Physics at Belle II

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** Beauty and charm of flavour physics
(and strangeness too)

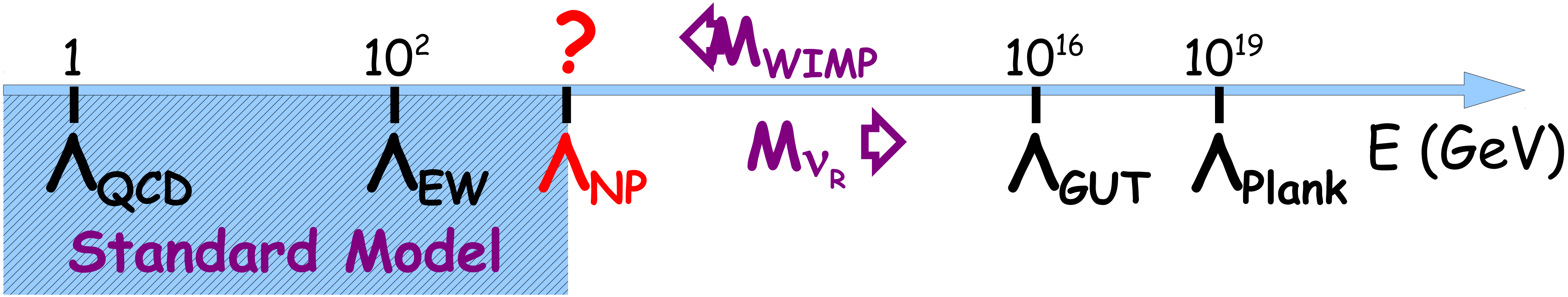
** Physics at Belle II: selected topics

** Belle II & the others: overlap & complementarity

Flavour physics confronts NP searches

The problem of today particle physics:

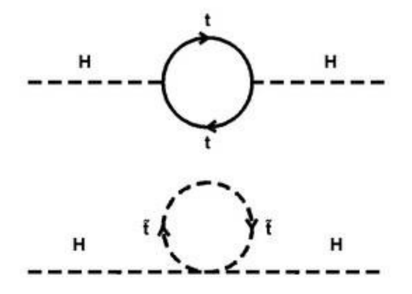
where is the NP scale Λ_{NP}? 1, 10, 10^{13}, 10^{16} TeV?



The quantum stabilization of the weak scale suggests ≤ 1 TeV (naturalness argument)

$$m_H^2 \rightarrow m_H^2 + \delta m_H^2$$

$$\delta m_H^2 = \frac{3 G_F}{\sqrt{2}\pi^2} m_t^2 \Lambda_{NP}^2 \sim \left(0.3\,\Lambda_{NP}\right)^2$$



Going BSM with flavour physics: why?

Indirect searches look for new physics through virtual effects of new particles in loops

* SM FCNCs and CPV occur at the loop level

* SM FV and CPV are governed by the weak interactions and suppressed by small mixing angles

* SM quark CPV comes from a single source (neglecting θ_{QCD})

New Physics does not necessarily share the SM pattern of FV and CPV: very large NP effects are possible

Past (SM) successes anticipating heavy flavours:

1970: charm from $K^0 \to \mu^+\mu^-$ (GIM)

1973: 3^{rd} generation from ϵ_K (Kobayashi & Maskawa)

mid 80s+: heavy top from semileptonic decays & Δm_B

Going BSM with flavour physics: why now?

* next-generation flavour experiments will be able to improve the experimental precision/ sensitivity by almost one order of magnitude

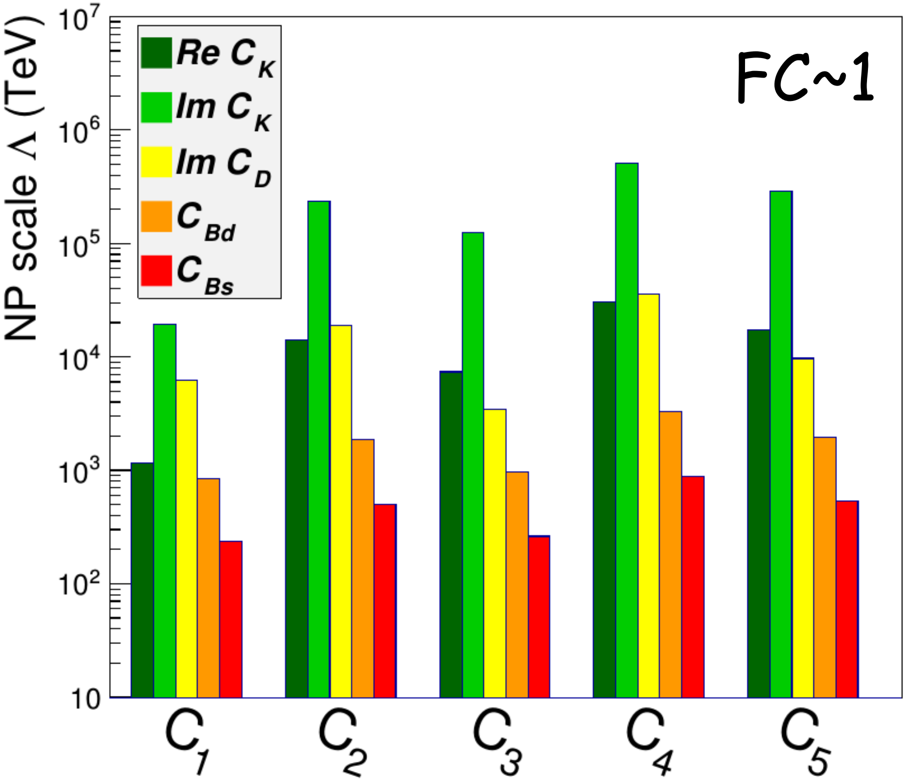
* enough NP-insensitive observables to pin down the SM contribution with the required accuracy

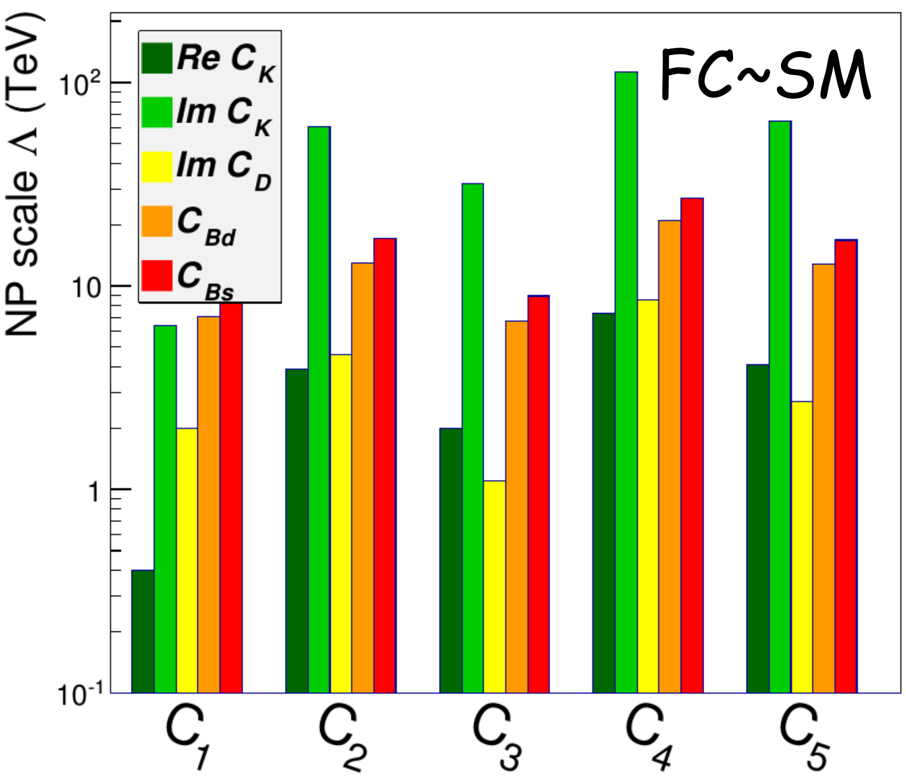
* several NP-sensitive observables not limited by systematics or theoretical uncertainties

Overall, the NP sensitivity extends to (i) the TeV region for SM-like flavour violation and to (ii) 10-100 TeV or even more in less constrained cases

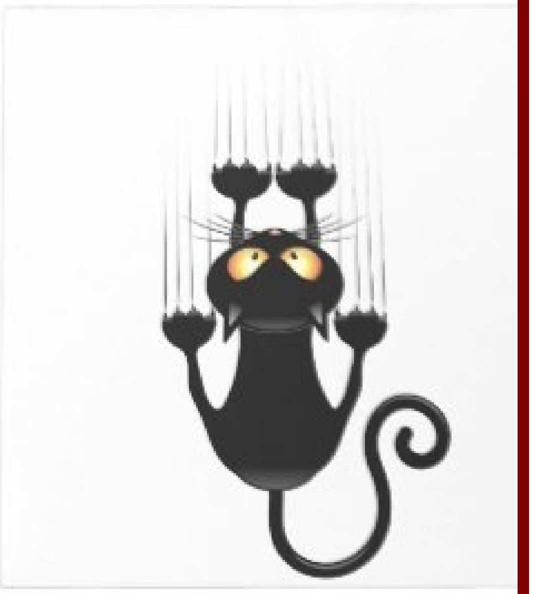
For example: lower bound on the NP scale from $\Delta F=2$ transitions (TeV @95%)

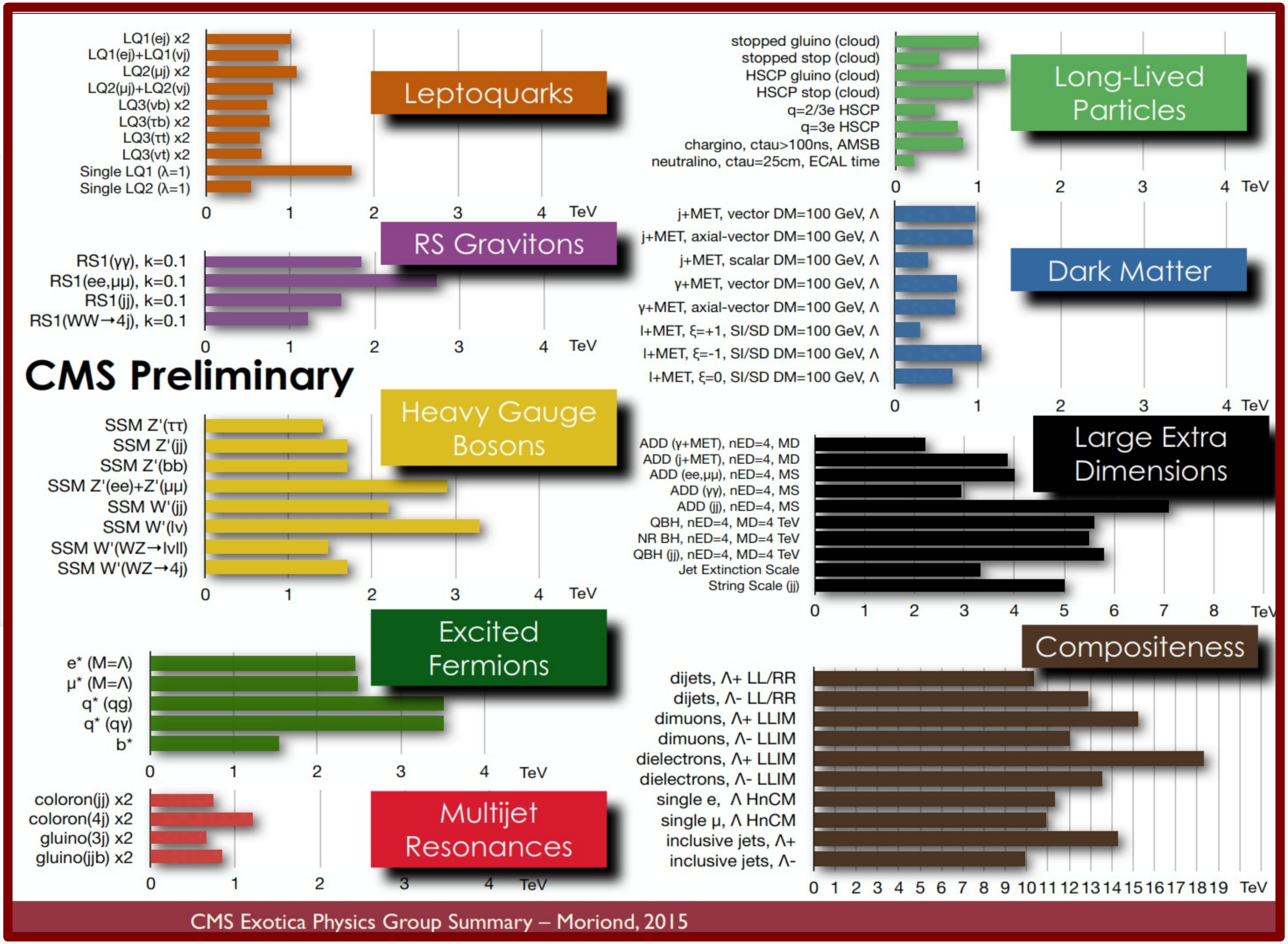
Λ (TeV)	K	D	B_d	B_s
FC~1	5×10^5	3.5×10^4	3.3×10^3	880
FC~SM	113	8.5	21	27





