New Physics Search

Opportunities in Flavour Physics

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Opportunities in Flavour Physics

- Introduction
  - QCD $\leftrightarrow$ New Physics
- Exploration of Higher Scales via Rare Decays
  - Inclusive Rare Decays $\bar{B} \to X_s\gamma$, $\bar{B} \to X_s\ell^+\ell^-$
  - $K \to \pi\nu\bar{\nu}$
  - $B \to \pi\pi$, $B \to K\pi$
- New physics in CP-violating observables
- Correlation of Collider and Flavour Physics via Squark Mixing

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Introduction

- Interplay of LHC and ILC:
  Complementarity of discovery and precision machine $\Rightarrow$ LHC/ILC study group

- However: ILC will not be built before 2016 (optimistic!)

- Obvious question:
  What is the role of the flavour factories in this game?

- Experimental 'Roadmap' of flavour physics:

  - e^+e^--B-experiments:
    B factories (Babar,Belle) $\geq$ 1999, CLEO III $\geq$ 2000,
    Upgraded or Super B factories $\geq$ 2010

  - Hadronic B-experiments:
    Tevatron II $\geq$ 2001, LHC (Atlas,CMS,LHCb) $\geq$ 2007, ((BTeV $\geq$ 2009))

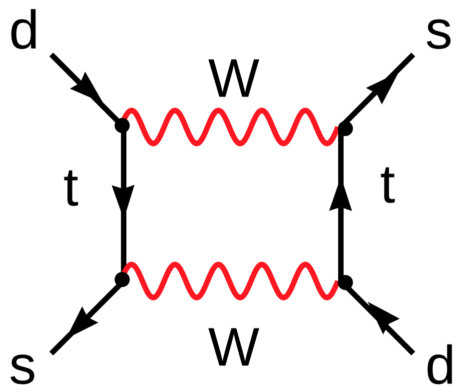
  - Kaon-experiments:
    Kopio,BNL $(K_L \to \pi^0 \nu\bar{\nu})$, NA 48/3,CERN $(K^+ \to \pi^+ \nu\bar{\nu}) \geq$ 2010

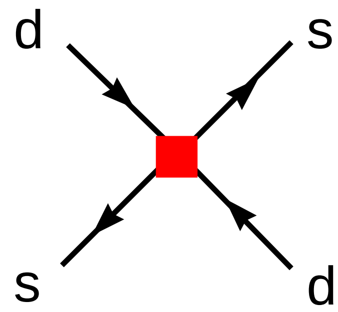
- Crucial problem in new physics search:
  Separation of new physics effects and hadronic uncertainties

Exploration of higher scales via flavour observables

$$\mathcal{L} = \mathcal{L}_{Gauge} + \mathcal{L}_{Higgs} + \sum_i \frac{c_i^{New}}{\Lambda} \mathcal{O}_i^{(5)} + \ldots$$

- SM as effective theory valid up to cut-off-scale Λ
- $K^0 - \bar{K}^0$-mixing $\mathcal{O}^6 = (\bar{s}\,d)^2$: $c^{SM}/M_W^2 \times (\bar{s}\,d)^2 + c^{New}/\Lambda^2 \times (\bar{s}\,d)^2 \Rightarrow \Lambda > 100\,\text{TeV}$

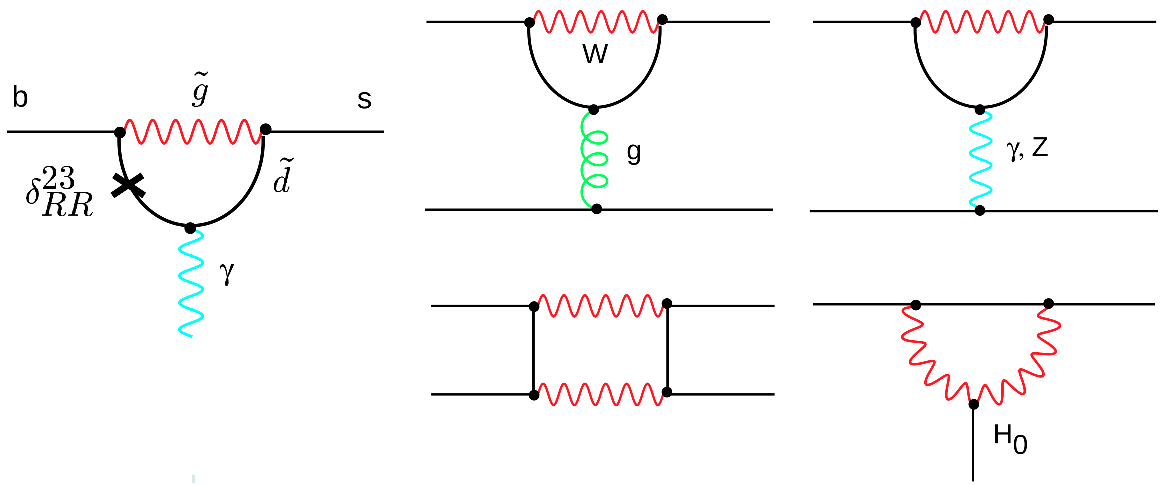




- Natural stabilisation of Higgs boson mass (i.e. supersymmetry) $\Rightarrow \Lambda \sim 1\text{TeV}$
  (but: little hierarchy problem)
- Expectation: flavour mixing restricted by additional symmetries

Rare decays and CP violating observables allow to analyse flavour symmetry breaking

- Flavourblind elektroweak structure of $\mathcal{O}_i$:
  - connects various (theoretically clean !) observables: $A_{CP}(B_d \to \Phi K_S) \Leftrightarrow BR(B \to X_s\gamma)$

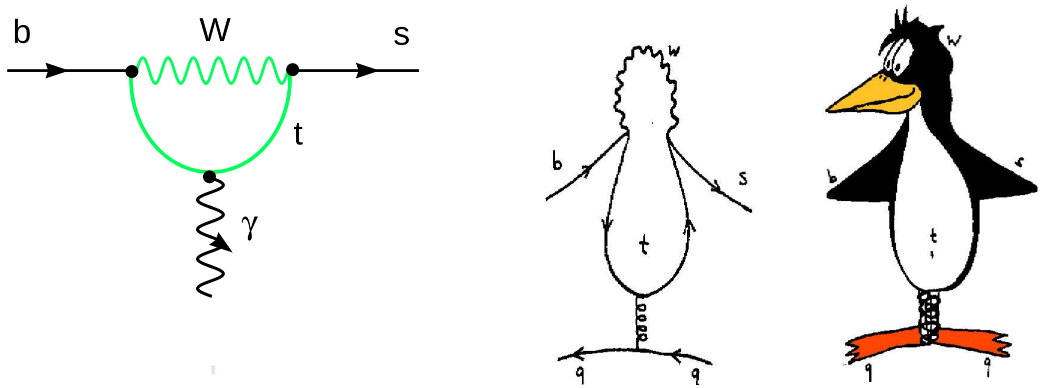


  - allows for model-independent analysis:

