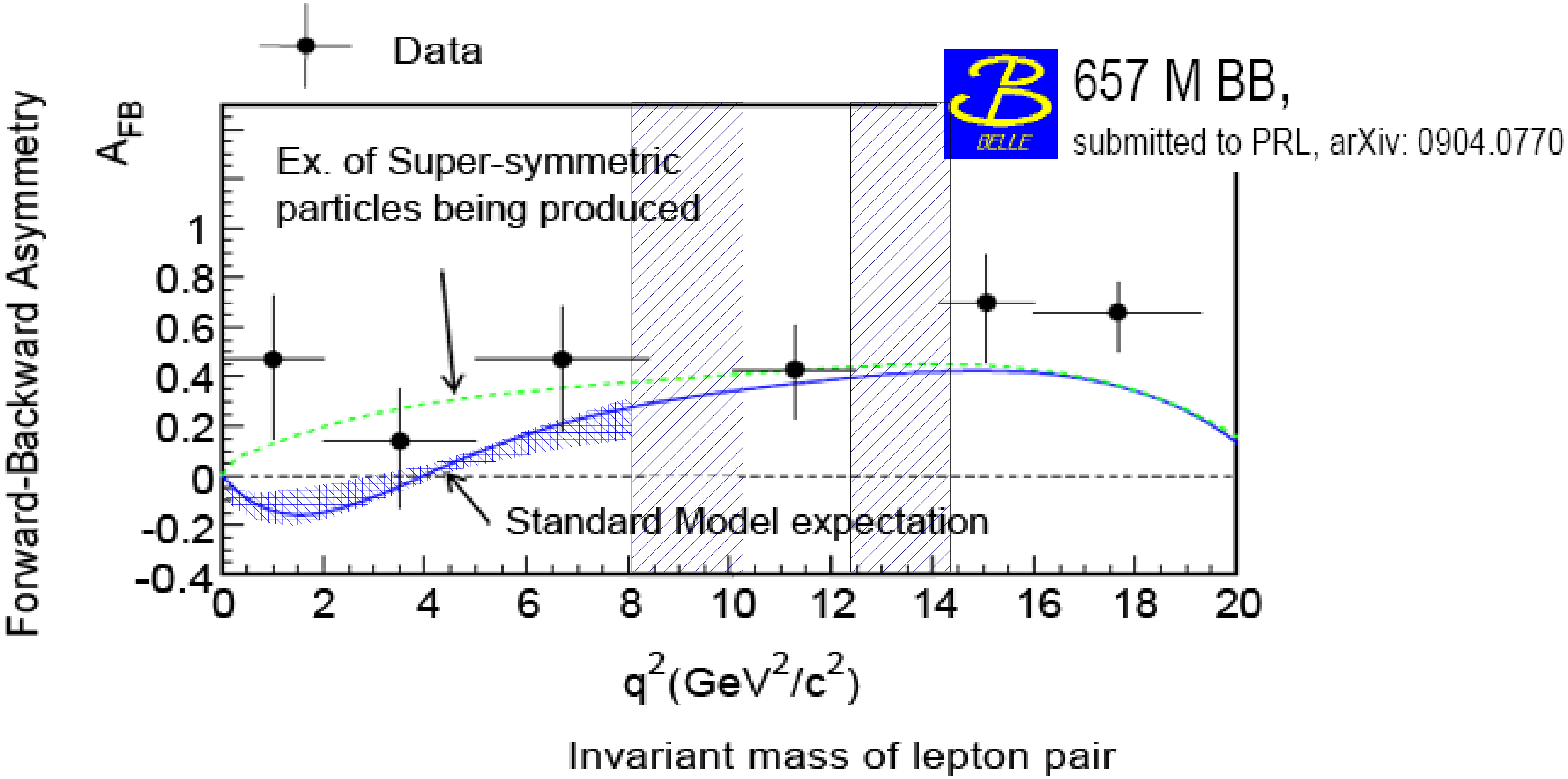


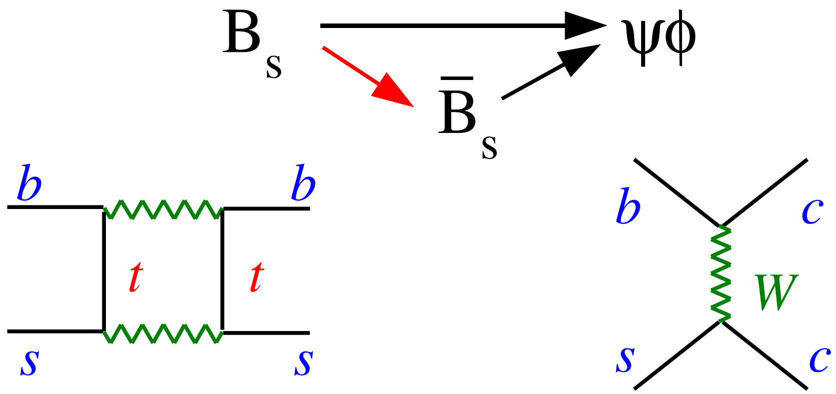
The agreement with SM expectations is not perfect...

...but claiming a significant deviation is definitely premature !

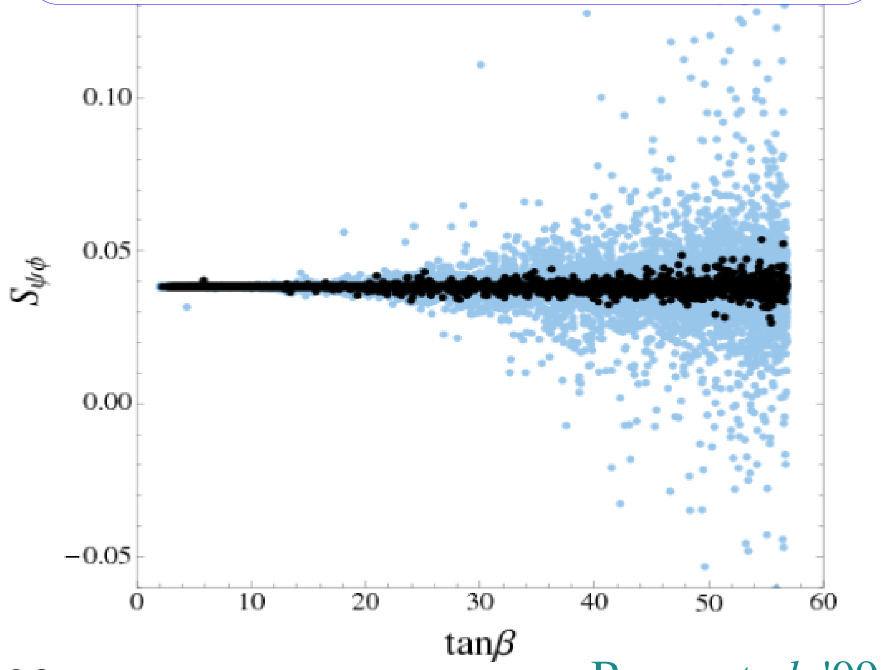
II. CPV in B_s mixing

The weak phase of B_s mixing is the last missing ingredients about down-type $\Delta F=2$ transitions [K, B_d, B_s]: a key element to understand if there is room for new sources of flavour symmetry breaking.