LHC already scratched the surface of the TeV region



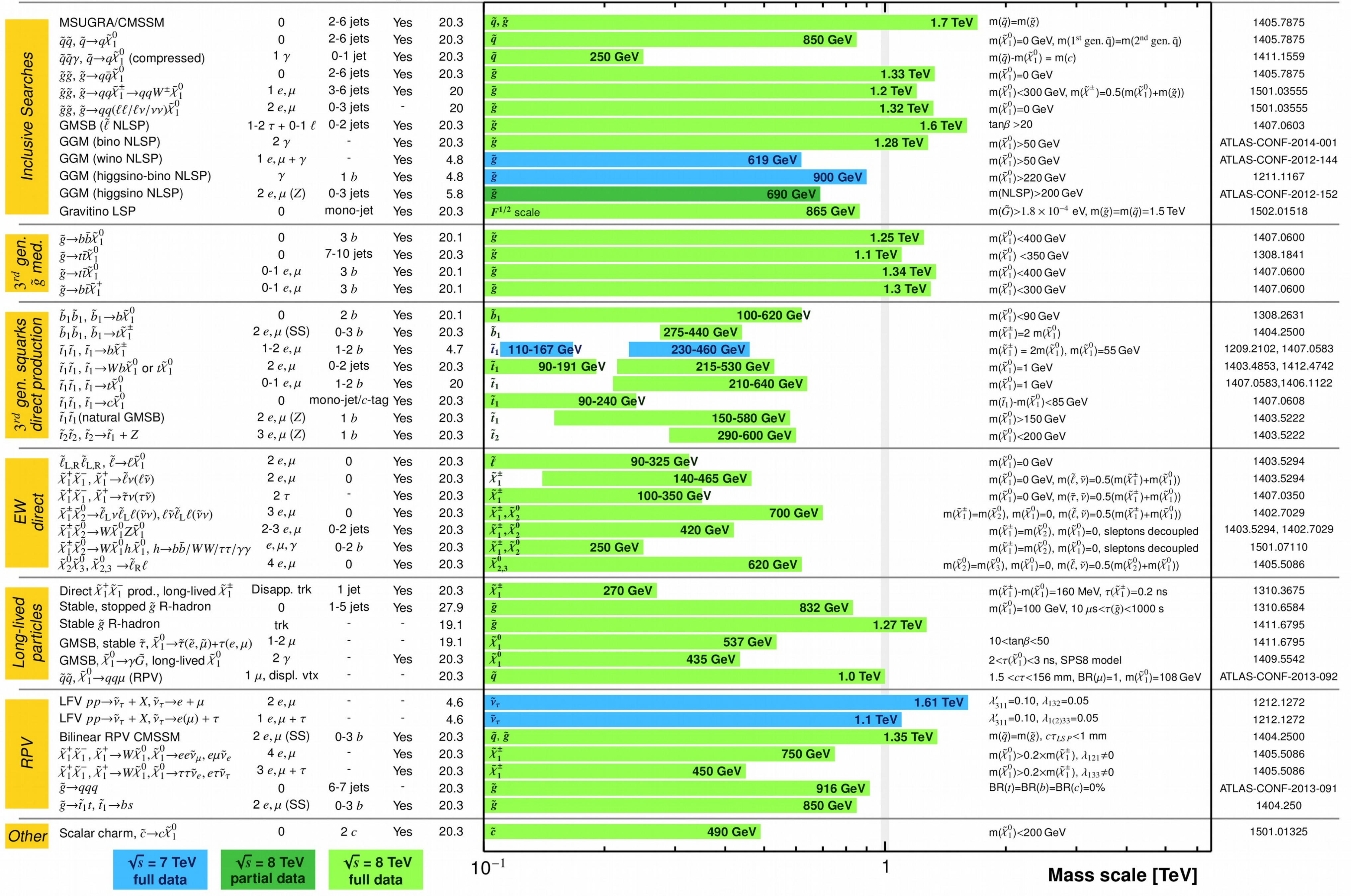


ATLAS SUSY Searches* - 95% CL Lower Limits

Status: Feb 2015

ATLAS Preliminary

$\sqrt{s}$ = 7, 8 TeV



	Model	e,μ,τ,γ	Jets	E_T^{miss}	$\int\mathcal{L}\,dt[\mathrm{fb}^{-1}]$	Mass limit		Reference
Inclusive Searches	MSUGRA/CMSSM	0	2-6 jets	Yes	20.3	$\tilde{q},\tilde{g}$ 1.7 TeV	m($\tilde{q}$)=m($\tilde{g}$)	1405.7875
	$\tilde{q}\tilde{q}$, $\tilde{q}\rightarrow q\tilde{\chi}_1^0$	0	2-6 jets	Yes	20.3	$\tilde{q}$ 850 GeV	m($\tilde{\chi}_1^0$)=0 GeV, m(1st gen. $\tilde{q}$)=m(2nd gen. $\tilde{q}$)	1405.7875
	$\tilde{q}\tilde{q}\gamma$, $\tilde{q}\rightarrow q\tilde{\chi}_1^0$ (compressed)	1 γ	0-1 jet	Yes	20.3	$\tilde{q}$ 250 GeV	m($\tilde{q}$)-m($\tilde{\chi}_1^0$) = m(c)	1411.1559
	$\tilde{g}\tilde{g}$, $\tilde{g}\rightarrow q\bar{q}\tilde{\chi}_1^0$	0	2-6 jets	Yes	20.3	$\tilde{g}$ 1.33 TeV	m($\tilde{\chi}_1^0$)=0 GeV	1405.7875
	$\tilde{g}\tilde{g}$, $\tilde{g}\rightarrow qq\tilde{\chi}_1^\pm\rightarrow qqW^\pm\tilde{\chi}_1^0$	1 e,μ	3-6 jets	Yes	20	$\tilde{g}$ 1.2 TeV	m($\tilde{\chi}_1^0$)<300 GeV, m($\tilde{\chi}^\pm$)=0.5(m($\tilde{\chi}_1^0$)+m($\tilde{g}$))	1501.03555
	$\tilde{g}\tilde{g}$, $\tilde{g}\rightarrow qq(\ell\ell/\ell\nu/\nu\nu)\tilde{\chi}_1^0$	2 e,μ	0-3 jets	-	20	$\tilde{g}$ 1.32 TeV	m($\tilde{\chi}_1^0$)=0 GeV	1501.03555
	GMSB ($\tilde{\ell}$ NLSP)	1-2 τ + 0-1 ℓ	0-2 jets	Yes	20.3	$\tilde{g}$ 1.6 TeV	tanβ >20	1407.0603
	GGM (bino NLSP)	2 γ	-	Yes	20.3	$\tilde{g}$ 1.28 TeV	m($\tilde{\chi}_1^0$)>50 GeV	ATLAS-CONF-2014-001
	GGM (wino NLSP)	1 $e,\mu+\gamma$	-	Yes	4.8	🟦 $\tilde{g}$ 619 GeV	m($\tilde{\chi}_1^0$)>50 GeV	ATLAS-CONF-2012-144
	GGM (higgsino-bino NLSP)	γ	1 b	Yes	4.8	🟦 $\tilde{g}$ 900 GeV	m($\tilde{\chi}_1^0$)>220 GeV	1211.1167
	GGM (higgsino NLSP)	2 e,μ (Z)	0-3 jets	Yes	5.8	▨ $\tilde{g}$ 690 GeV	m(NLSP)>200 GeV	ATLAS-CONF-2012-152
	Gravitino LSP	0	mono-jet	Yes	20.3	$F^{1/2}$ scale 865 GeV	m($\tilde{G}$)>1.8×10^{-4} eV, m($\tilde{g}$)=m($\tilde{q}$)=1.5 TeV	1502.01518
3^{rd} gen. $\tilde{g}$ med.	$\tilde{g}\rightarrow b\bar{b}\tilde{\chi}_1^0$	0	3 b	Yes	20.1	$\tilde{g}$ 1.25 TeV	m($\tilde{\chi}_1^0$)<400 GeV	1407.0600
	$\tilde{g}\rightarrow t\bar{t}\tilde{\chi}_1^0$	0	7-10 jets	Yes	20.3	$\tilde{g}$ 1.1 TeV	m($\tilde{\chi}_1^0$) <350 GeV	1308.1841
	$\tilde{g}\rightarrow t\bar{t}\tilde{\chi}_1^0$	0-1 e,μ	3 b	Yes	20.1	$\tilde{g}$ 1.34 TeV	m($\tilde{\chi}_1^0$)<400 GeV	1407.0600
	$\tilde{g}\rightarrow b\bar{t}\tilde{\chi}_1^+$	0-1 e,μ	3 b	Yes	20.1	$\tilde{g}$ 1.3 TeV	m($\tilde{\chi}_1^0$)<300 GeV	1407.0600
3^{rd} gen. squarks direct production	$\tilde{b}_1\tilde{b}_1$, $\tilde{b}_1\rightarrow b\tilde{\chi}_1^0$	0	2 b	Yes	20.1	$\tilde{b}_1$ 100-620 GeV	m($\tilde{\chi}_1^0$)<90 GeV	1308.2631
	$\tilde{b}_1\tilde{b}_1$, $\tilde{b}_1\rightarrow t\tilde{\chi}_1^\pm$	2 e,μ (SS)	0-3 b	Yes	20.3	$\tilde{b}_1$ 275-440 GeV	m($\tilde{\chi}_1^\pm$)=2 m($\tilde{\chi}_1^0$)	1404.2500
	$\tilde{t}_1\tilde{t}_1$, $\tilde{t}_1\rightarrow b\tilde{\chi}_1^\pm$	1-2 e,μ	1-2 b	Yes	4.7	🟦 $\tilde{t}_1$ 110-167 GeV 🟦 230-460 GeV	m($\tilde{\chi}_1^\pm$) = 2m($\tilde{\chi}_1^0$), m($\tilde{\chi}_1^0$)=55 GeV	1209.2102, 1407.0583
	$\tilde{t}_1\tilde{t}_1$, $\tilde{t}_1\rightarrow Wb\tilde{\chi}_1^0$ or $t\tilde{\chi}_1^0$	2 e,μ	0-2 jets	Yes	20.3	$\tilde{t}_1$ 90-191 GeV 215-530 GeV	m($\tilde{\chi}_1^0$)=1 GeV	1403.4853, 1412.4742
	$\tilde{t}_1\tilde{t}_1$, $\tilde{t}_1\rightarrow t\tilde{\chi}_1^0$	0-1 e,μ	1-2 b	Yes	20	$\tilde{t}_1$ 210-640 GeV	m($\tilde{\chi}_1^0$)=1 GeV	1407.0583,1406.1122
	$\tilde{t}_1\tilde{t}_1$, $\tilde{t}_1\rightarrow c\tilde{\chi}_1^0$	0	mono-jet/c-tag	Yes	20.3	$\tilde{t}_1$ 90-240 GeV	m($\tilde{t}_1$)-m($\tilde{\chi}_1^0$)<85 GeV	1407.0608
	$\tilde{t}_1\tilde{t}_1$(natural GMSB)	2 e,μ (Z)	1 b	Yes	20.3	$\tilde{t}_1$ 150-580 GeV	m($\tilde{\chi}_1^0$)>150 GeV	1403.5222
	$\tilde{t}_2\tilde{t}_2$, $\tilde{t}_2\rightarrow\tilde{t}_1+Z$	3 e,μ (Z)	1 b	Yes	20.3	$\tilde{t}_2$ 290-600 GeV	m($\tilde{\chi}_1^0$)<200 GeV	1403.5222
EW direct	$\tilde{\ell}_{L,R}\tilde{\ell}_{L,R}$, $\tilde{\ell}\rightarrow\ell\tilde{\chi}_1^0$	2 e,μ	0	Yes	20.3	$\tilde{\ell}$ 90-325 GeV	m($\tilde{\chi}_1^0$)=0 GeV	1403.5294