- Flavour part of $\mathcal{O}_i$:
  - new flavour structures, i.e. squark-mixing in SUSY or
  - minimal flavour violation flavour symmetry / CP broken by Yukawa couplings only

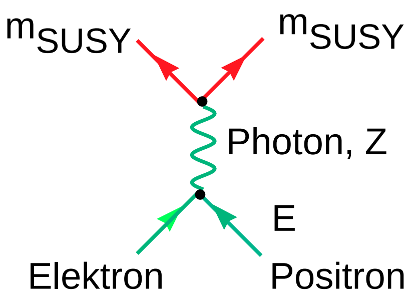
  * $[b \to s] \leftrightarrow [b \to d] \leftrightarrow [s \to d]$ * RG-invariant definition (d'Ambrosio et al.)

- Rare B decays like $b \to s\,\gamma$ or $b \to s\,\ell^+\ell^-$ directly probe the SM at the one-loop level.



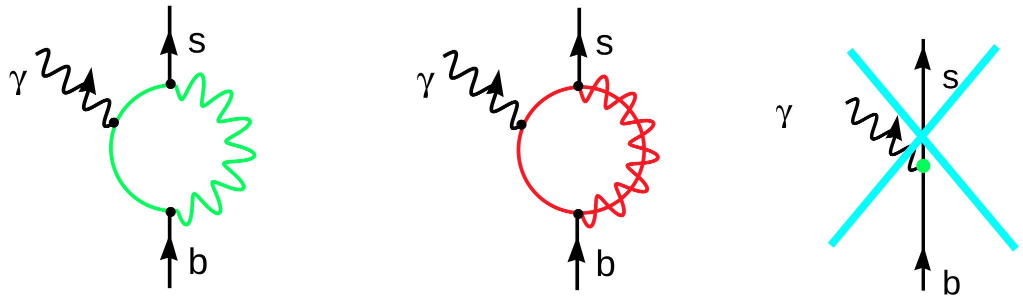
- Search strategies for new degrees of freedom beyond the SM (i.e. for supersymmetry)

Direct:



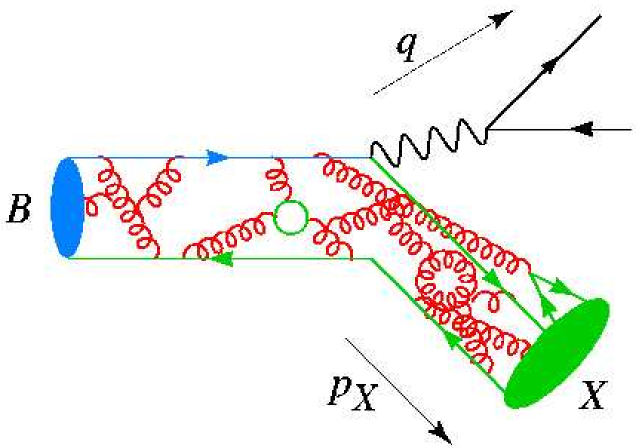
$2m_{SUSY}c^2 \leq E$

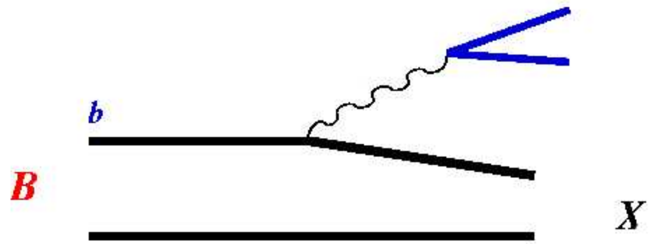
Indirect:



- High sensitivity for 'New Physics' (↔ elektroweak precision data, 10% ↔ 0.1%)

This indirect information is analogous to some direct information of a linear collider.





Separation of new physics effects and hadronic uncertainties!

Three strategies:

* focus on inclusive modes:

$$\Gamma(\bar{B} \to X_s\gamma) \xrightarrow{m_b\to\infty} \Gamma(b \to X_s^{parton}\gamma)\,, \quad \Delta^{nonpert.} \sim \Lambda_{QCD}^2/m_b^2$$

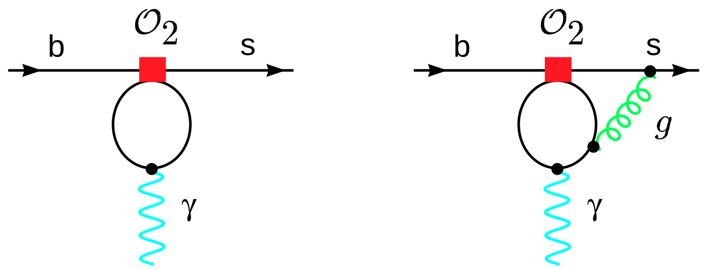
No linear term Λ_{QCD}/m_b
(perturbatively calculable contribution dominant)

* focus on ratios of exclusive modes like asymmetries
(hadronic uncertainties partially cancel out)

* focus on specific decays like $K \to \pi\nu\bar{\nu}$
(hadronic matrix elements known from experiment)

Present status of $\bar{B} \to X_s\gamma$

Problem: renormalization scheme of the charm mass (NNLL) (Gambino, Misiak)



$m_c^{\text{pole}}/m_b^{\text{pole}} = 0.29 \pm 0.02 \;\Leftrightarrow\; m_c^{\overline{\text{MS}}}(\mu)/m_b^{1S} = 0.23 \pm 0.05$

. $\Rightarrow$ central value $\sim +11\%$

Present NLL Prediction: (Hurth, Lunghi, Porod)

$$BR(\bar{B} \to X_s\gamma) \times 10^4 = \left(3.79 \;\; {}^{+0.26}_{-0.44}\Big|_{m_c/m_b} \pm 0.02_{\text{CKM}} \pm 0.25_{\text{param}} \pm 0.15_{\text{scale}}\right)$$

NNLL QCD calculation needed for uncertainty $\ll 10\%$! (work in progress !)