Theoretical clean extraction via $B_s \to \psi\phi$ [$b+s \to c\bar{c}s+s$]



A non-zero CP asym. in $B_s \to \psi\phi$ rules out both SM and MFV



Buras *et al.* '09

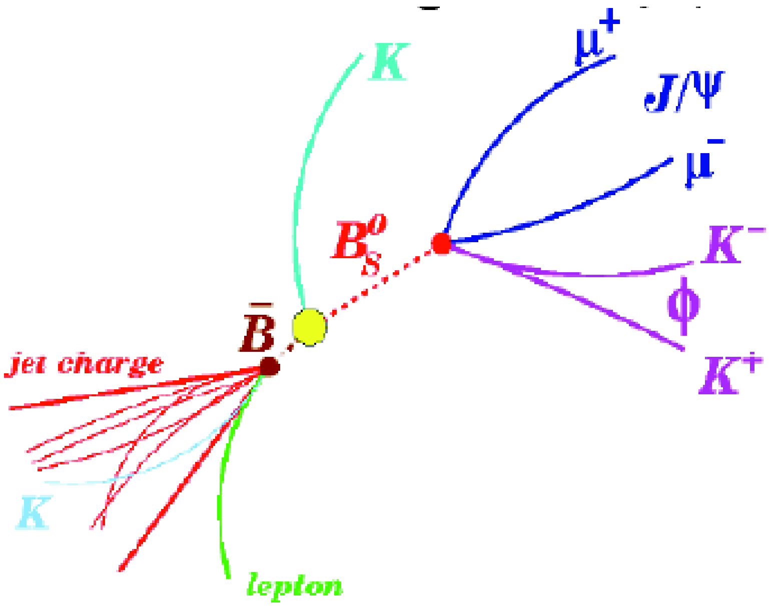
Experimentally quite challenging:

- Fast oscillations
- Non-trivial angular analysis
- Simultaneous fit of $\Delta\Gamma_s$ and the mixing phase

II. CPV in B_S mixing

1. Reconstruct decays from stable products:
   - $B_s \to J/\Psi[\mu^+\mu^-]\ \Phi[K^+K^-]$
   - $B_d \to J/\Psi[\mu^+\mu^-]\ K^{*0}[K^+\pi^-]$ (control sample)

2. Measure lifetime $ct = m_B * L_{xy}/p_T$
   - Proper time resolution essential to resolve oscillations

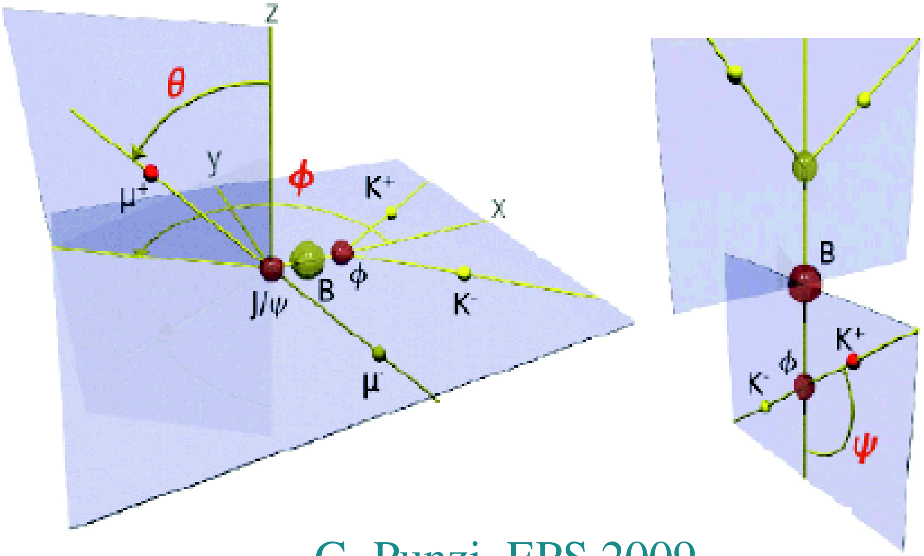


3. Measure decay angles in transversity base:

$$\vec{w} = (\vartheta, \phi, \psi)$$

4. Identify Bs flavor at production time:
   - Flavor Tagging (Tag decision ξ)

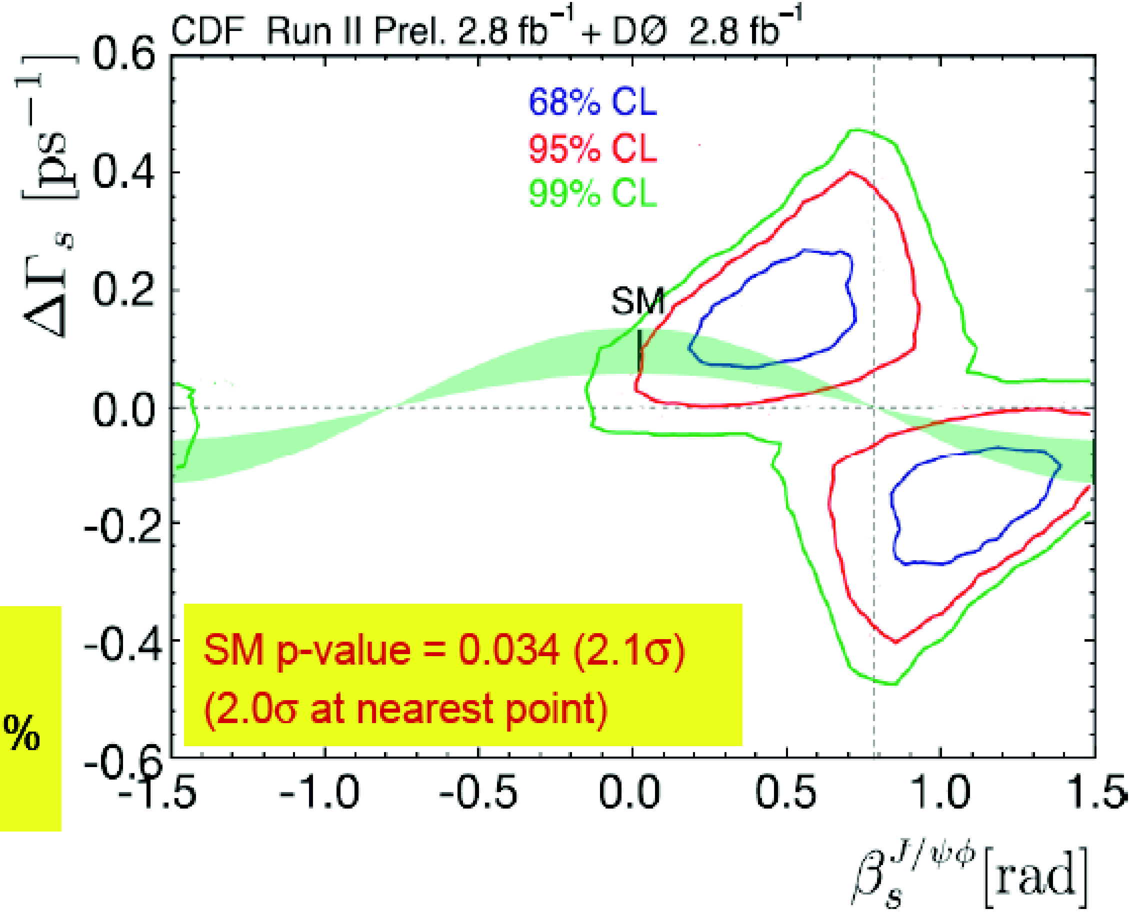
5. Perform maximum likelihood fit:
   - Likelihood in m, ct, w , ξ



G. Punzi, EPS 2009

Combined Tevatron result *(NEW)*

- Full inclusion of systematics and non-Gaussian effects
- No constraints. Make available to combination groups.