	$\tilde{\chi}_1^+\tilde{\chi}_1^-$, $\tilde{\chi}_1^+\rightarrow\tilde{\ell}\nu(\ell\tilde{\nu})$	2 e,μ	0	Yes	20.3	$\tilde{\chi}_1^\pm$ 140-465 GeV	m($\tilde{\chi}_1^0$)=0 GeV, m($\tilde{\ell},\tilde{\nu}$)=0.5(m($\tilde{\chi}_1^\pm$)+m($\tilde{\chi}_1^0$))	1403.5294
	$\tilde{\chi}_1^+\tilde{\chi}_1^-$, $\tilde{\chi}_1^+\rightarrow\tilde{\tau}\nu(\tau\tilde{\nu})$	2 τ	-	Yes	20.3	$\tilde{\chi}_1^\pm$ 100-350 GeV	m($\tilde{\chi}_1^0$)=0 GeV, m($\tilde{\tau},\tilde{\nu}$)=0.5(m($\tilde{\chi}_1^\pm$)+m($\tilde{\chi}_1^0$))	1407.0350
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\rightarrow\tilde{\ell}_L\nu\tilde{\ell}_L\ell(\tilde{\nu}\nu),\ell\tilde{\nu}\tilde{\ell}_L\ell(\tilde{\nu}\nu)$	3 e,μ	0	Yes	20.3	$\tilde{\chi}_1^\pm,\tilde{\chi}_2^0$ 700 GeV	m($\tilde{\chi}_1^\pm$)=m($\tilde{\chi}_2^0$), m($\tilde{\chi}_1^0$)=0, m($\tilde{\ell},\tilde{\nu}$)=0.5(m($\tilde{\chi}_1^\pm$)+m($\tilde{\chi}_1^0$))	1402.7029
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\rightarrow W\tilde{\chi}_1^0Z\tilde{\chi}_1^0$	2-3 e,μ	0-2 jets	Yes	20.3	$\tilde{\chi}_1^\pm,\tilde{\chi}_2^0$ 420 GeV	m($\tilde{\chi}_1^\pm$)=m($\tilde{\chi}_2^0$), m($\tilde{\chi}_1^0$)=0, sleptons decoupled	1403.5294, 1402.7029
	$\tilde{\chi}_1^\pm\tilde{\chi}_2^0\rightarrow W\tilde{\chi}_1^0h\tilde{\chi}_1^0$, $h\rightarrow b\bar{b}/WW/\tau\tau/\gamma\gamma$	e,μ,γ	0-2 b	Yes	20.3	$\tilde{\chi}_1^\pm,\tilde{\chi}_2^0$ 250 GeV	m($\tilde{\chi}_1^\pm$)=m($\tilde{\chi}_2^0$), m($\tilde{\chi}_1^0$)=0, sleptons decoupled	1501.07110
	$\tilde{\chi}_2^0\tilde{\chi}_3^0$, $\tilde{\chi}_{2,3}^0\rightarrow\tilde{\ell}_R\ell$	4 e,μ	0	Yes	20.3	$\tilde{\chi}_{2,3}^0$ 620 GeV	m($\tilde{\chi}_2^0$)=m($\tilde{\chi}_3^0$), m($\tilde{\chi}_1^0$)=0, m($\tilde{\ell},\tilde{\nu}$)=0.5(m($\tilde{\chi}_2^0$)+m($\tilde{\chi}_1^0$))	1405.5086
Long-lived particles	Direct $\tilde{\chi}_1^+\tilde{\chi}_1^-$ prod., long-lived $\tilde{\chi}_1^\pm$	Disapp. trk	1 jet	Yes	20.3	$\tilde{\chi}_1^\pm$ 270 GeV	m($\tilde{\chi}_1^\pm$)-m($\tilde{\chi}_1^0$)=160 MeV, τ($\tilde{\chi}_1^\pm$)=0.2 ns	1310.3675
	Stable, stopped $\tilde{g}$ R-hadron	0	1-5 jets	Yes	27.9	$\tilde{g}$ 832 GeV	m($\tilde{\chi}_1^0$)=100 GeV, 10 μs<τ($\tilde{g}$)<1000 s	1310.6584
	Stable $\tilde{g}$ R-hadron	trk	-	-	19.1	$\tilde{g}$ 1.27 TeV		1411.6795
	GMSB, stable $\tilde{\tau}$, $\tilde{\chi}_1^0\rightarrow\tilde{\tau}(\tilde{e},\tilde{\mu})+\tau(e,\mu)$	1-2 μ	-	-	19.1	$\tilde{\chi}_1^0$ 537 GeV	10<tanβ<50	1411.6795
	GMSB, $\tilde{\chi}_1^0\rightarrow\gamma\tilde{G}$, long-lived $\tilde{\chi}_1^0$	2 γ	-	Yes	20.3	$\tilde{\chi}_1^0$ 435 GeV	2<τ($\tilde{\chi}_1^0$)<3 ns, SPS8 model	1409.5542
	$\tilde{q}\tilde{q}$, $\tilde{\chi}_1^0\rightarrow qq\mu$ (RPV)	1 μ, displ. vtx	-	-	20.3	$\tilde{q}$ 1.0 TeV	1.5 <$c\tau$<156 mm, BR(μ)=1, m($\tilde{\chi}_1^0$)=108 GeV	ATLAS-CONF-2013-092
RPV	LFV $pp\rightarrow\tilde{\nu}_\tau+X,\tilde{\nu}_\tau\rightarrow e+\mu$	2 e,μ	-	-	4.6	🟦 $\tilde{\nu}_\tau$ 1.61 TeV	λ'_{311}=0.10, λ_{132}=0.05	1212.1272
	LFV $pp\rightarrow\tilde{\nu}_\tau+X,\tilde{\nu}_\tau\rightarrow e(\mu)+\tau$	1 $e,\mu+\tau$	-	-	4.6	🟦 $\tilde{\nu}_\tau$ 1.1 TeV	λ'_{311}=0.10, $\lambda_{1(2)33}$=0.05	1212.1272
	Bilinear RPV CMSSM	2 e,μ (SS)	0-3 b	Yes	20.3	$\tilde{q},\tilde{g}$ 1.35 TeV	m($\tilde{q}$)=m($\tilde{g}$), $c\tau_{LSP}$<1 mm	1404.2500
	$\tilde{\chi}_1^+\tilde{\chi}_1^-$, $\tilde{\chi}_1^+\rightarrow W\tilde{\chi}_1^0$, $\tilde{\chi}_1^0\rightarrow ee\tilde{\nu}_\mu, e\mu\tilde{\nu}_e$	4 e,μ	-	Yes	20.3	$\tilde{\chi}_1^\pm$ 750 GeV	m($\tilde{\chi}_1^0$)>0.2×m($\tilde{\chi}_1^\pm$), $\lambda_{121}\neq0$	1405.5086
	$\tilde{\chi}_1^+\tilde{\chi}_1^-$, $\tilde{\chi}_1^+\rightarrow W\tilde{\chi}_1^0$, $\tilde{\chi}_1^0\rightarrow\tau\tau\tilde{\nu}_e, e\tau\tilde{\nu}_\tau$	3 $e,\mu+\tau$	-	Yes	20.3	$\tilde{\chi}_1^\pm$ 450 GeV	m($\tilde{\chi}_1^0$)>0.2×m($\tilde{\chi}_1^\pm$), $\lambda_{133}\neq0$	1405.5086
	$\tilde{g}\rightarrow qqq$	0	6-7 jets	-	20.3	$\tilde{g}$ 916 GeV	BR(t)=BR(b)=BR(c)=0%	ATLAS-CONF-2013-091
	$\tilde{g}\rightarrow\tilde{t}_1t$, $\tilde{t}_1\rightarrow bs$	2 e,μ (SS)	0-3 b	Yes	20.3	$\tilde{g}$ 850 GeV		1404.250
Other	Scalar charm, $\tilde{c}\rightarrow c\tilde{\chi}_1^0$	0	2 c	Yes	20.3	$\tilde{c}$ 490 GeV	m($\tilde{\chi}_1^0$)<200 GeV	1501.01325