Estimate of the reduction of the scheme dependence at NNLL: $12.4\% \to 5.1\%$
Asatrian et al. hep-ph/0505068

Experiment:

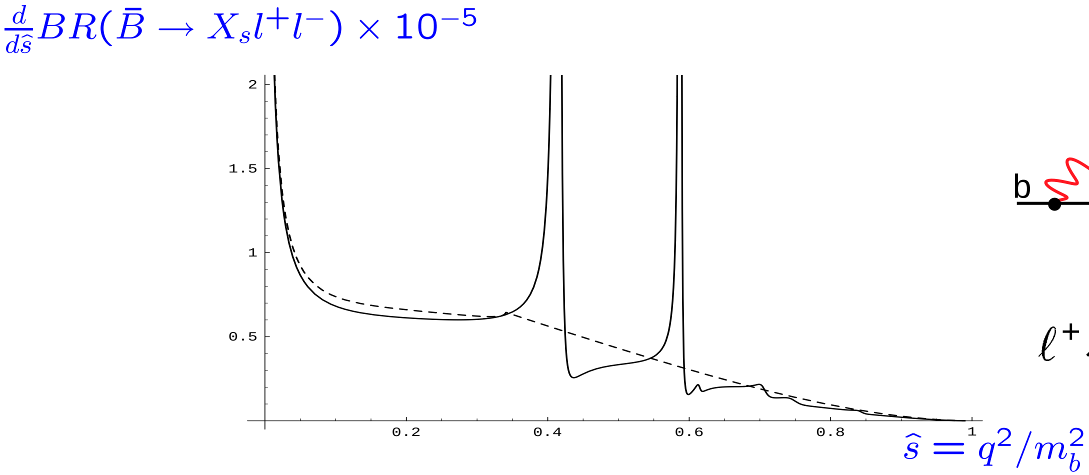
$$BR(\bar{B} \to X_s\gamma) = (3.52 \pm 0.30) \times 10^{-4}$$ CLEO, ALEPH, BELLE, BABAR

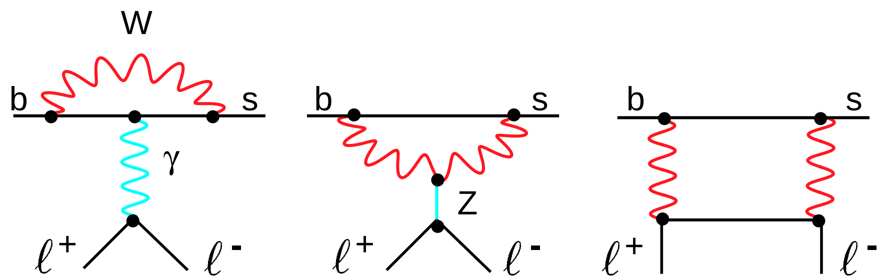
The $\bar{B} \to X_s\gamma$ data already leads to significant restrictions on the parameter space of various extensions of the SM.

Clearly, this indirect information will be most valuable when the general nature of new physics will be identified in the direct search (LHC).

$\bar{B} \to X_s \ell^+ \ell^-$: Dilepton mass spectrum

- on-shell-$c\bar{c}$-resonances, cuts necessary : $1\text{GeV}^2 < q^2 < 6\text{GeV}^2$ and $14.4\text{GeV}^2 < q^2$
  perturbative contributions dominant





- Theory NNLL QCD: Ghinculov, Hurth, Isidori, Yao

$$BR(\bar{B} \to X_s \ell^+ \ell^-)_{Cut:\ q^2 \in [1GeV^2, 6GeV^2]} = (1.63 \pm 0.20) \times 10^{-6}$$

$$BR(\bar{B} \to X_s l^+ l^-)_{Cut:\ q^2 > 14.4 GeV^2} = (4.04 \pm 0.78) \times 10^{-7}$$

NNLL QCD corrections $q^2 \in [1GeV^2, 6GeV^2]$

central value: -14%, perturbative error: $13\% \to 6.5\%$

- Electroweak two-loop corrections: Bobeth, Gambino, Gorbahn, Haisch

-1.5% shift for $\alpha_{em}(\mu = m_b)$, -8.5% for $\alpha_{em}(\mu = m_W)$

Experimental issues

- Semi-Inclusive Measurements ($m(\ell^+\ell^-) > 0.2GeV$)

  Belle, PRL 90 (2003) 021801 :
  $BR(\bar{B} \to X_s\ell^+\ell^-) = (6.1 \pm 1.4(stat) + 1.4 - 1.1(syst))10^{-6}$

  Update ICHEP 2004:
  $BR(\bar{B} \to X_s\ell^+\ell^-) = (4.11 \pm 0.83(stat) + 0.74 - 0.70(syst))10^{-6}$

  Babar, PRL 93 (2004) 081802 :
  $BR(\bar{B} \to X_s\ell^+\ell^-) = (5.6 \pm 1.5(stat) \pm 0.6(syst) \pm 1.1(mod))10^{-6}$

  - in agreement with corresponding SM prediction:
    $(4.6 \pm 0.8) \times 10^{-6}$ (Ghinculov,Hurth,Isidori,Yao))
    not sensitive yet for NNLL
  - semiinclusive: modelling of hadronic mass distribution

- Separate experimental data on two perturbative windows in dilepton mass spectrum desirable (Babar already made first separate measurements with large errors)