SM p-value = 0.034 (2.1σ)
(2.0σ at nearest point)

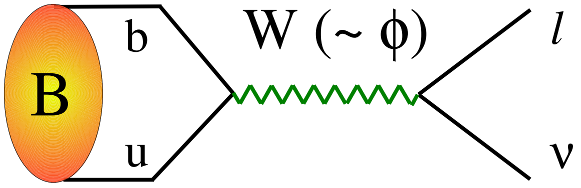
$\beta_s^{J/\psi\phi}$ range:
[0.27,0.59] U [0.97,1.30] @68%
[0.10,1.42] @95%

- Compared to HFAG 2008:
  Larger CDF sample + Better accounting for tails ⇒ same level of SM agreement.
- Both CDF and D0 currently working on **2x** samples.
- Expect improved precision by ***simultaneous fit*** of CDF and D0 samples.

G. Punzi, EPS 2009

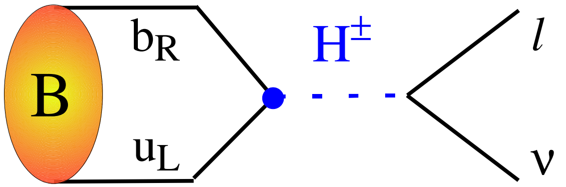
III. B(B→τν)

The helicity suppression of the SM amplitude makes B→τν an excellent probe of models with 2 Higgs doublets (such as the MSSM):



longitudinal comp. of the W

$$B(B\to l\nu) = \underbrace{B_{SM}}_{C_0\, f_B^2\, |V_{ub}|^2} \left(1 - \frac{m_B^2 \tan\beta^2}{M_H^2 (1 + \epsilon_0 \tan\beta)} \right)^2$$



extra tree-level contribution
simple M_H & $\tan\beta$ dependence

up to ~ 30% (negative) correction in the MSSM at large tanβ

Very clean test of the SM, provided we have reliable independet infos on f_B & V_{ub}

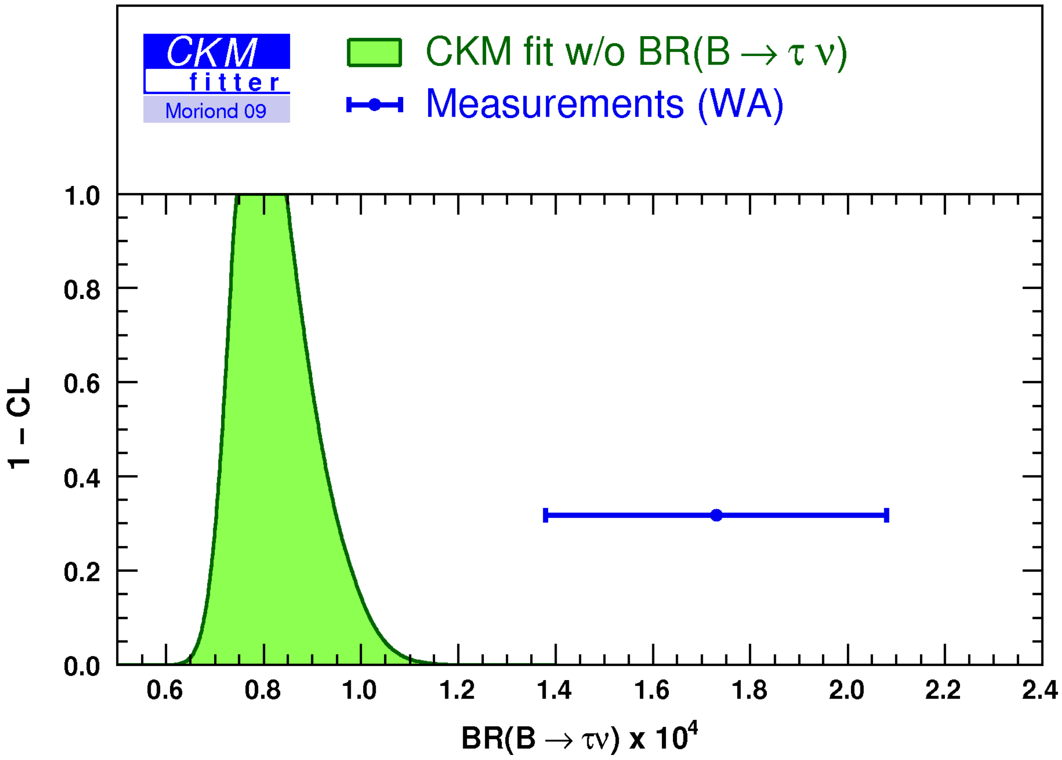
III. B(B→τν)

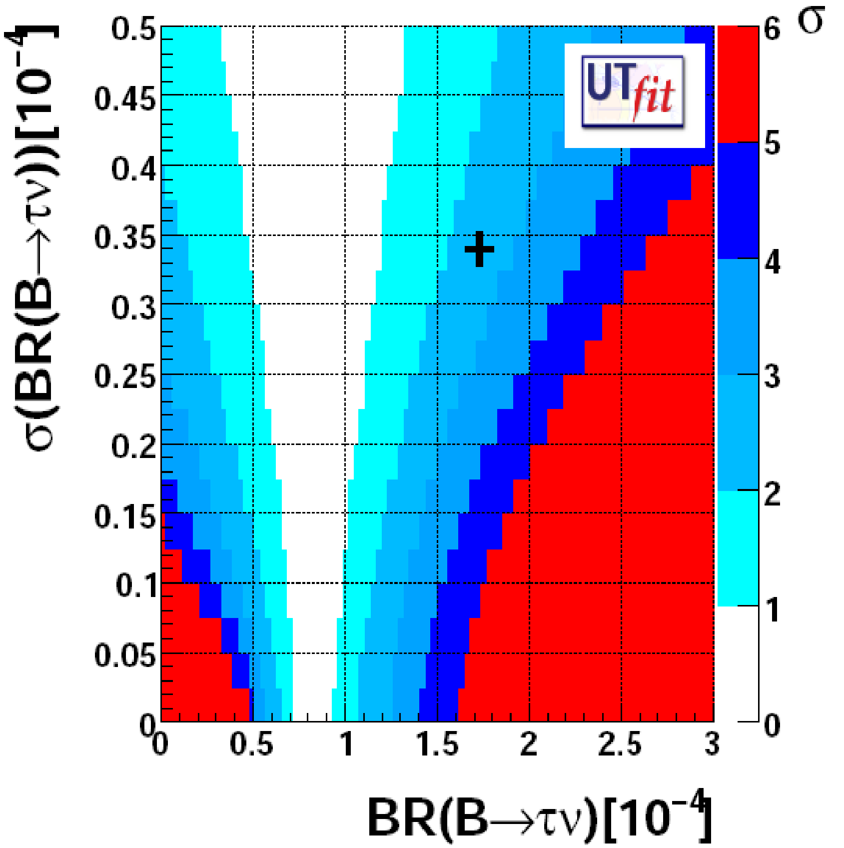
$\mathrm{B}(B \to \tau\nu)_{\mathrm{exp}} = (1.73 \pm 0.34)\times 10^{-4}$ Babar + Belle '09