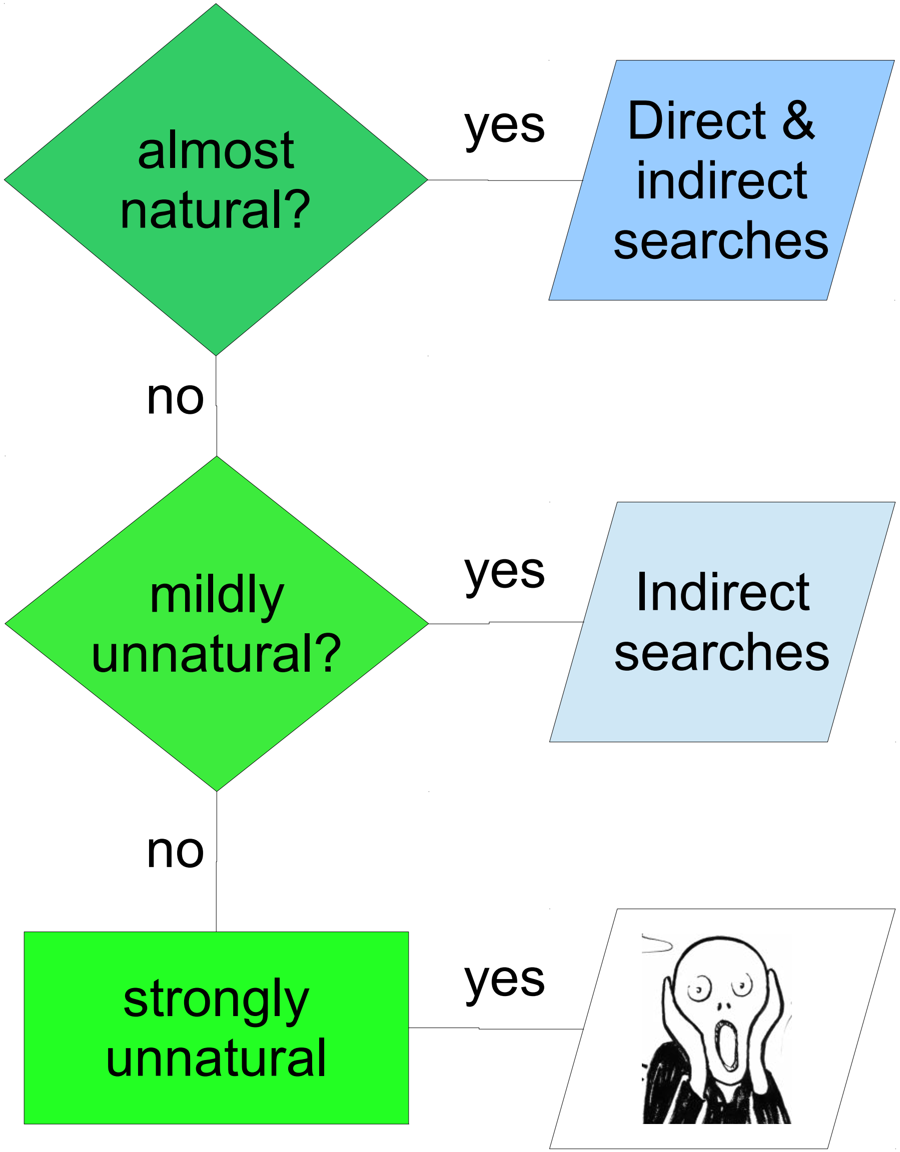
🟦 $\sqrt{s}$ = 7 TeV full data

▨ $\sqrt{s}$ = 8 TeV partial data

🟩 $\sqrt{s}$ = 8 TeV full data

*Only a selection of the available mass limits on new states or phenomena is shown. All limits quoted are observed minus 1σ theoretical signal cross section uncertainty.

How much "natural" is Nature?



almost natural?

yes

Direct & indirect searches

no

mildly unnatural?

yes

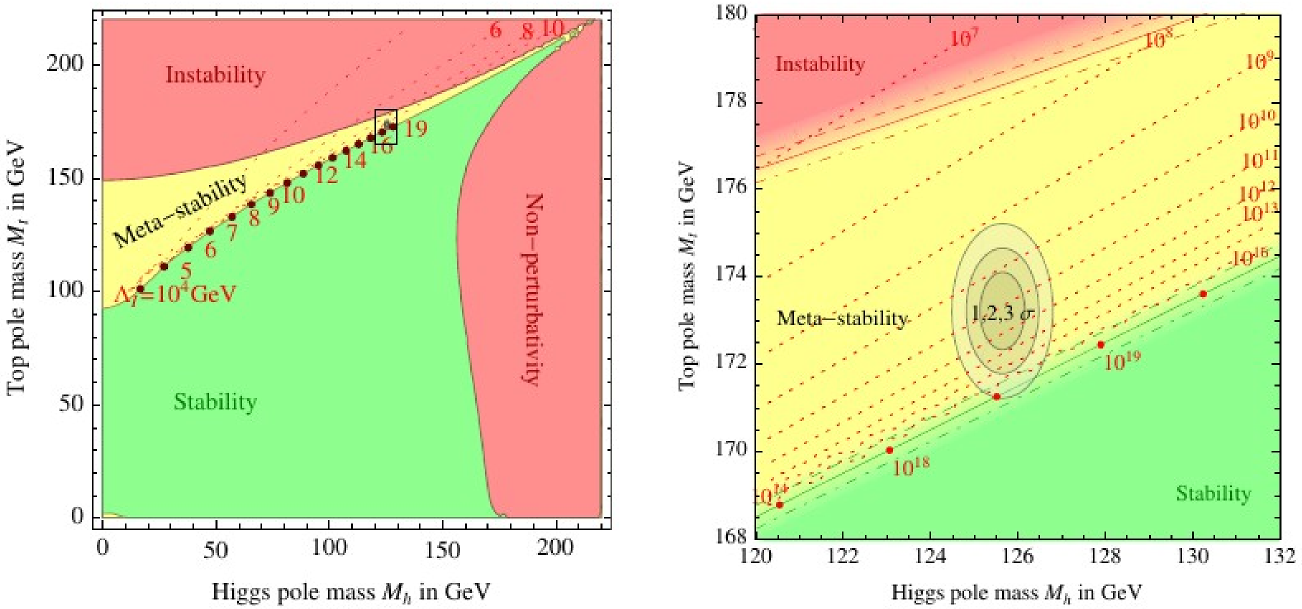
Indirect searches

no

strongly unnatural

yes

illustration by G. Villadoro

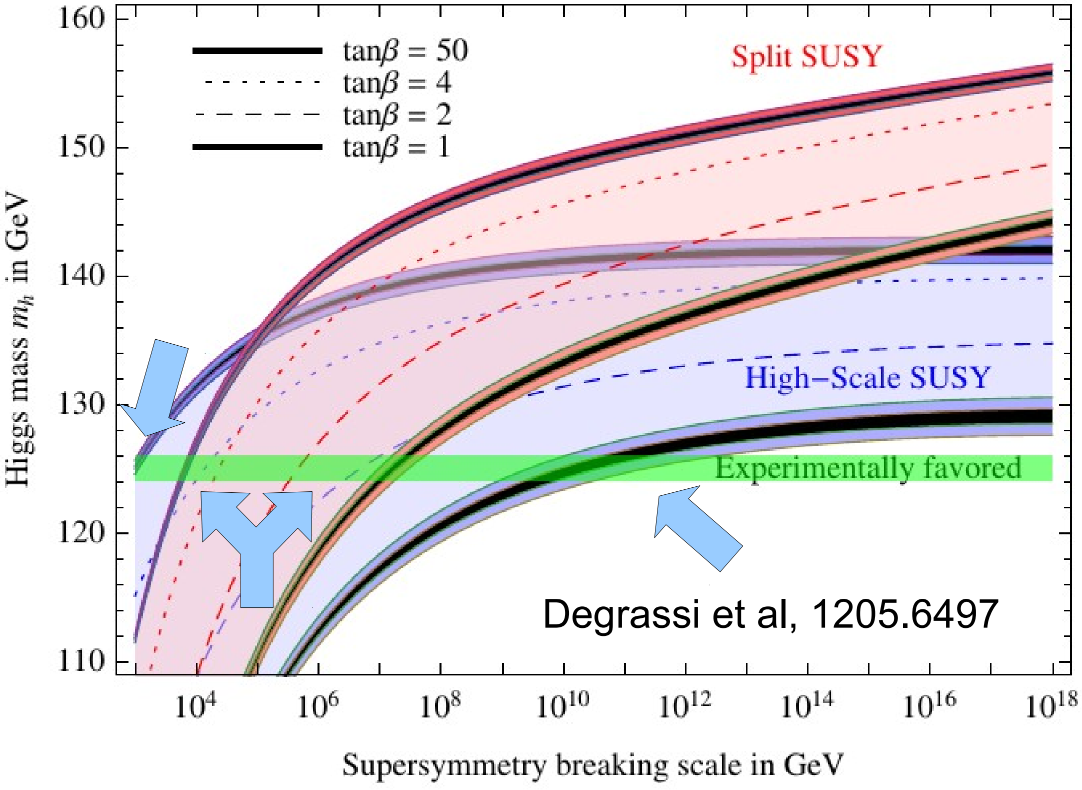


Buttazzo et al, 1307.3536

What does Higgs have to say?

- * unfortunately we do not drop the cliff, staying on the edge does not help!
- * Interesting (althoug model-dependent) information