- End of Babar and Belle (1/ab): 15% accuracy possible

- LHCb: only semi-inclusive analysis possible without the π_0 modes

- Fully inclusive measurement possible within a Super-B factory

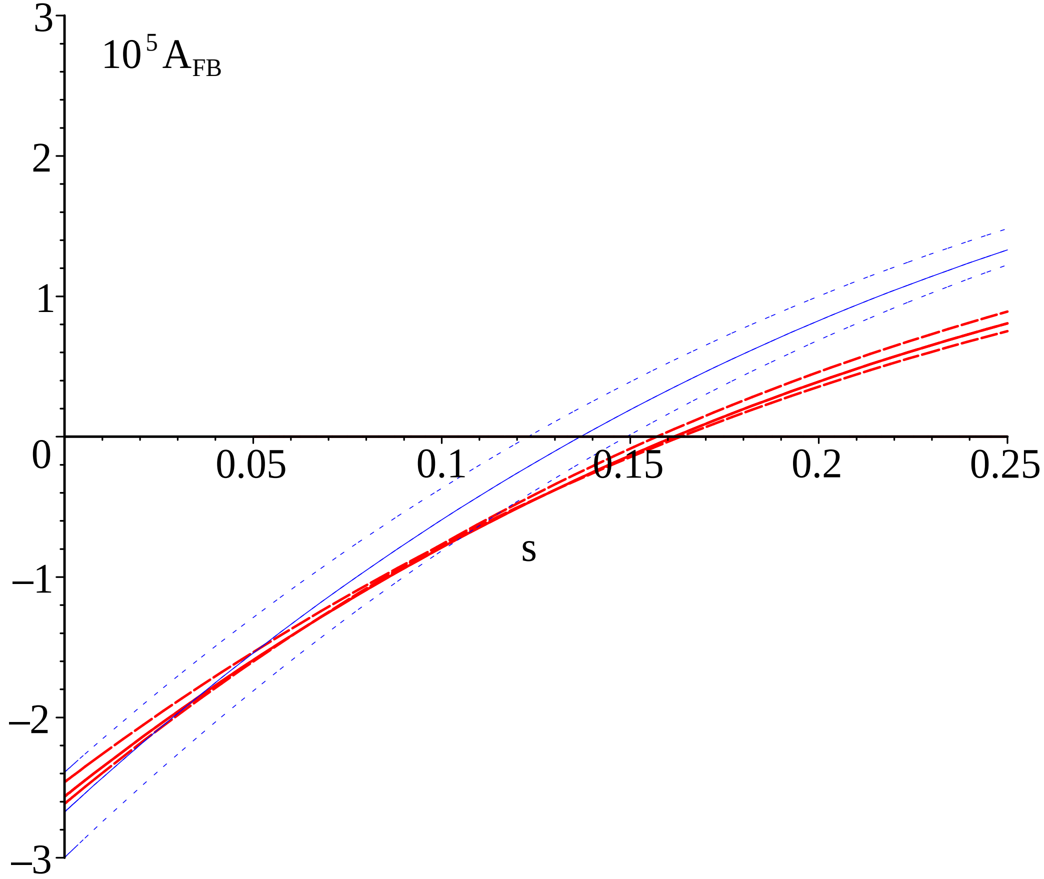
$\bar{B} \to X_s \ell^+ \ell^-$: Forward-backward-charge-asymmetry

Precision test of SM ! $A_{\rm FB} \equiv \frac{1}{\Gamma_{semilep}} \left(\int_0^1 d(\cos\theta) \frac{d^2\Gamma}{dq^2 d\cos\theta} - \int_{-1}^0 d(\cos\theta) \frac{d^2\Gamma}{dq^2 d\cos\theta} \right)$

(θ angle between l^+ and B momenta in dilepton CMS)

$$A_{FB}(q_0^2) = 0 \quad \text{for} \quad q_0^2 \sim C_7/C_9$$

NNLL corrections induce large $\sim 16\%$ Shift of the Zero: $q_0^2 = (3.90 \pm 0.25) GeV^2$
(Ghinculov, Hurth, Isidori, Yao) (Asatrian, Bieri, Greub, Hovhannisyan)



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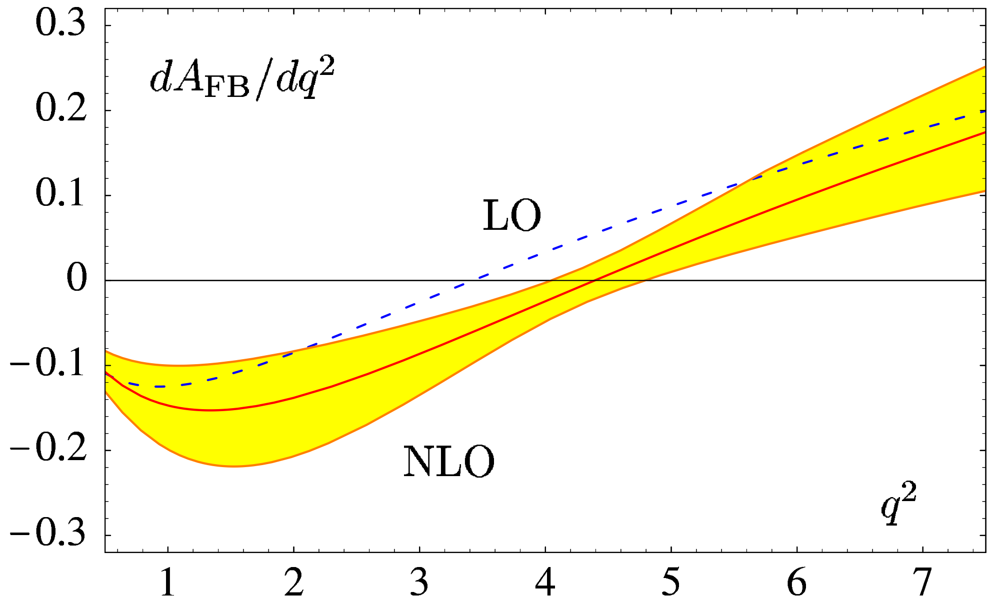
FB-charge-asymmetry in $B \to K^* \ell^+ \ell^-$



- In contrast to the branching ratio the zero of the FBA is almost insensitive to hadronic uncertainties. At LO the zero depends on the short-distance Wilson coefficients only:

$$q_0^2 = q_0^2(C_7, C_9), \quad q_0^2 = (3.4 + 0.6 - 0.5) GeV^2 \quad (LO)$$

- NLO contribution calculated within QCD factorization approach leads to a large shift: Beneke,Feldmann,Seidel

$$q_0^2 = (4.39 + 0.38 - 0.35) GeV^2 \quad (NLO)$$

- Issue of power corrections ($1/m_b$) !