$(0.88 \pm 0.11)\times 10^{-4}$ UTfit '09 – global SM fit [5% error on f_b ! - very dangerous]

$\mathrm{B}_{\mathrm{SM}} =$ $(0.98 \pm 0.24)\times 10^{-4}$ UTfit '09 – no global fit [$f_b = 200 \pm 20$]

$(1.14 \pm 0.28)\times 10^{-4}$ [V_{ub} from UTfit '09 + $f_b = 216 \pm 21$ HPQCD '05]





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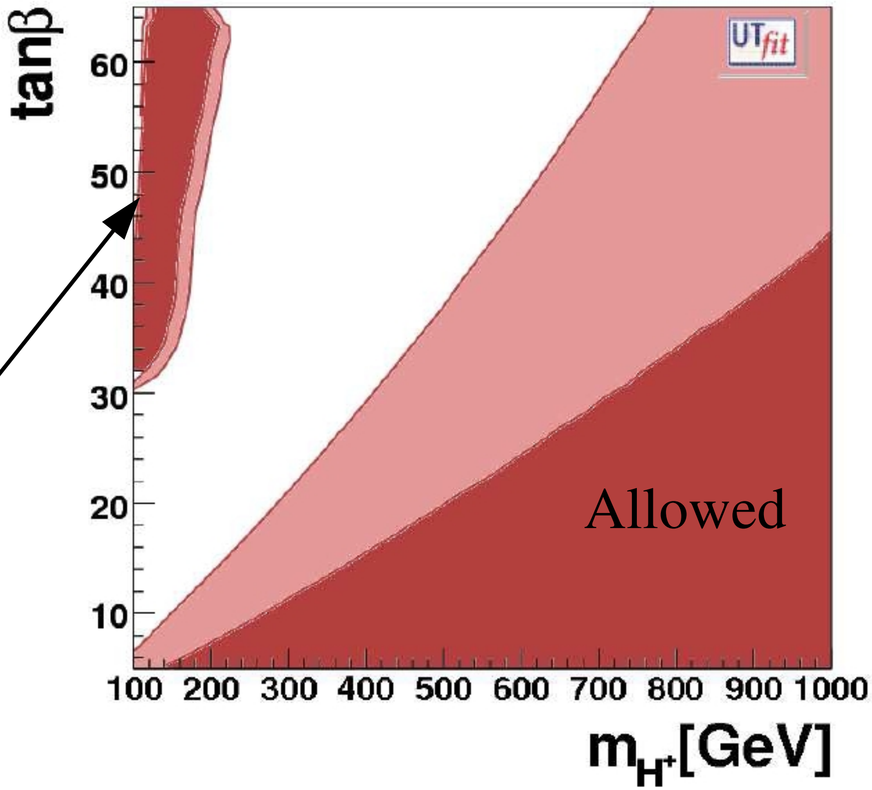
Once more, it is too early to claim new physics...

...but it is certainly a stringent constraint on 2HDM & MSSM at large tanβ, with great potential of improvement in the future



Fine-tuned area with large B($B\to\tau\nu$) [excluded by $K\to\mu\nu$]

What we could still hope to learn

General arguments:

- Future experiments should be ambitious...
- ...concentrate on clean & rare processes...
- ...and should not worry too much about what will happen at the LHC

A closer look to three particulary relevant sectors:

LFV in charged leptons

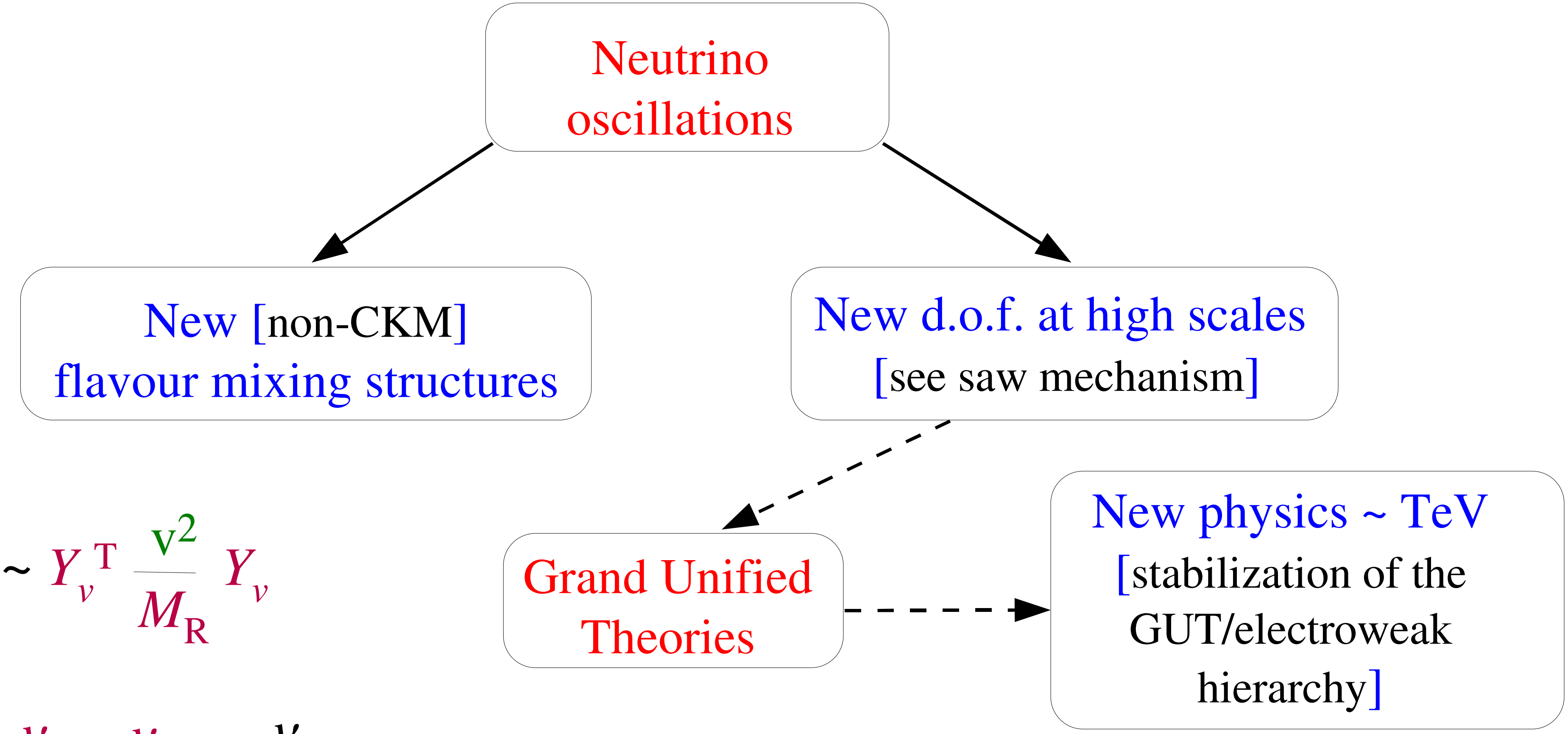
Very rare K decays

Rare B decays

N.B.: This choice reflects some theoretical prejudicies
(and the limited time...)