Predicted range for the Higgs mass



Degrassi et al, 1205.6497

Players on the flavour playground

CMS
Compact Muon Solenoid

ATLAS

LHCb

Belle II

BESIII

NA62
P326

KOTO

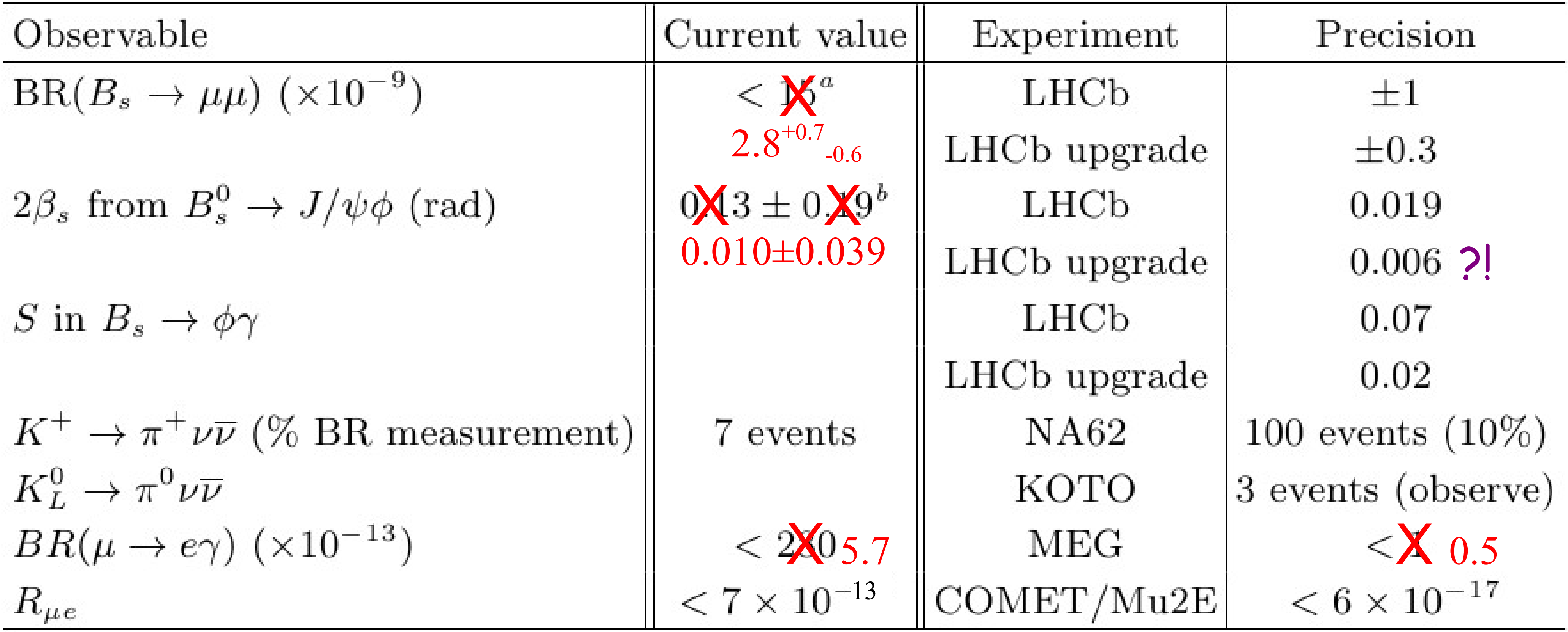
Mu2e

COMET

μ e γ

What Belle II cannot do

Golden modes of other flavor experiments

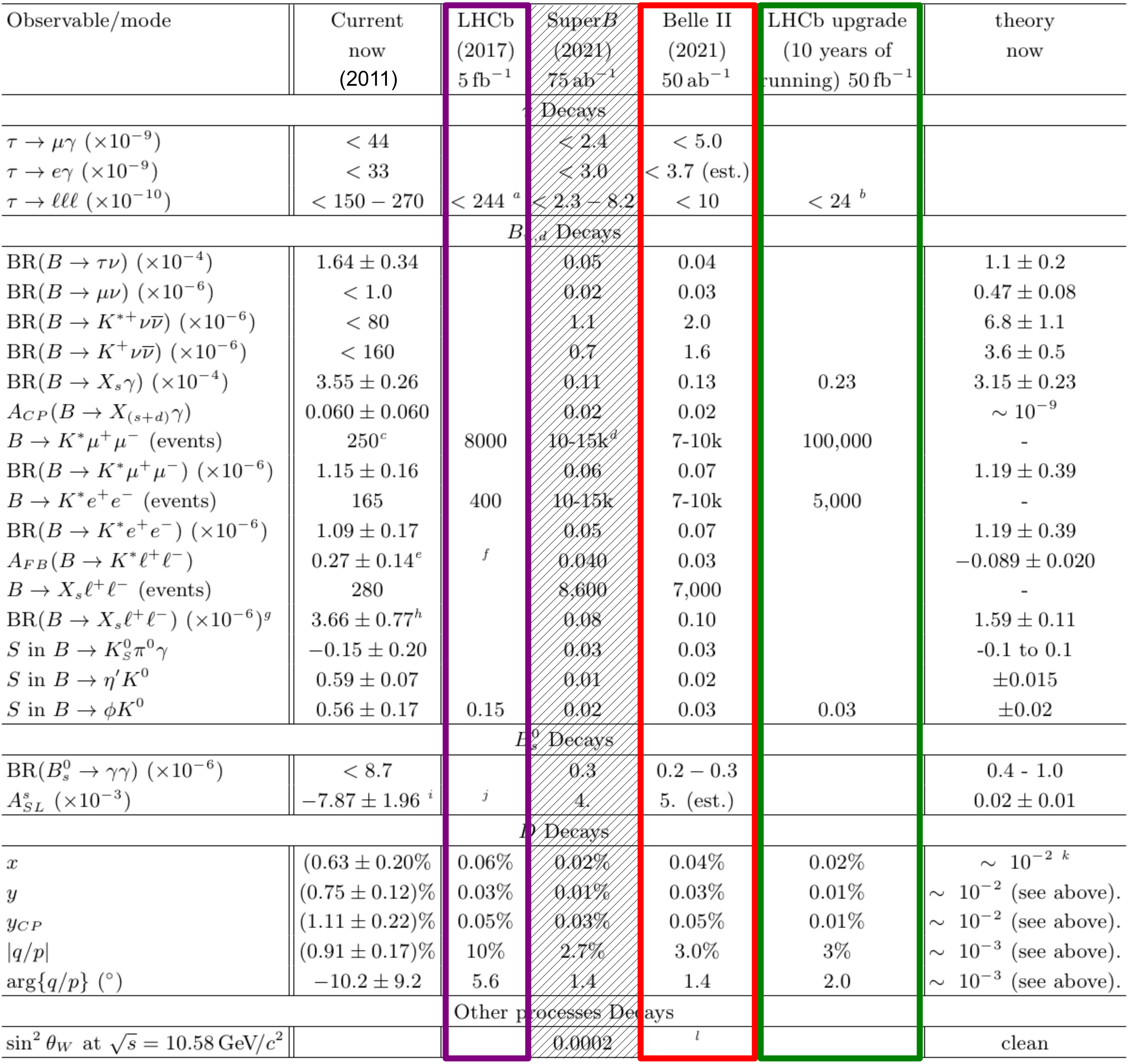


Observable	Current value	Experiment	Precision
$\mathrm{BR}(B_s \to \mu\mu)$ $(\times 10^{-9})$	$< \cancel{15}^{a}$ $2.8^{+0.7}_{-0.6}$	LHCb	± 1
		LHCb upgrade	± 0.3
$2\beta_s$ from $B_s^0 \to J/\psi\phi$ (rad)	$0.\cancel{1}3 \pm 0.\cancel{1}9^{b}$ 0.010±0.039	LHCb	0.019
		LHCb upgrade	0.006 ?!
S in $B_s \to \phi\gamma$		LHCb	0.07
		LHCb upgrade	0.02
$K^+ \to \pi^+ \nu\bar{\nu}$ (% BR measurement)	7 events	NA62	100 events (10%)
$K_L^0 \to \pi^0 \nu\bar{\nu}$		KOTO	3 events (observe)
$BR(\mu \to e\gamma)$ $(\times 10^{-13})$	$< 2\cancel{8}0$ 5.7	MEG	$< \cancel{1}$ 0.5
$R_{\mu e}$	$< 7 \times 10^{-13}$	COMET/Mu2E	$< 6 \times 10^{-17}$

based on arXiv:1109.5028

Belle II golden channels

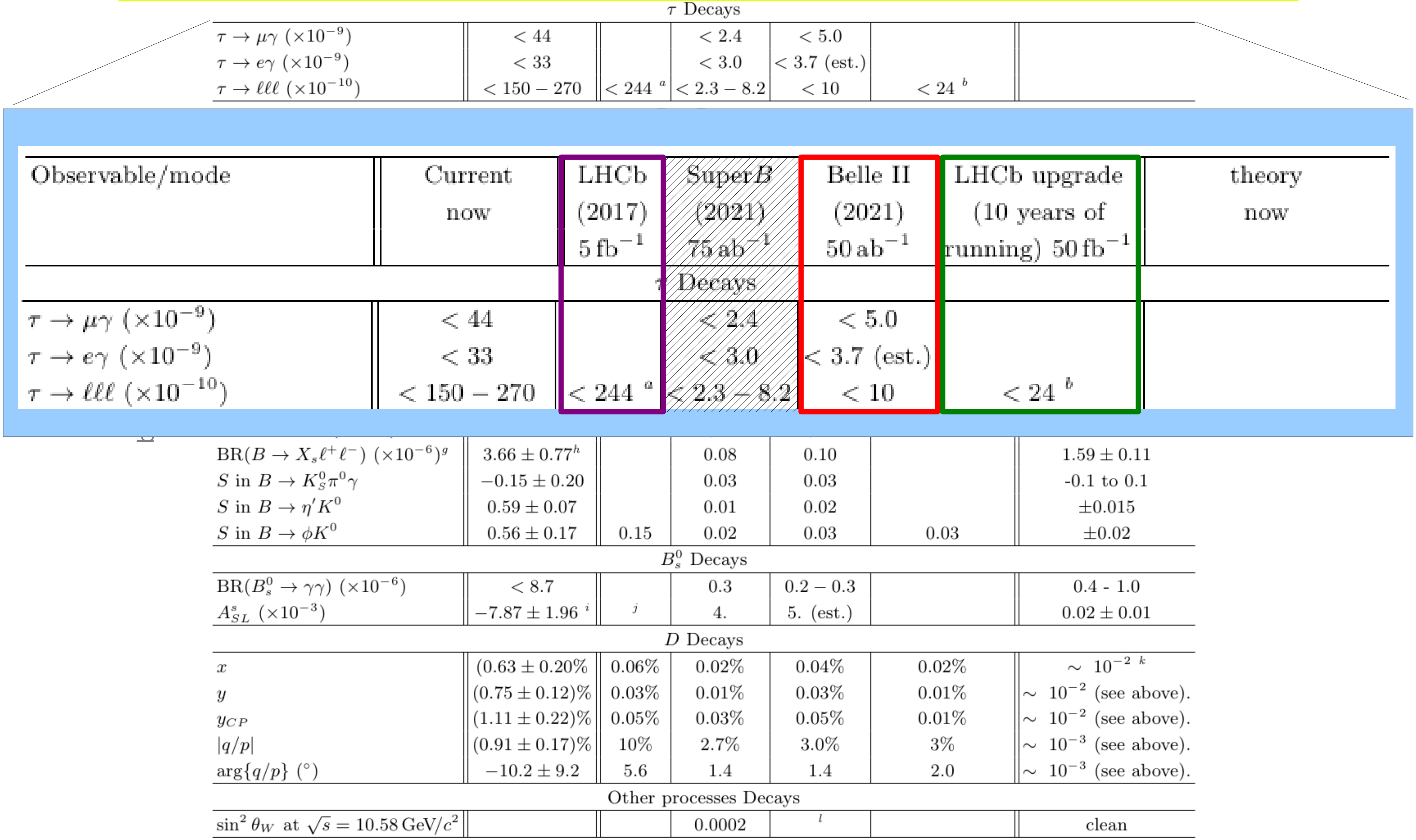
based on arXiv:1109.5028



Observable/mode	Current now (2011)	LHCb (2017) $5\,\mathrm{fb}^{-1}$	SuperB (2021) $75\,\mathrm{ab}^{-1}$	Belle II (2021) $50\,\mathrm{ab}^{-1}$	LHCb upgrade (10 years of running) $50\,\mathrm{fb}^{-1}$	theory now
τ Decays						
$\tau \to \mu\gamma$ $(\times 10^{-9})$	< 44		< 2.4	< 5.0		
$\tau \to e\gamma$ $(\times 10^{-9})$	< 33		< 3.0	< 3.7 (est.)		
$\tau \to \ell\ell\ell$ $(\times 10^{-10})$	$< 150 - 270$	< 244 [a]	$< 2.3 - 8.2$	< 10	< 24 [b]	
$B_{,d}$ Decays						
$\mathrm{BR}(B \to \tau\nu)$ $(\times 10^{-4})$	1.64 ± 0.34		0.05	0.04		1.1 ± 0.2
$\mathrm{BR}(B \to \mu\nu)$ $(\times 10^{-6})$	< 1.0		0.02	0.03		0.47 ± 0.08
$\mathrm{BR}(B \to K^{*+}\nu\overline{\nu})$ $(\times 10^{-6})$	< 80		1.1	2.0		6.8 ± 1.1
$\mathrm{BR}(B \to K^{+}\nu\overline{\nu})$ $(\times 10^{-6})$	< 160		0.7	1.6		3.6 ± 0.5
$\mathrm{BR}(B \to X_s\gamma)$ $(\times 10^{-4})$	3.55 ± 0.26		0.11	0.13	0.23	3.15 ± 0.23
$A_{CP}(B \to X_{(s+d)}\gamma)$	0.060 ± 0.060		0.02	0.02		$\sim 10^{-9}$
$B \to K^*\mu^+\mu^-$ (events)	250^c	8000	10-15k[d]	7-10k	100,000	-
$\mathrm{BR}(B \to K^*\mu^+\mu^-)$ $(\times 10^{-6})$	1.15 ± 0.16		0.06	0.07		1.19 ± 0.39
$B \to K^*e^+e^-$ (events)	165	400	10-15k	7-10k	5,000	-
$\mathrm{BR}(B \to K^*e^+e^-)$ $(\times 10^{-6})$	1.09 ± 0.17		0.05	0.07		1.19 ± 0.39
$A_{FB}(B \to K^*\ell^+\ell^-)$	0.27 ± 0.14^e	[f]	0.040	0.03		-0.089 ± 0.020
$B \to X_s\ell^+\ell^-$ (events)	280		8,600	7,000		-
$\mathrm{BR}(B \to X_s\ell^+\ell^-)$ $(\times 10^{-6})^g$	3.66 ± 0.77^h		0.08	0.10		1.59 ± 0.11
S in $B \to K_S^0\pi^0\gamma$	-0.15 ± 0.20		0.03	0.03		-0.1 to 0.1
S in $B \to \eta' K^0$	0.59 ± 0.07		0.01	0.02		± 0.015
S in $B \to \phi K^0$	0.56 ± 0.17	0.15	0.02	0.03	0.03	± 0.02
B_s^0 Decays						
$\mathrm{BR}(B_s^0 \to \gamma\gamma)$ $(\times 10^{-6})$	< 8.7		0.3	$0.2 - 0.3$		0.4 - 1.0
A_{SL}^s $(\times 10^{-3})$	-7.87 ± 1.96 [i]	[j]	4.	5. (est.)		0.02 ± 0.01
D Decays						
x	$(0.63 \pm 0.20\%$	0.06%	0.02%	0.04%	0.02%	$\sim 10^{-2}$ [k]
y	$(0.75 \pm 0.12)\%$	0.03%	0.01%	0.03%	0.01%	$\sim 10^{-2}$ (see above).
y_{CP}	$(1.11 \pm 0.22)\%$	0.05%	0.03%	0.05%	0.01%	$\sim 10^{-2}$ (see above).
$\|q/p\|$	$(0.91 \pm 0.17)\%$	10%	2.7%	3.0%	3%	$\sim 10^{-3}$ (see above).
$\arg\{q/p\}$ $(^\circ)$	-10.2 ± 9.2	5.6	1.4	1.4	2.0	$\sim 10^{-3}$ (see above).
Other processes Decays						
$\sin^2\theta_W$ at $\sqrt{s} = 10.58\,\mathrm{GeV}/c^2$			0.0002	[l]		clean