- Theoretical errors in branching ratio: $\Delta BR(B \to K^* \mu^+ \mu^-) = (^{+26}_{-17}, \pm 6, ^{+6}_{-4}, ^{-0.7}_{+0.4}, \pm 2)\%$ Ball et al.

conclusions on rare $b \to s\gamma$ and $b \to s\ell^+\ell^-$ modes

- Model-independent analysis of $b \to s\ell^+\ell^-$ and $b \to s\gamma$

  * Global fit to the Wilson coefficients C_7, C_9, C_{10}
  $\Rightarrow$ Determines magnitude + sign of these coefficients

  * In MFV the sign of C_7 is already fixed by $b \to s\ell^+\ell^-$ data Gambino, Haisch, Misiak

- For new physics search measurements of kinematical distributions are needed (high statistics necessary !):

  Super-B: 7% accuracy in s_0 possible
  Super-B reports of KEK, hep-ph/0406071, and of SLAC, hep-ph/0503261.

- Impact of NNLL (NLL) QCD calculations in inclusive modes crucial !

- In exclusive modes issue of $1/m_b$ corrections has to be improved (SCET,...)!

Intermezzo: There is still some beauty in kaon physics !

- BNL–E787: three events 3/2004 !

$$BR(K^+ \to \pi^+ \nu\bar{\nu}) = \left(1.47\, {}^{+\,1.3}_{-\,0.9}\right) \times 10^{-10}$$

- Present SM theory (in future error below 5% possible):

$$BR(K^+ \to \pi^+ \nu\bar{\nu})_{\mathrm{SM}} = (0.80 \pm 0.11) \times 10^{-10} \; .$$

What makes the neutrino modes $K \to \pi\nu\bar{\nu}$ so attractive?

- leading hadronic matrix element is known from K_{l3} decays: $< \pi \,|\, (\bar{s}d)_{V-A} \,|\, K >$
- amplitude dominated by short-distance due to quadratic GIM: $A^q \sim m_q^2 V_{qs} V_{qd}$

Neutrino modes as theoretically clean as inclusive B decays !

$\Rightarrow$ highly sensitive probe for degrees of freedom at higher scales

Proposed experiment at CERN, NA48/3: 'decay in flight'

80 $K^+ \to \pi^+ \nu\bar{\nu}$ events in about two years of data taking

(4×10^{12} kaon decays/SPS year, 10% acceptance, SM)

main background: $K^+ \to \pi^+ \pi^0$

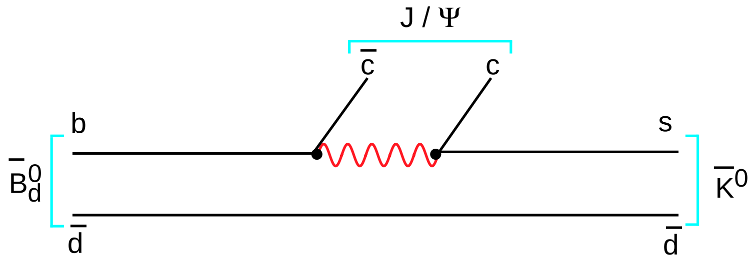
(γ veto much easier because of high energy kaon beam)

New physics in CP-violating observables ?

- SM is very predictive only one CP-violating parameter.
(Kobayashi-Maskawa 1972 !)

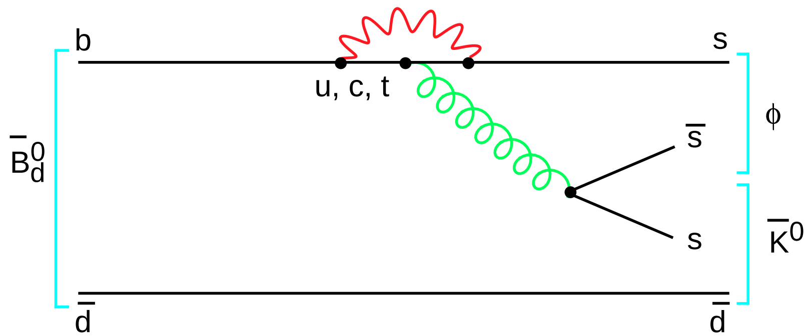
- Baryon asymmetry: one needs more sources of CP violation, but not necessarily relevant at low energies

- KM mechanism has passed successfully its first precision test in tree process:



$$A_{\rm CP}(t) = \frac{\Gamma(\bar{B}^0(t) \to f) - \Gamma(B^0(t) \to f)}{\Gamma(\bar{B}^0(t) \to f) + \Gamma(B^0(t) \to f)}, \quad A_{\rm CP}(B_d \to J/\psi K_S) = \sin(2\beta)\sin(\Delta m_B t)$$

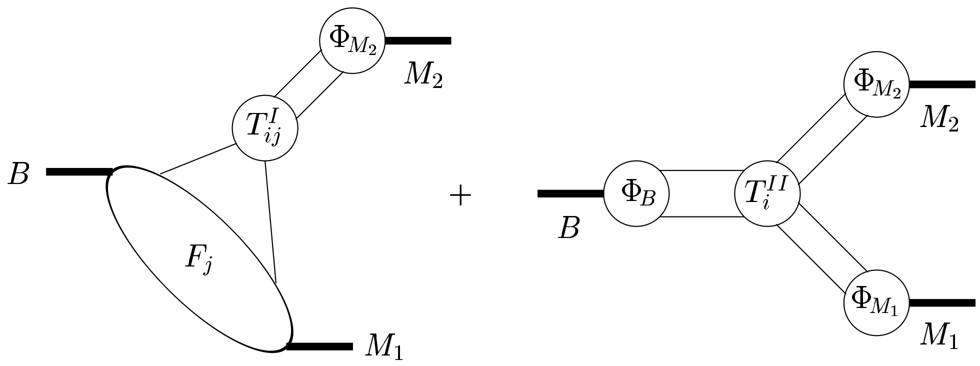
- Test in $A_{\rm CP}(B_d \to \Phi K_S)$ is still open Penguin



Not conclusive yet, various $b \to s\bar{s}s$ modes have different hadronic uncertainties

Hadronic charmless B decays

- QCD factorization theorems for $B \to \pi\pi$ and $B \to K\pi$



$$\langle \pi K | Q_i | B \rangle = F_0^{B\to\pi}\, T^{\mathrm{I}}_{K,i} * f_K \Phi_K + F_0^{B\to K}\, T^{\mathrm{I}}_{\pi,i} * f_\pi \Phi_\pi + T^{\mathrm{II}}_i * f_B \Phi_B * f_K \Phi_K * f_\pi \Phi_\pi + O(1/m_b)$$

- Factorization in B-decays
  - Short-distance effects identified + systematically calculable in perturbation theory
  - Non-perturbative effects parametrized in terms of a few universal functions (parton distributions, form factors, light-cone distribution amplitudes)
  - Hope to achieve necessary accuracy to extract CKM elements
  - Limiting factor: Insufficient information on power-suppressed terms

- Quantum field theoretical description: SCET (no OPE !) HQET is not applicable to B decays in which some of the outgoing, light particles have momenta of order m_b.