I. *Lepton Flavour Violation in charged leptons*

After what we learned from neutrino physics, LFV in charged leptons is probably the most interesting search in the flavour sector:



Neutrino oscillations

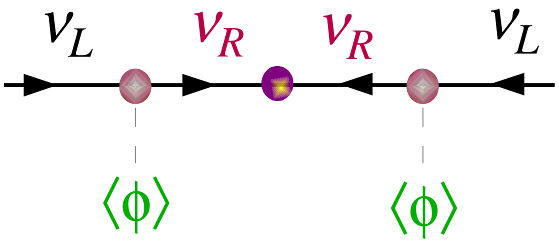
New [non-CKM] flavour mixing structures

New d.o.f. at high scales [see saw mechanism]

Grand Unified Theories

New physics ~ TeV [stabilization of the GUT/electroweak hierarchy]

$$m_\nu \sim Y_\nu^{T} \frac{v^2}{M_R} Y_\nu$$



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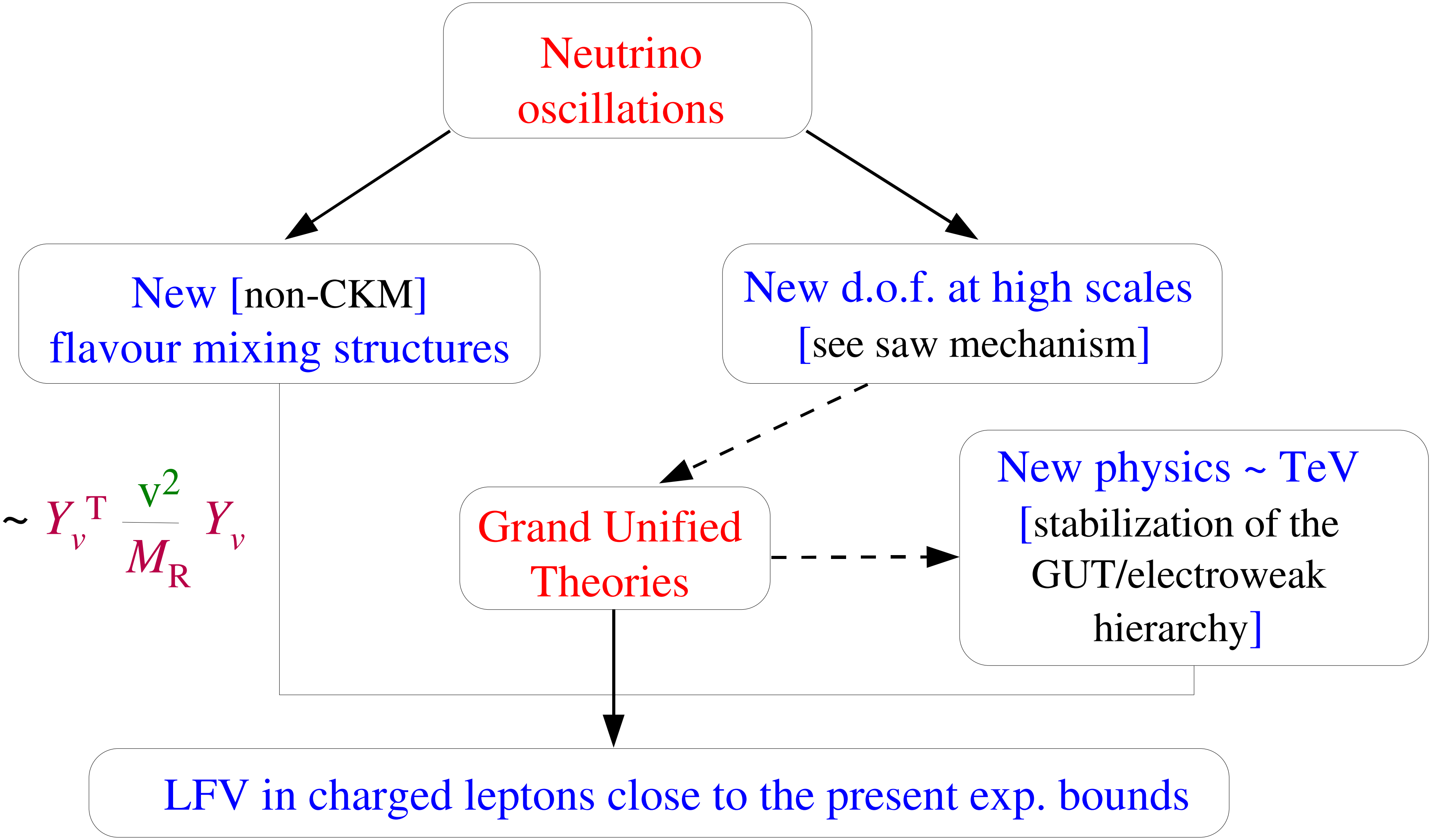

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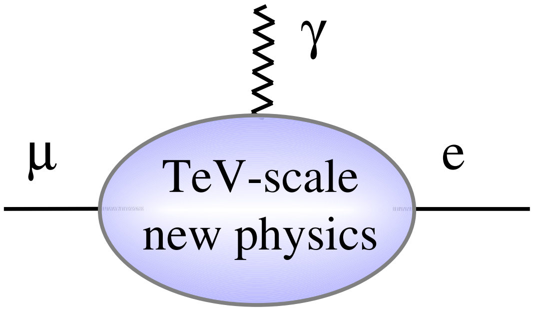
LFV in charged leptons close to the present exp. bounds