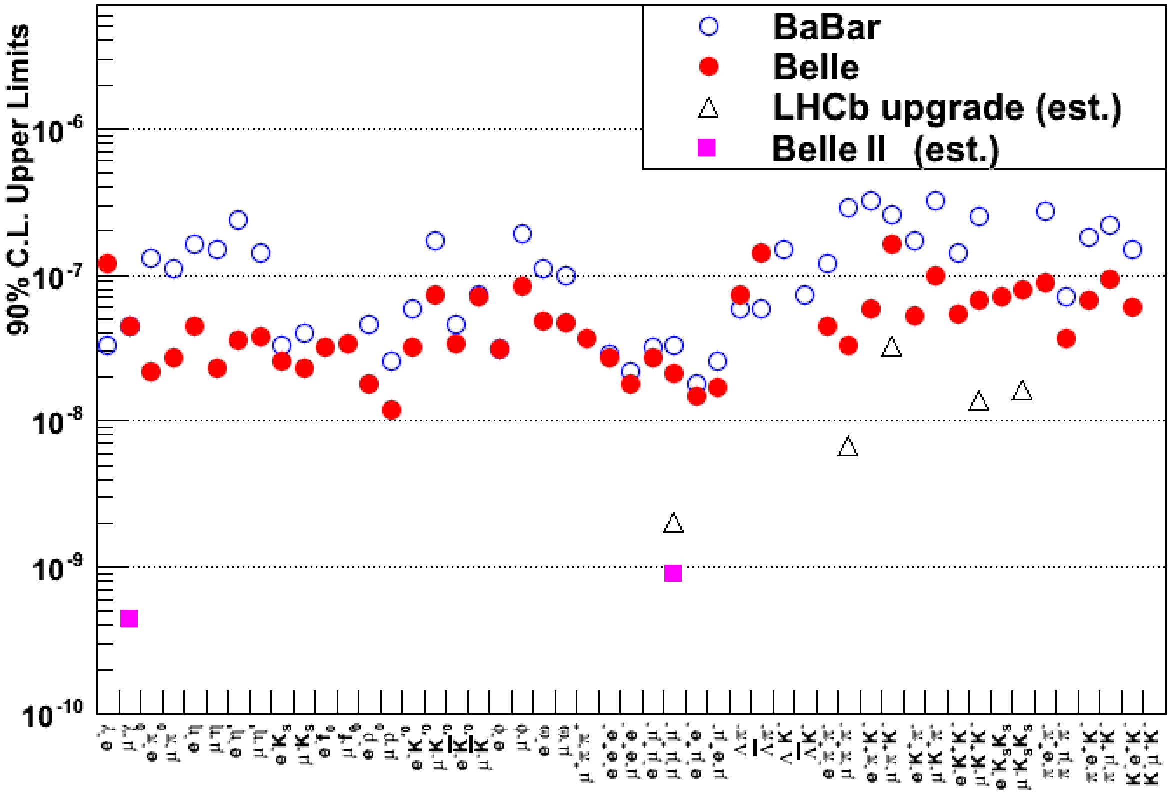
Belle II golden channels

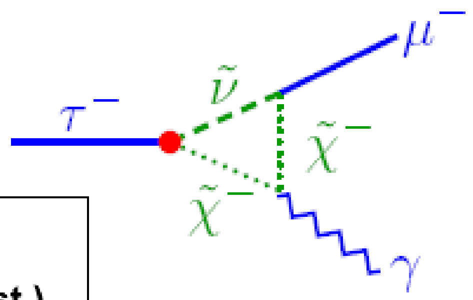
τ flavor violation

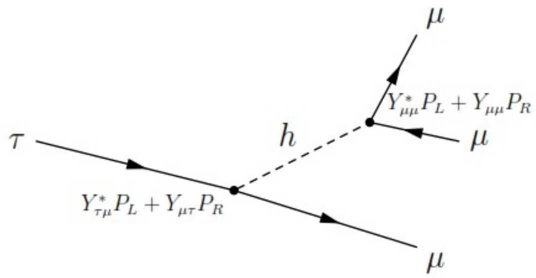


Observable/mode	Current now	LHCb (2017) 5 fb^{-1}	Super$B$ (2021) 75 ab^{-1}	Belle II (2021) 50 ab^{-1}	LHCb upgrade (10 years of running) 50 fb^{-1}	theory now
τ Decays						
$\tau \to \mu\gamma$ $(\times 10^{-9})$	< 44		< 2.4	< 5.0		
$\tau \to e\gamma$ $(\times 10^{-9})$	< 33		< 3.0	< 3.7 (est.)		
$\tau \to \ell\ell\ell$ $(\times 10^{-10})$	$< 150 - 270$	< 244 [a]	$< 2.3 - 8.2$	< 10	< 24 [b]	
BR$(B \to X_s \ell^+\ell^-)$ $(\times 10^{-6})$[g]	3.66 ± 0.77[h]		0.08	0.10		1.59 ± 0.11
S in $B \to K_S^0 \pi^0 \gamma$	-0.15 ± 0.20		0.03	0.03		-0.1 to 0.1
S in $B \to \eta' K^0$	0.59 ± 0.07		0.01	0.02		± 0.015
S in $B \to \phi K^0$	0.56 ± 0.17	0.15	0.02	0.03	0.03	± 0.02
B_s^0 Decays						
BR$(B_s^0 \to \gamma\gamma)$ $(\times 10^{-6})$	< 8.7		0.3	$0.2 - 0.3$		0.4 - 1.0
A_{SL}^s $(\times 10^{-3})$	-7.87 ± 1.96 [i]	[j]	4.	5. (est.)		0.02 ± 0.01
D Decays						
x	$(0.63 \pm 0.20\%$	0.06%	0.02%	0.04%	0.02%	$\sim 10^{-2}$ [k]
y	$(0.75 \pm 0.12)\%$	0.03%	0.01%	0.03%	0.01%	$\sim 10^{-2}$ (see above).
y_{CP}	$(1.11 \pm 0.22)\%$	0.05%	0.03%	0.05%	0.01%	$\sim 10^{-2}$ (see above).
$\|q/p\|$	$(0.91 \pm 0.17)\%$	10%	2.7%	3.0%	3%	$\sim 10^{-3}$ (see above).
arg$\{q/p\}$ $(^\circ)$	-10.2 ± 9.2	5.6	1.4	1.4	2.0	$\sim 10^{-3}$ (see above).
Other processes Decays						
$\sin^2\theta_W$ at $\sqrt{s} = 10.58\,\mathrm{GeV}/c^2$			0.0002	[l]		clean