Phenomenolgical approach to $B \to \pi\pi$

Feldmann,Hurth

- Use pure QCD-factorization part ($\neq$ BBNS) and general isospin analysis of the non-factorizable part.

- Infer information on nonfactorizable parameters from experimental data by producing random parameters values and calculating the χ^2-value.

- Nonfactorizable corrections are numerically not negligible

  Default scenario in the BBNS approach where all nonfactorizable isospin amplitudes $r_i(I, \Delta I)$ are small is disfavoured by data ! ('so-called $B \to \pi\pi$ puzzle')

- We also identify model dependence in phenomenological studies due to additional assumptions.
  - BBNS Identification/parametrization of dominant $1/m_b$ effects
    only simple $1/m_b$ SCET operators considered, not most general parametrization
  - charming penguins Dominance of certain flavour topologies in naive quark picture
    relation to QCD/SCET unclear
  - $SU(3)$ Application of approximate flavour symmetries
    hadronic errors difficult to estimate

Details:

Standard Isopin Analysis:

$$\begin{aligned}
\sqrt{2}\,\langle\pi^-\pi^0|H_{\rm eff}|B^-\rangle &\simeq \lambda_u^{(d)}\,[3A_u(2,3/2)] + \lambda_c^{(d)}\,[3A_c(2,3/2)] \\
\langle\pi^+\pi^-|H_{\rm eff}|\bar{B}^0\rangle &\simeq \lambda_u^{(d)}\,[-A_u(0,1/2)+A_u(2,3/2)] + \lambda_c^{(d)}\,[-A_c(0,1/2)+A_c(2,3/2)] \\
\sqrt{2}\,\langle\pi^0\pi^0|H_{\rm eff}|\bar{B}^0\rangle &\simeq \lambda_u^{(d)}\,[A_u(0,1/2)+2A_u(2,3/2)] + \lambda_c^{(d)}\,[A_c(0,1/2)+2A_c(2,3/2)]\ ,
\end{aligned}$$

$\lambda_i^{(q)} = V_{ib}V_{iq}^*$, $A_i(I,\Delta I)$: I denotes the total isospin I of the final state and ΔI the isospin of the operators in the weak effective hamiltonian.

$$A_i(I,\Delta I) = A_i^F(I,\Delta I) + A_i^{NF}(I,\Delta I)$$

- Factorizable Part:
  A_i^F fixed by QCD factorization with overall normalization: $A_{\pi\pi} = \frac{iG_F}{\sqrt{2}}\,(m_B^2 - m_\pi^2)\,F_0^{B\to\pi}(m_\pi^2)\,f_\pi$

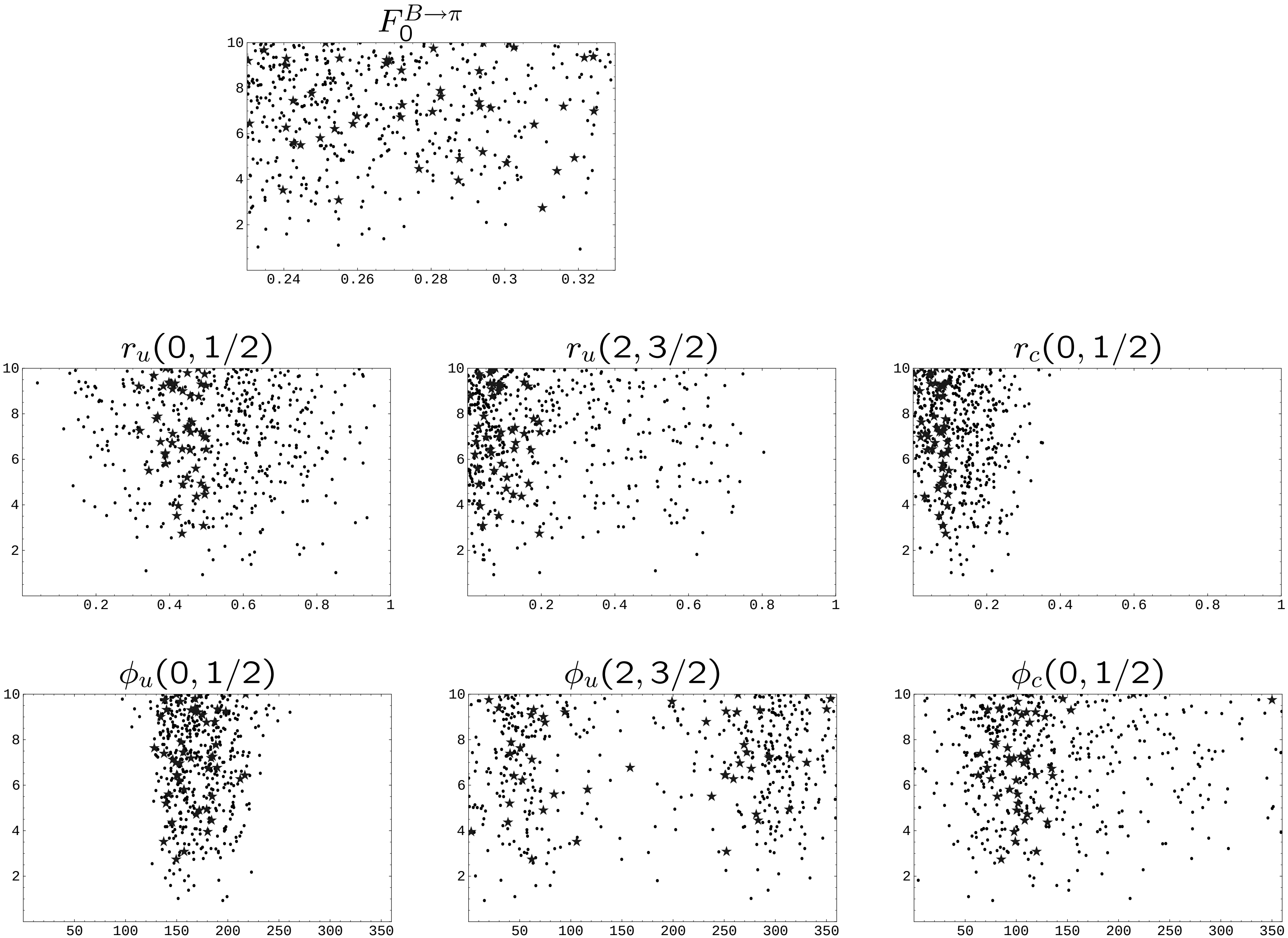
- Nonfactorizable Part: $A_i^{NF}(I,\Delta I) := r_i(I,\Delta I)\,e^{i\phi_i(I,\Delta I)}\,A_{\pi\pi}$