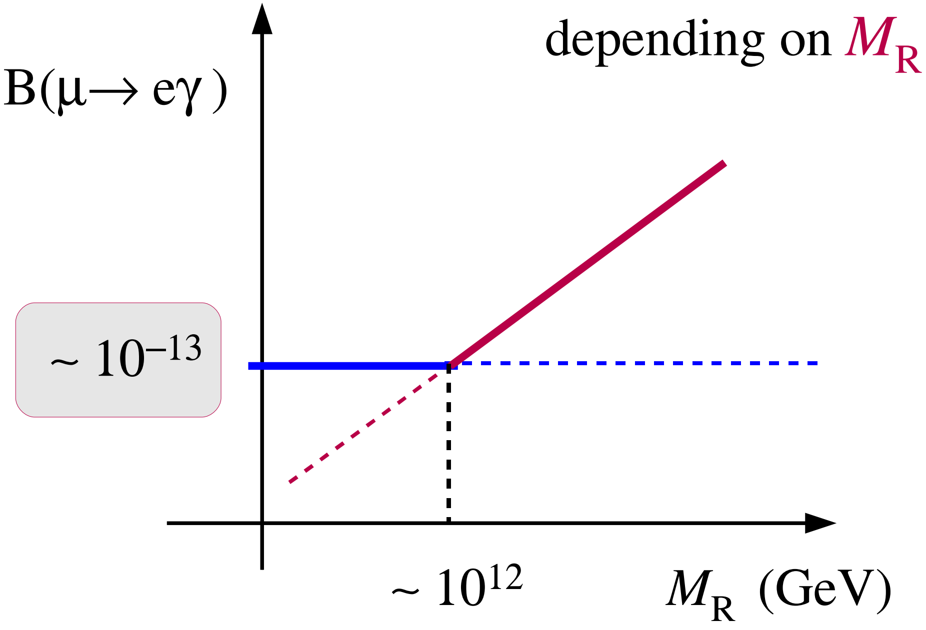
In non-GUT theories we can arbitrarily suppress LFV rates by lowering M_R (or the normalization of Y_ν). This is not possible in GUT frameworks ⇒ contribution from quark Yukawas which are M_R-independent

$$A(l_i \to l_j\, \gamma) = a\, [Y_e\, Y_\nu^{+} Y_\nu]_{ij} + b\, [Y_U^{+} Y_U\, Y_D]_{ij}$$

Normalization depending on M_R

M_R independent





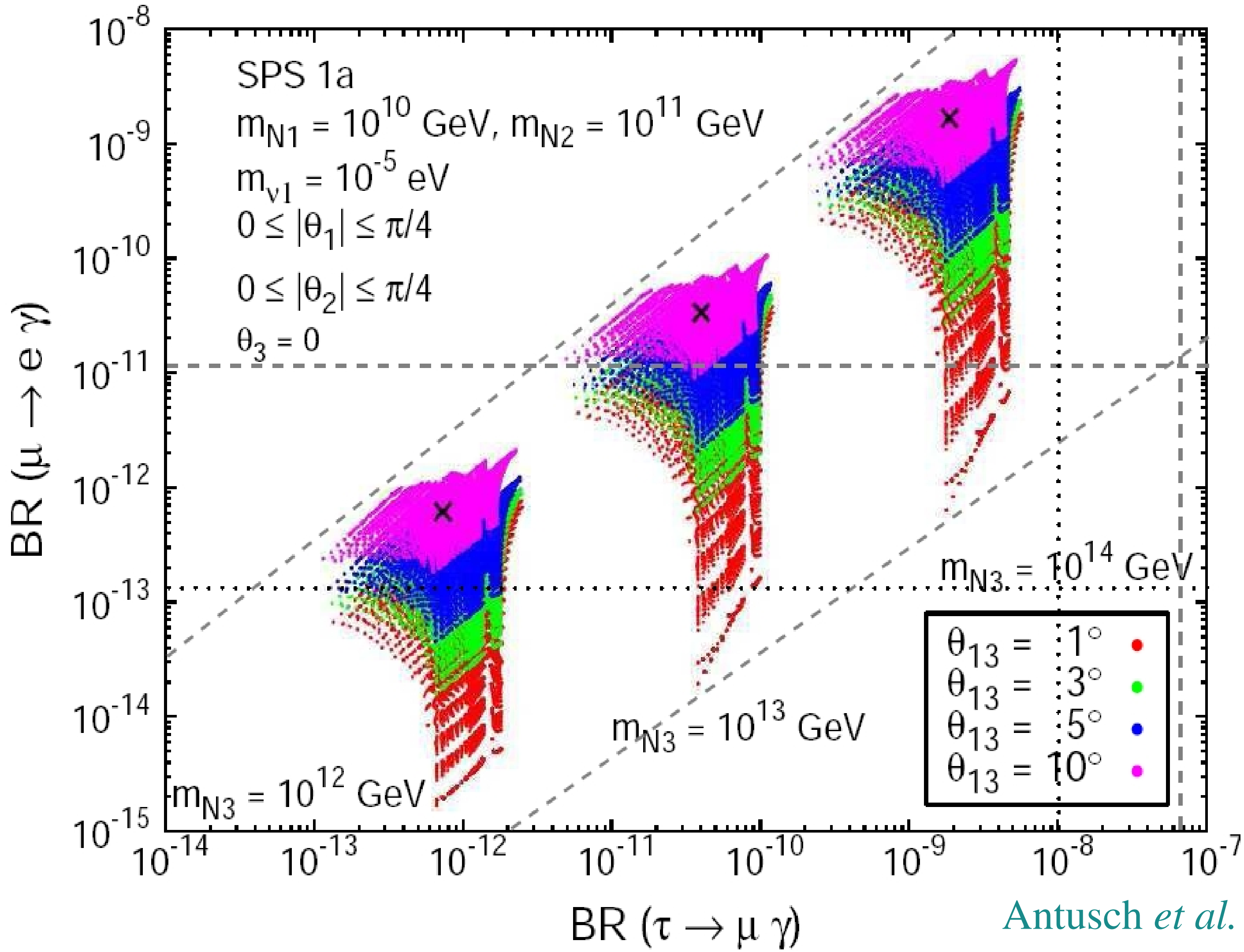
In GUT theories with new particles carrying lepton-flavor at the TeV scale (*e.g. the sleptons in the MSSM*)

MEG has high chances to see μ→ eγ

(*but remember that* $\Gamma \sim \Lambda^{-4}$)

Ratios of different LFV rates are potentially a useful ingredient to distinguish different underlying mechanisms of flavour symmetry breaking

E.g. : $\tau\to\mu\gamma$ vs. $\mu\to e\gamma$ in MSSM + heavy N_R [no GUT constraints]



Antusch *et al.* '06

Note that
$B(\tau\to\mu\gamma)/B(\mu\to e\gamma)$
cannot be arbitrarily large

↓

if $\mu\to e\gamma$ will be seen
at MEG (BR $>10^{-13}$)
the search for $\tau\to\mu\gamma$ at
SuperB is very interesting,

...but the opposite
is also true

II. *Very rare K decays*

The MFV hypothesis is unlikely to be exact:

- not compatible (in its more constrained form) with GUTs ⇒ at some level we should expect some *contamination from the lepton Yukawa couplings* in the quark sector
- it could well be only an approximate infrared property of the underlying theory ⇒ some *deviations* could appear *in the most suppressed processes*

⬇

Potentially large non-SM effects in $K \to \pi\nu\nu$ decays which receive the strongest CKM suppression within the SM ($V_{ts}^{*} V_{td} \sim \lambda^5$)