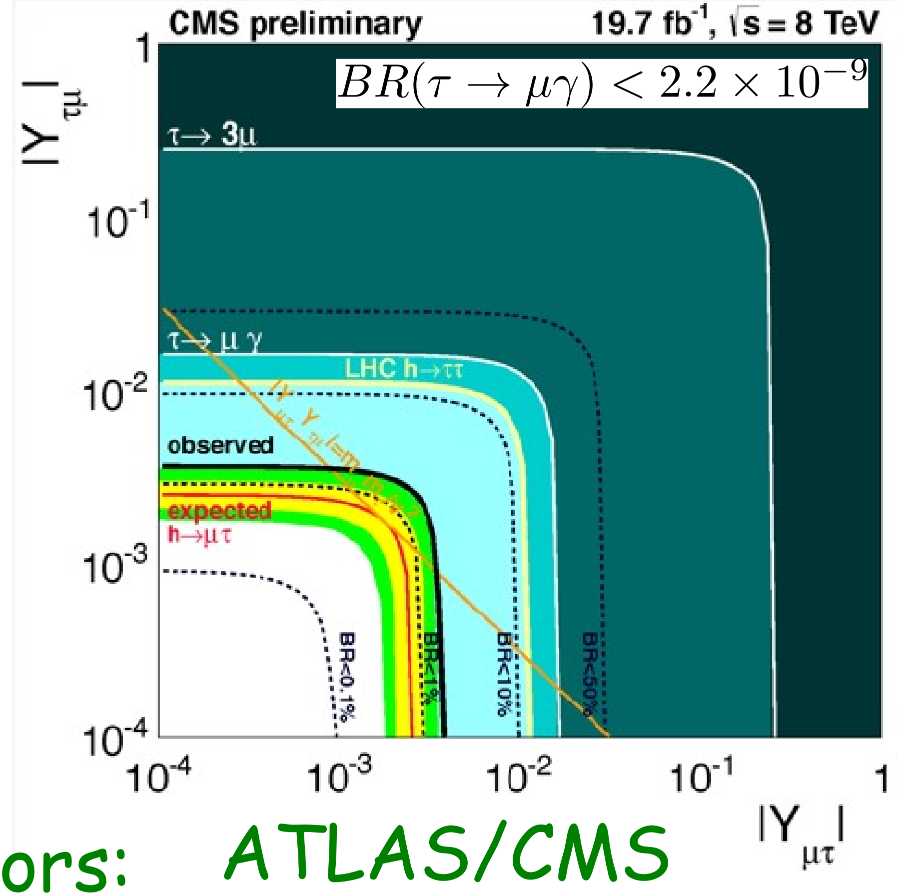
τ flavour violation







Harnik, Kopp, Zupan, arXiv:1209.1397



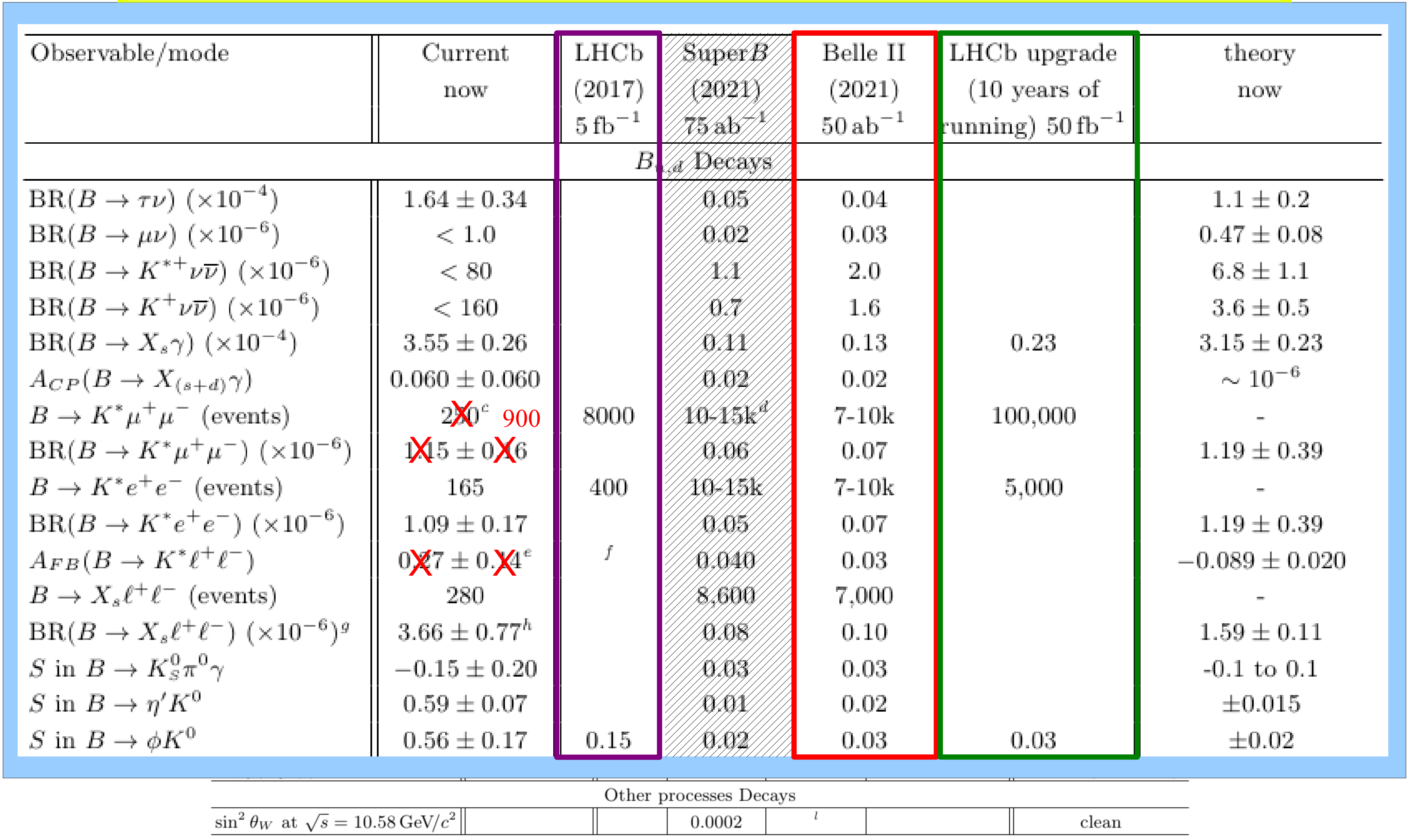
Est. sensitivities: 4x10^{-9} (μγ), 1x10^{-9} (3μ)

Null test of the SM

Strong model-dependent competitors: ATLAS/CMS

MEG: BR(μ → eγ) < 5.7x10^{-13} @90%CL → 5x10^{-14} (upgrade)

Belle II golden channels
FCNC & CPV in B$_{d/u}$ decays



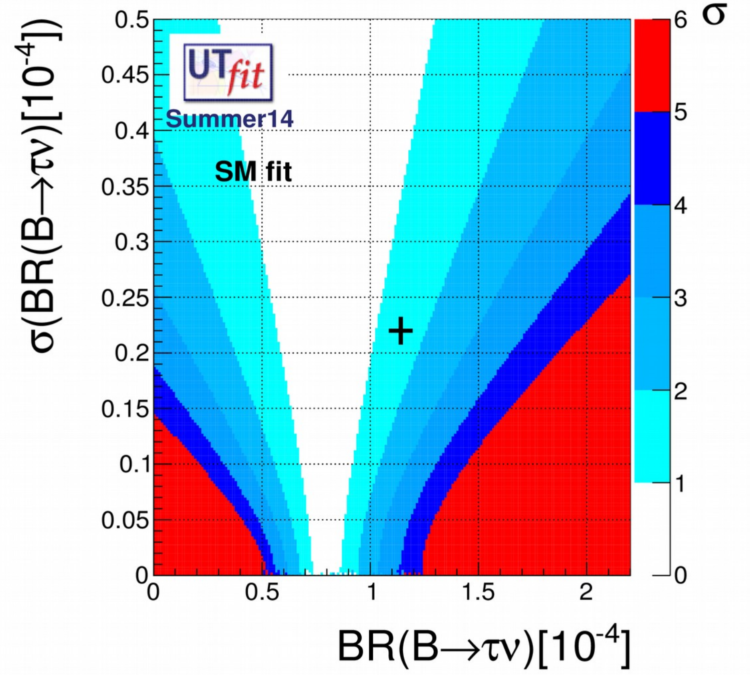
Observable/mode	Current now	LHCb (2017) 5 fb^{-1}	Super*B* (2021) 75 ab^{-1}	Belle II (2021) 50 ab^{-1}	LHCb upgrade (10 years of running) 50 fb^{-1}	theory now
			$B_{u,d}$ Decays			
$\mathrm{BR}(B \to \tau\nu)$ $(\times 10^{-4})$	1.64 ± 0.34		0.05	0.04		1.1 ± 0.2
$\mathrm{BR}(B \to \mu\nu)$ $(\times 10^{-6})$	< 1.0		0.02	0.03		0.47 ± 0.08
$\mathrm{BR}(B \to K^{*+}\nu\bar{\nu})$ $(\times 10^{-6})$	< 80		1.1	2.0		6.8 ± 1.1
$\mathrm{BR}(B \to K^{+}\nu\bar{\nu})$ $(\times 10^{-6})$	< 160		0.7	1.6		3.6 ± 0.5
$\mathrm{BR}(B \to X_s\gamma)$ $(\times 10^{-4})$	3.55 ± 0.26		0.11	0.13	0.23	3.15 ± 0.23
$A_{CP}(B \to X_{(s+d)}\gamma)$	0.060 ± 0.060		0.02	0.02		$\sim 10^{-6}$
$B \to K^*\mu^+\mu^-$ (events)	2~~5~~0^c 900	8000	10-15k^d	7-10k	100,000	-
$\mathrm{BR}(B \to K^*\mu^+\mu^-)$ $(\times 10^{-6})$	1~~.1~~5 ± 0.~~1~~6		0.06	0.07		1.19 ± 0.39
$B \to K^*e^+e^-$ (events)	165	400	10-15k	7-10k	5,000	-
$\mathrm{BR}(B \to K^*e^+e^-)$ $(\times 10^{-6})$	1.09 ± 0.17		0.05	0.07		1.19 ± 0.39
$A_{FB}(B \to K^*\ell^+\ell^-)$	0~~.2~~7 ± 0.~~1~~4^e	^{f}	0.040	0.03		-0.089 ± 0.020
$B \to X_s\ell^+\ell^-$ (events)	280		8,600	7,000		-
$\mathrm{BR}(B \to X_s\ell^+\ell^-)$ $(\times 10^{-6})^g$	3.66 ± 0.77^h		0.08	0.10		1.59 ± 0.11
S in $B \to K^0_S\pi^0\gamma$	-0.15 ± 0.20		0.03	0.03		-0.1 to 0.1
S in $B \to \eta' K^0$	0.59 ± 0.07		0.01	0.02		±0.015
S in $B \to \phi K^0$	0.56 ± 0.17	0.15	0.02	0.03	0.03	±0.02

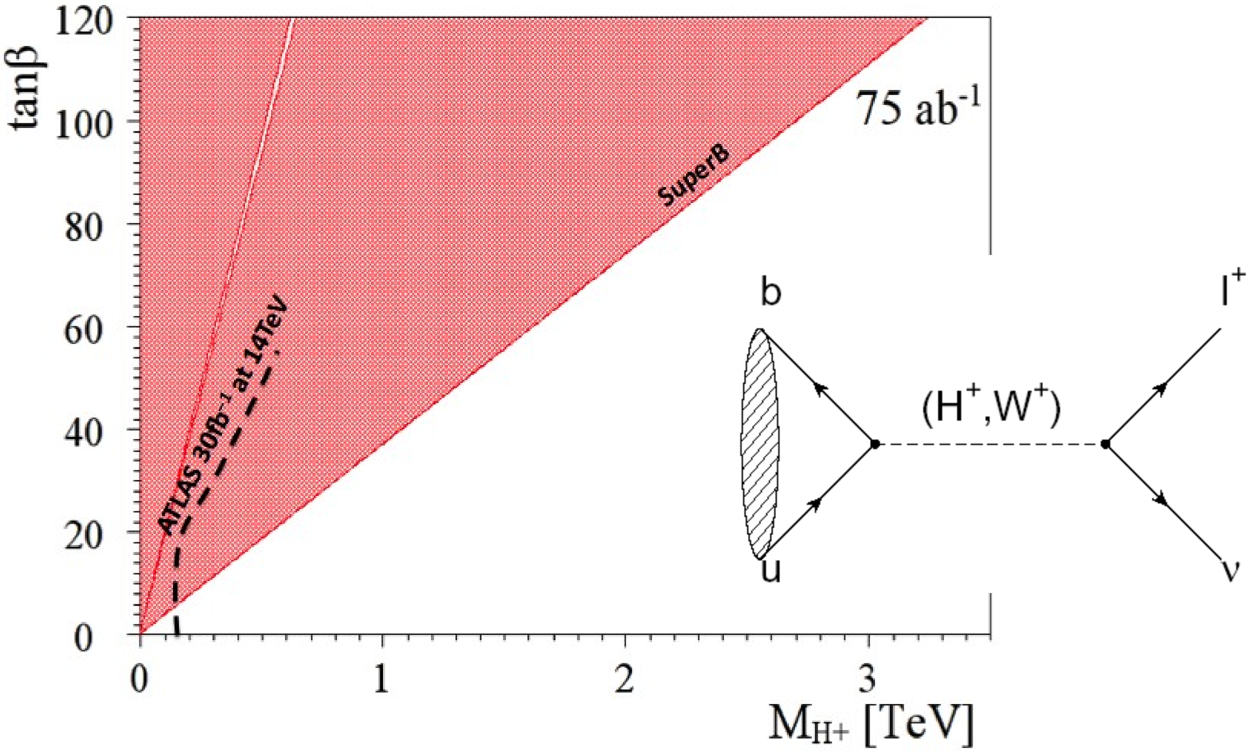
			Other processes Decays			
$\sin^2\theta_W$ at $\sqrt{s} = 10.58\,\mathrm{GeV}/c^2$			0.0002	^{l}		clean