  * Unconstrained Scenario:

$$0.23 \le F_0^{B\to\pi}(m_\pi^2) \le 0.33,\ 0 \le r_{u,c}(I,\Delta I) \le 1.0,\ 0^\circ \le \phi_{u,c}(I,\Delta I) \le 360^\circ\ ,$$

  * Constrained Scenario:

$$r_u(0,1/2) < 0.5\ ,\quad r_u(2,3/2) < 0.2\ ,\quad r_c(0,1/2) < 0.1$$



dots for unconstrained, stars for constrained scenario.

Is there a R_n-puzzle in $B \to K\pi$?

CP averaged branching ratios:

$$R = \frac{\tau_{B^+}}{\tau_{B^0}} \frac{\text{BR}[B_d^0 \to \pi^- K^+] + \text{BR}[\bar{B}_d^0 \to \pi^+ K^-]}{\text{BR}[B_d^+ \to \pi^+ K^0] + \text{BR}[B_d^- \to \pi^- \bar{K}^0]} = 0.82 \pm 0.056$$

$$R_n = \frac{1}{2} \frac{\text{BR}[B_d^0 \to \pi^- K^+] + \text{BR}[\bar{B}_d^0 \to \pi^+ K^-]}{\text{BR}[B_d^0 \to \pi^0 K^0] + \text{BR}[\bar{B}_d^0 \to \pi^0 \bar{K}^0]} = 0.789 \pm 0.075$$

$$R_c = 2 \frac{\text{BR}[B_d^+ \to \pi^0 K^+] + \text{BR}[B_d^- \to \pi^0 K^-]}{\text{BR}[B_d^+ \to \pi^+ K^0] + \text{BR}[B_d^- \to \pi^- \bar{K}^0]} = 1.004 \pm 0.084$$

- pre-ICHEP04 data:
  $R = 0.91 \pm 0.07$, $R_n = 0.76 \pm 0.10$, $R_c = 1.17 \pm 0.12$

- Approach based on QCD factorization (BBNS)
  $R = 0.91^{+0.13}_{-0.11}$, $R_n = 1.16^{+0.22}_{-0.19}$, $R_c = 1.15^{+0.19}_{-0.17}$

- SM-Fit to $\pi\pi$ + $SU(3)_F$ (Buras et al)
  $R = 0.94^{+0.03}_{-0.03}$, $R_n = 1.14^{+0.08}_{-0.07}$, $R_c = 1.11^{+0.06}_{-0.07}$
  (Note: errors reflect only experimental uncertainties of $B \to \pi\pi$)

Does the R_n puzzle guide us to new physics?

Does the R_n puzzle guide us to new physics?

- large nonfactorizable contributions allow for large $SU(3)_F$ or isospin-violating effects (Feldmann, Hurth) ('so-called $\pi\pi$ puzzle perhaps solves $K\pi$ puzzle')

- radiative corrections to decays with charged particles in the final states may not have been taken into account properly in the experimental analysis ($B^0 \to \pi^+ K^-$ not yet updated !!)

- possible underestimation of π_0 detection efficiency ($R_n * R_c$)

conclusions on $B \to \pi\pi$ and $B \to K\pi$:

- Use the future data to test various theoretical assumptions on dynamics with the help of a general isospin analysis of the nonfactorizable contributions.

- So-called $\pi\pi$ puzzle perhaps solves $K\pi$ puzzle

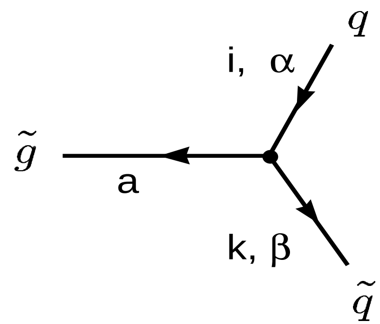
- Challenge for theory:

development of non-perturbative methods within SCET:

SCET sum rules De Fazio,Feldmann,Hurth hep-ph/0504088

Correlations between B and collider physics via squark mixing within SUSY

- In the unconstrained MSSM (too many ?) new contributions to flavour violation
  - CKM induced contributions from H^+, χ^+ exchanges
  - flavour mixing in the sfermion mass matrix
- Gluino-quark-squark coupling: $-ig_s T^a_{\beta\alpha}(\Gamma^{ki}_{QL} P_L - \Gamma^{ki}_{QR} P_R)$



- Possible disalignment of quarks and squarks
  - quark mass matrices are diagonal !
  - squarks are rotated ‘parallel‘ to their fermionic superpartners !
  - in general not mass eigenstates: $\tilde{q}_{L,R} = \Gamma^+_{QL,R} \tilde{q}_i$

Sfermion mass matrix in uMSSM in $\tilde{q}_{L,R}$ basis:

$$\mathcal{M}^2_{D/U} = (F/D)^{D/U}_{6\times 6} + \begin{pmatrix} m^2_{Q,LL} & m^2_{D/U,LR} \\ m^2_{D/U,RL} & m^2_{(D/U,RR} \end{pmatrix}$$

from F, D terms	from soft breaking
3×3 diagonal submatrices	m_i^2 not diagonal

FCNC are induced by off-diagonal (off-generational) terms in $m^2_{LL}, m^2_{RR}, m^2_{LR}$

- Low energy constraints
  - K-physics: ϵ'/ϵ, K^0-$\bar{K}^0$ mixing, . . .
    significantly constrain $1-2$ and $1-3$ mixing
  - B-physics: $b \to s\gamma$, ΔM_{B_s}, . . .
    most important beyond SM contributions: H^+, $\tilde{\chi}_i^+$, $\tilde{g}$

- Correlations to Collider Physics (Hurth,Porod)
  - squark decays:

$$\begin{aligned} \tilde{u}_i &\to u_j \tilde{\chi}_k^0\,,\; d_j \tilde{\chi}_l^+ \\ \tilde{d}_i &\to d_j \tilde{\chi}_k^0\,,\; u_j \tilde{\chi}_l^- \end{aligned}$$

    with $i = 1,..,6$, $j = 1,2,3$, $k = 1,..,4$ and $l = 1,2$.
  - these decays are governed by the same mixing matrices as the contributions to flavour violating low-energy observables.