II. *Very rare K decays*

The unique features of $K \to \pi \nu\nu$

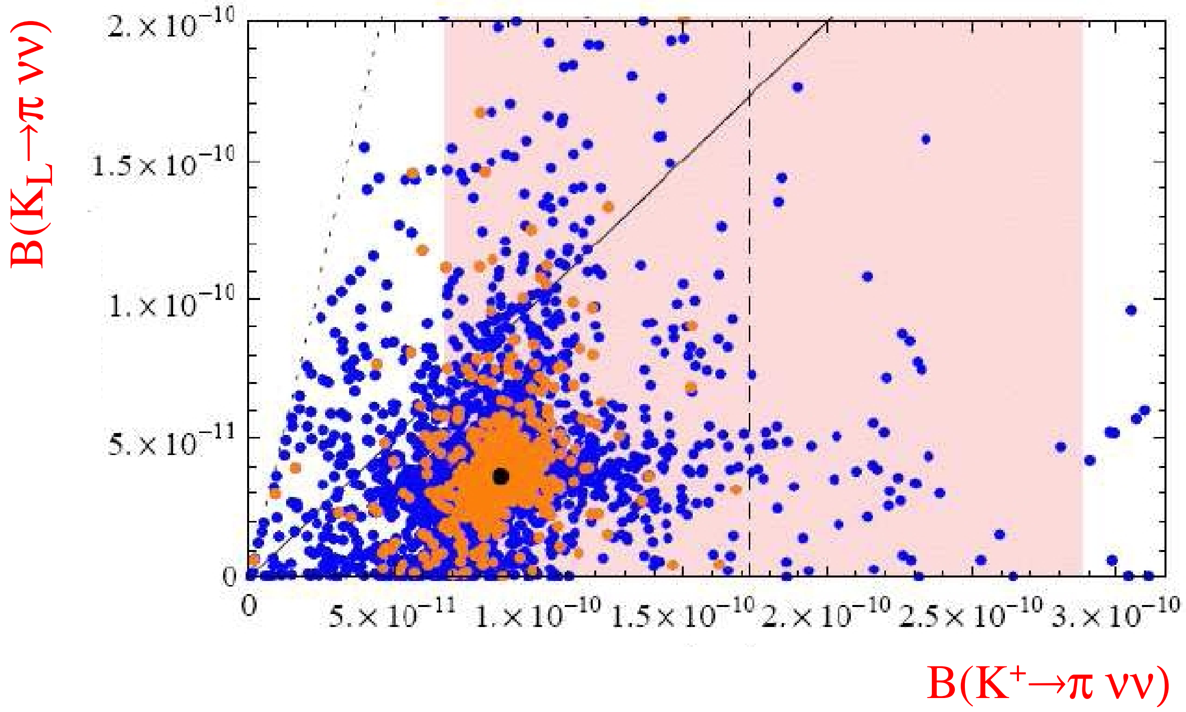
- Smallness of the CKM suppression factor ($V_{ts}^{*}V_{td} \sim \lambda^5$)
- High th. cleanness (unique for loop-induced meson decays):
  ~2% for BR(K_L) & ~ 5% for BR(K^+)

⬇

A unique probe of possible deviations from MFV

a "must" to improve their measurements in the LHC era

E.g.: Warped 5th dimension with Zq_Lq_L custodial protection



Blanke *et al.* '08

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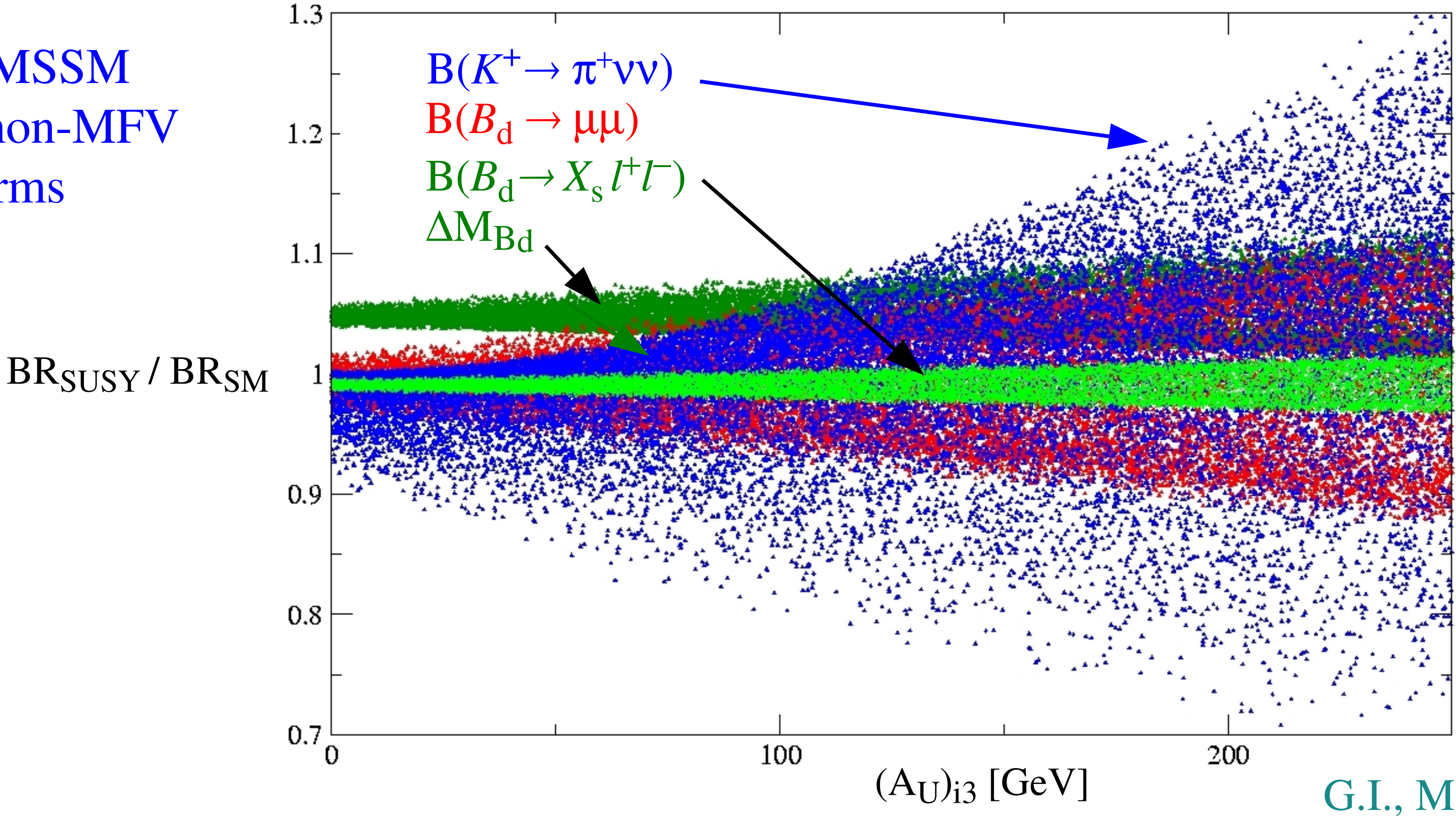
E.g.: MSSM with non-MFV A_U terms



G.I., Mescia, Paradisi, Smith, Trine, '06

III. *Rare B decays*

Beside the improvements in $A_{CP}(B_s \to \psi\phi)$, $B \to \tau\nu$, $A_{FB}(B \to K^* l^+ l^-)$, $A_{CP}(B \to X_s\gamma)$

B-physics observables of great interest in the LHC era the helicity-suppressed $B \to l^+ l^-$ decays