  Squarks can have large flavourviolating decay modes, compatible with present data from flavour physics.

Strategy

- take SPS1a as starting point:

  $M_0 = 100$ GeV, $M_{1/2} = 250$ GeV
  $A_0 = -100$ GeV, $\tan\beta = 10$, $\mu > 0$
  $\Rightarrow$
  $M_2 = 192$ GeV, $\mu = 351$ GeV
  $m_{H^+} = 403$ GeV $m_{\tilde{g}} = 594$ GeV, $m_{\tilde{t}_1} = 400$ GeV
  $m_{\tilde{t}_2} = 590$ GeV, $m_{\tilde{q}_R} \simeq 550$ GeV, $m_{\tilde{q}_L} \simeq 570$ GeV

  (SPheno 2.0)

- vary off-diagonal squark mass entries.

- accept points with $2 \leq 10^4$ BR$(b \to s\gamma) \leq 4.5$ and $\Delta M_{B_s} \geq 14$ ps^{-1}

- For simplicity: real parameters only

- QCD corrections for $b \to s\gamma$ as given in
  Borzumati et al., Phys. Rev. D62, 075005 (2000) and
  Besmer et al., Nucl.Phys.B609:359 (2001)

- ΔM_{B_s}, as given in
  Baek et al. , Phys. Rev. D64, 095001 (2001)

$\Rightarrow$ Typical results:

Branching ratios (in %) of u-type squarks

	$\tilde{\chi}^0_1 c$	$\tilde{\chi}^0_1 t$	$\tilde{\chi}^0_2 c$	$\tilde{\chi}^0_2 t$	$\tilde{\chi}^0_3 c$	$\tilde{\chi}^0_3 t$	$\tilde{\chi}^0_4 c$	$\tilde{\chi}^0_4 t$	$\tilde{\chi}^+_1 s$	$\tilde{\chi}^+_1 b$	$\tilde{\chi}^+_2 s$	$\tilde{\chi}^+_2 b$
$\tilde{u}_1$	4.7	18	5.2	9.6	6×10^{-3}	0	0.02	0	11.3	46.4	2×10^{-3}	4.7
$\tilde{u}_2$	.19.6	1.1	0.4	17.5	2×10^{-2}	0	6×10^{-2}	0	0.5	57.5	3×10^{-3}	2.9
$\tilde{u}_3$	7.3	3.7	20	1.4	6×10^{-2}	0	0.6	0	40.3	3.1	1	18.5
$\tilde{u}_6$	5.7	0.4	11.1	5.3	4×10^{-2}	5.7	0.6	13.2	22.9	13.1	0.6	8.0

Branching ratios (in %) of d-type squarks

	$\tilde{\chi}^0_1 s$	$\tilde{\chi}^0_1 b$	$\tilde{\chi}^0_2 s$	$\tilde{\chi}^0_2 b$	$\tilde{\chi}^0_3 s$	$\tilde{\chi}^0_3 b$	$\tilde{\chi}^0_4 s$	$\tilde{\chi}^0_4 b$	$\tilde{\chi}^-_1 b$	$\tilde{\chi}^-_1 t$	$\tilde{\chi}^-_2 b$	$\tilde{\chi}^-_2 t$	$\tilde{u}_1 W^-$
$\tilde{d}_1$	1.2	5.7	8.4	30.6	2×10^{-2}	1.5	0.2	0.9	16.6	34.1	0.6	0	0
$\tilde{d}_2$	.17.4	5.8	5.1	15.7	7×10^{-2}	7.4	0.3	09.2	9.7	19.7	0.7	0	8.8
$\tilde{d}_4$	14.7	21.7	11.3	2.2	5×10^{-2}	10.6	0.5	8.4	22.1	3.6	1.2	0	3.4
$\tilde{d}_6$	1.7	0.5	20.5	6.9	0.1	0.9	1.2	1.3	40.3	10.2	3.4	11.1	1.8

Gluino branching ratios larger than 1%.

Final state	BR [%]	Final state	BR [%]
$\tilde{u}_1 c$	12.9	$\tilde{d}_1 s$	7.2
$\tilde{u}_1 t$	5.7	$\tilde{d}_1 b$	19.8
$\tilde{u}_2 c$	0.4	$\tilde{d}_2 s$	6.1
$\tilde{u}_2 t$	7.6	$\tilde{d}_2 b$	4.7
$\tilde{u}_3 c$	0.6	$\tilde{d}_3 d$	10.0
$\tilde{u}_4 u$	5.5	$\tilde{d}_4 s$	3.5
$\tilde{u}_5 u$	3.0	$\tilde{d}_4 b$	4.9
		$\tilde{d}_5 d$	2.1

conclusions on correlations via squark mixing

- $b \to s\gamma$ and ΔM_{B_s} (still ?) allow for large mixings between second and third generation squarks, for example $\tilde{t}_i$, $\tilde{c}_i$ can have large flavour violating decay modes,
- makes life at LHC potentially more interesting and more difficult,
- extra information from ILC or flavour factories needed.

FLAVOUR IN THE ERA OF THE LHC

a Workshop
on the interplay of flavour and collider physics

First meeting: CERN, November 7-11 2005

http://mlm.home.cern.ch/mlm/FlavLHC.html

The goal of this Workshop is to outline and document a programme for flavour physics for the next decade, addressing in particular the complementarity and synergy between the LHC and the flavour factories vis a vis the discovery and exploration potential for new physics.

The format of the Workshop will follow the standard CERN experience, with an opening meeting with plenary sessions and with the start of the WG activities, followed by 2-3 meetings of the WG's to take place during the following year, and a final plenary meeting at the end.