⬇

Present status:

$$B(B_s \to \mu\mu) < 4.8 \times 10^{-8}\ (95\%\mathrm{CL})$$

$$B(B_d \to \mu\mu) < 7.6 \times 10^{-9}\ (95\%\mathrm{CL})$$

[CDF '09]

$$B(B_s \to \mu\mu)_{SM} = 3.2(2) \times 10^{-9}$$

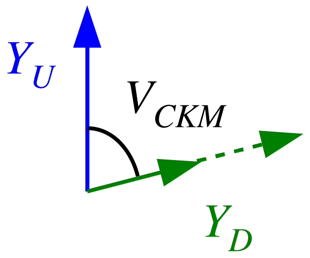
$$B(B_d \to \mu\mu)_{SM} = 1.0(1) \times 10^{-10}$$

e channels suppressed by $(m_e/m_\mu)^2$

τ channles enhanced by $(m_\tau/m_\mu)^2$

Unique probes of the MSSM at moderate/large tanβ

III. *Rare B decays*

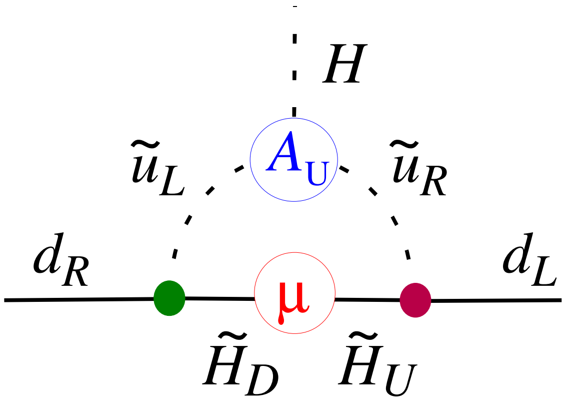


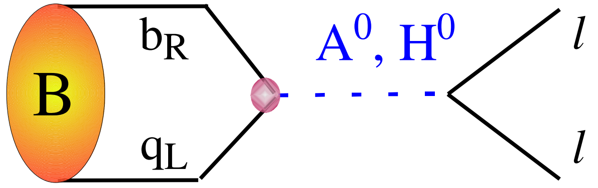
$$\mathrm{diag}(Y_U) = \mathrm{diag}(m_u)\,/\langle H_U\rangle$$

$$\mathrm{diag}(Y_D) = \mathrm{diag}(m_d)\,/\langle H_D\rangle = \tan\beta\; m_d\,/\langle H_U\rangle$$

The different normalization of the Yukawa couplings induces an effective <u>Higgs-mediated FCNC coupling</u>:

no impact in helicity-conserving processes, but possible large effect in $B\to l^+l^-$





$$A(B\to ll)_H \sim \frac{m_b\, m_l}{M_A^2}\,\frac{\mu\, A_U}{\tilde{M}_q^2}\,\tan^3\beta$$

<u>Possible large enhancement over the SM</u>
(but the magnitude of the effect can vary a lot in different SUSY-breaking scenarios)

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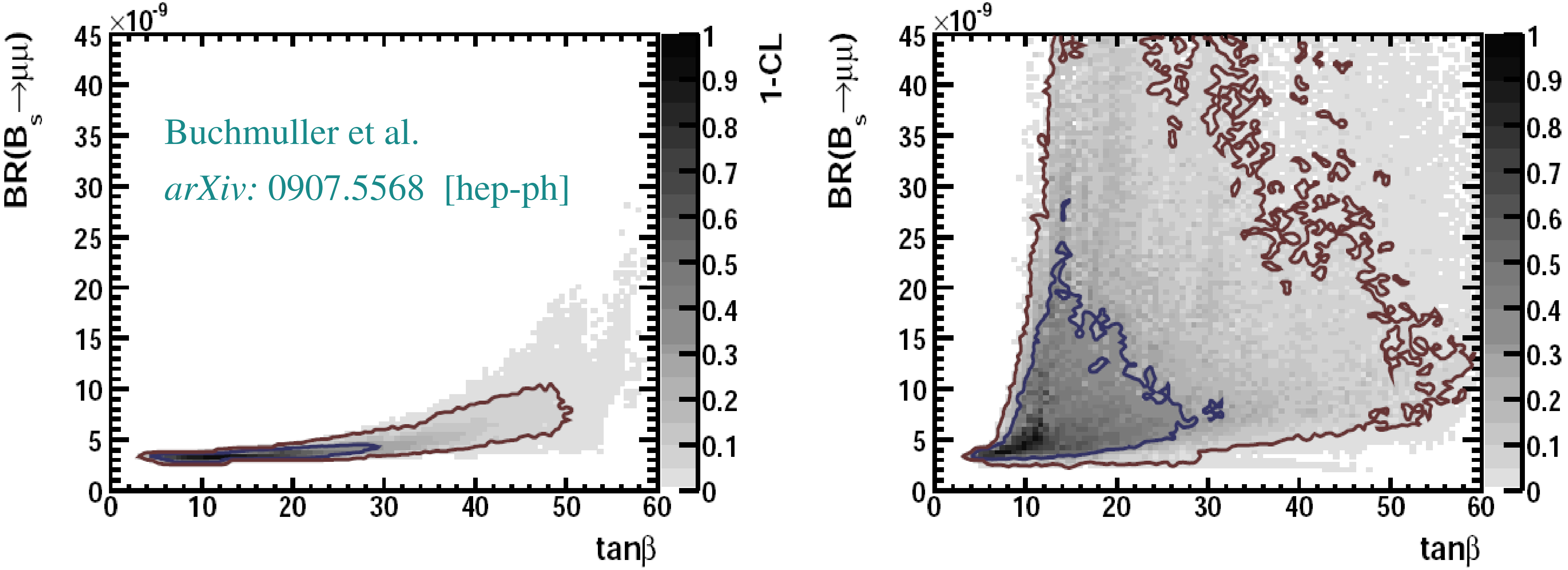
Constrained - MSSM

Constrained – MSSM with non-universal Higgs masses (NUHM)



Buchmuller et al.

arXiv: 0907.5568 [hep-ph]

Reaching the SM level would lead to a very significant constraint in the (C)MSSM

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$B(B_d \to \mu\mu) < 7.6 \times 10^{-9}$ (95%CL) $B(B_d \to \mu\mu)_{SM} = 1.0(1) \times 10^{-10}$

- Th. error controlled by f_B (⇒lattice). Not a big issue if deviations from SM are large, but important to improve in view of future precise measurements

- The $B(B_d \to \mu\mu)/B(B_s \to \mu\mu)$ ratio is a key observable to proof or falsify MFV

Conclusions

We learned a lot about flavour physics in the recent past...
...but a lot remains to be discovered !

We have understood that TeV-scale NP models must have a rather sophisticated flavour structure (not to be excluded by present data) but we have not clearly identified this structure yet

⬇

Important to continue high-precision flavour physics in the LHC era

- There is not a unique (or a unique class) of outstanding observable(s), and correspondingly there is not a preferred flavour facility
- Progress in this field requires a collective effort in several directions: B, τ, K, μ decays, concentrating on the theoretically-clean observables [*mainly leptonic/semileptonic final states*]
- Full complementarity with high-pt physics, under the (optimistic?) assumption of new degrees of freedom at the TeV scale