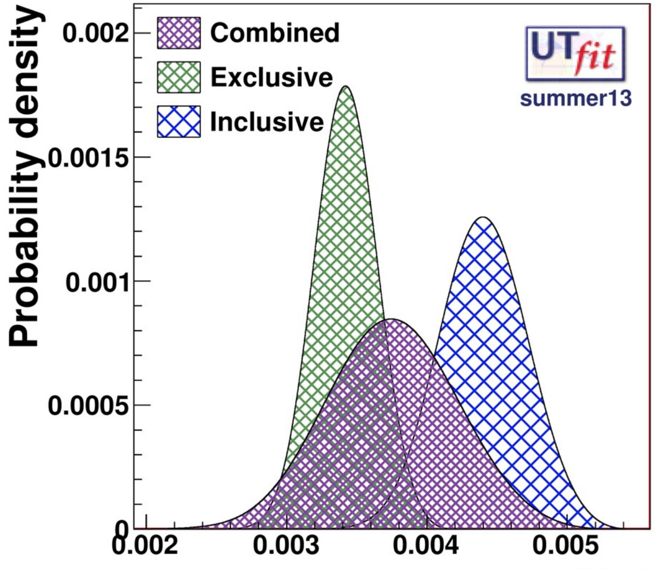
B physics: Rare decays

An example: $B^\pm \to \ell^\pm \nu$

- decay rate modified by charged Higgs boson exchange





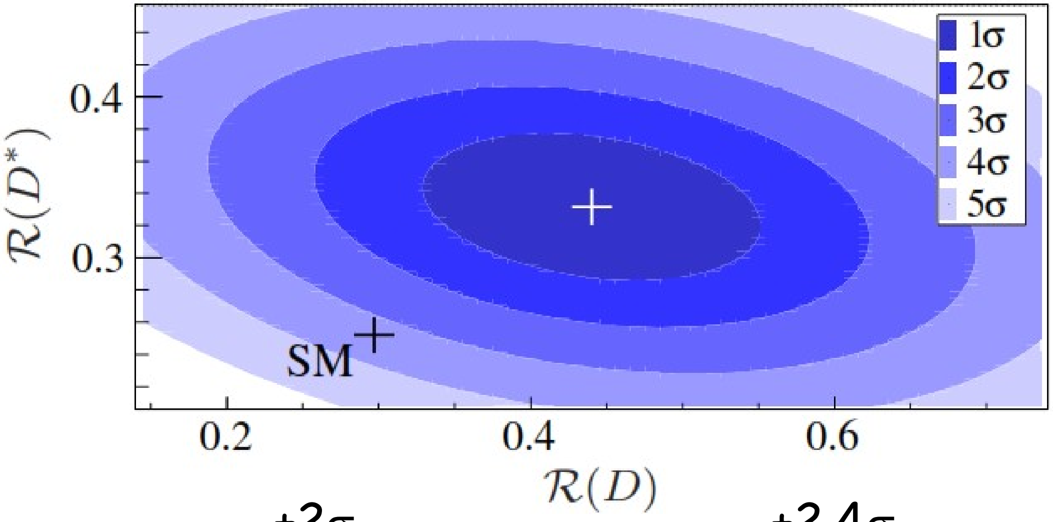


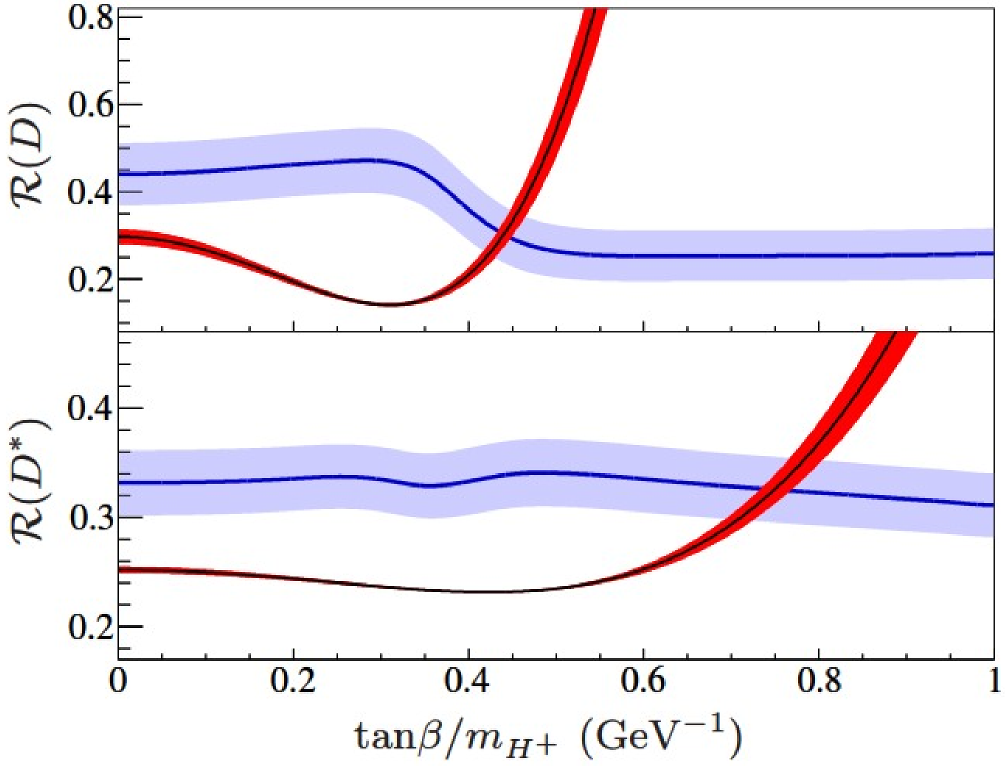
~2σ discrepancy

understand what's going on in $B \to D^{(*)}\tau\nu$

Simplest realizations of 2HDM cannot explain the excess in the two channels simoultaneously

BaBar Collaboration, arXiv:1303.0571





+2σ +2.4σ

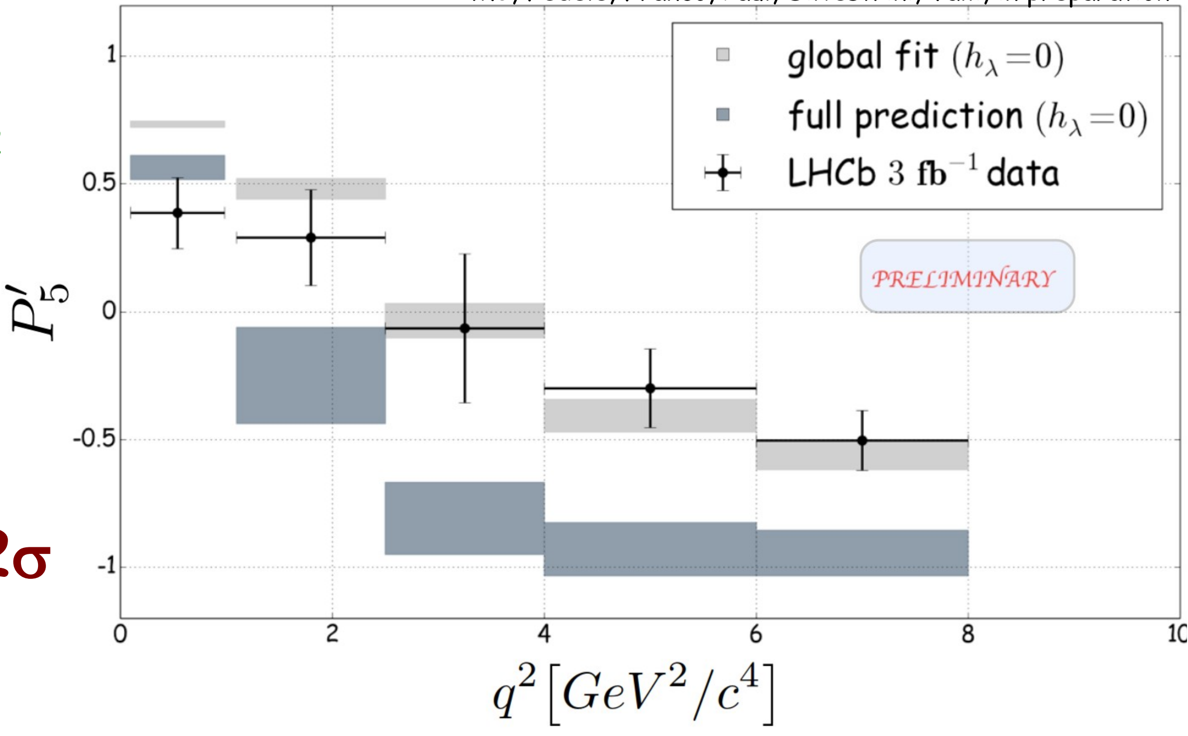
$$\mathcal{R}(D)_{\text{exp}} = 0.440 \pm 0.072 \quad \mathcal{R}(D^*)_{\text{exp}} = 0.332 \pm 0.030$$
$$\mathcal{R}(D)_{\text{SM}} = 0.297 \pm 0.017 \quad \mathcal{R}(D^*)_{\text{SM}} = 0.252 \pm 0.003$$

3.4σ excess

- **needs to break the relation $y_i \propto m_i$** Celis et al., arXiv:1210.8443
- **can be explained by new interactions involving τs only** see e.g. Biancofiore et al., arXiv:1302.1042

B physics: $B \to K^*\ell^+\ell^-$

LHCb claims P_5' to be 3.7σ off for $4.3 < q^2 < 8.7$ GeV^2

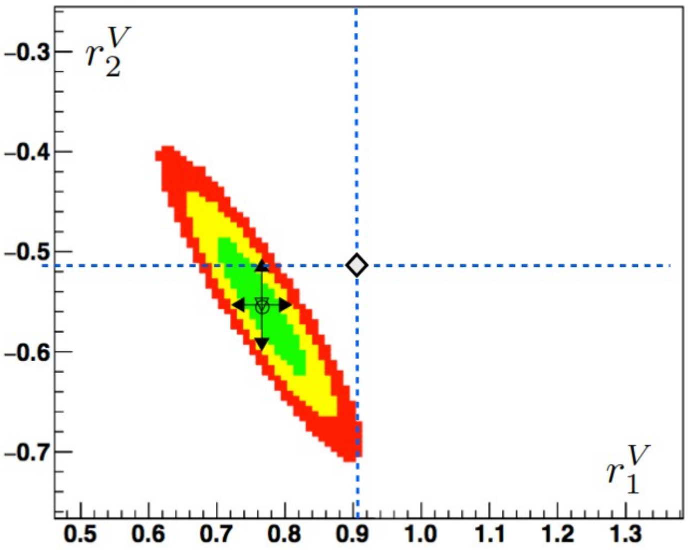


MC, Fedele, Franco, Paul, Silvestrini, Valli, in preparation

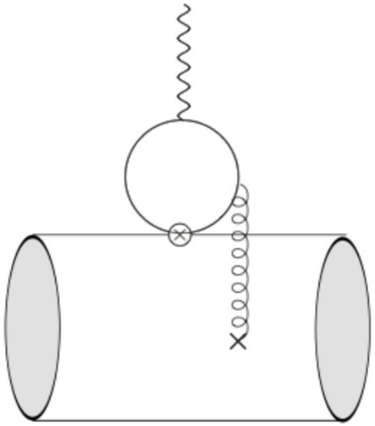
Factorized formulae cannot fully reproduce the data: a fit shows that P_5' can be addressed but deviations ≥2σ are present in the other angular coefficients

+ constraints on the FFs

Bin $q^2\,[GeV^2/c^4]$	A_{FB}	F_L	S_3	S_4	S_5	S_7	S_8	S_9
$[0.1, 0.98]$	1.6	0.2	−0.9	0.6	−1.2	0.3	1.0	−1.4
$[1.1, 2.5]$	0.1	−0.6	−0.9	−0.6	−0.8	−2.2	−0.8	−1.3
$[2.5, 4]$	−0.6	0.7	0.8	−1.1	−0.1	0.6	0.2	−0.8
$[4, 6]$	−1.3	−2.4	1.8	−1.0	0.3	−0.2	1.8	−0.4
$[6, 8]$	−1.4	−1.6	1.4	−2.3	0.2	−0.7	−1.2	−0.4
$[1.1, 6]$	−1.2	−1.5	1.6	−1.2	−0.1	−1.5	0.6	−0.6



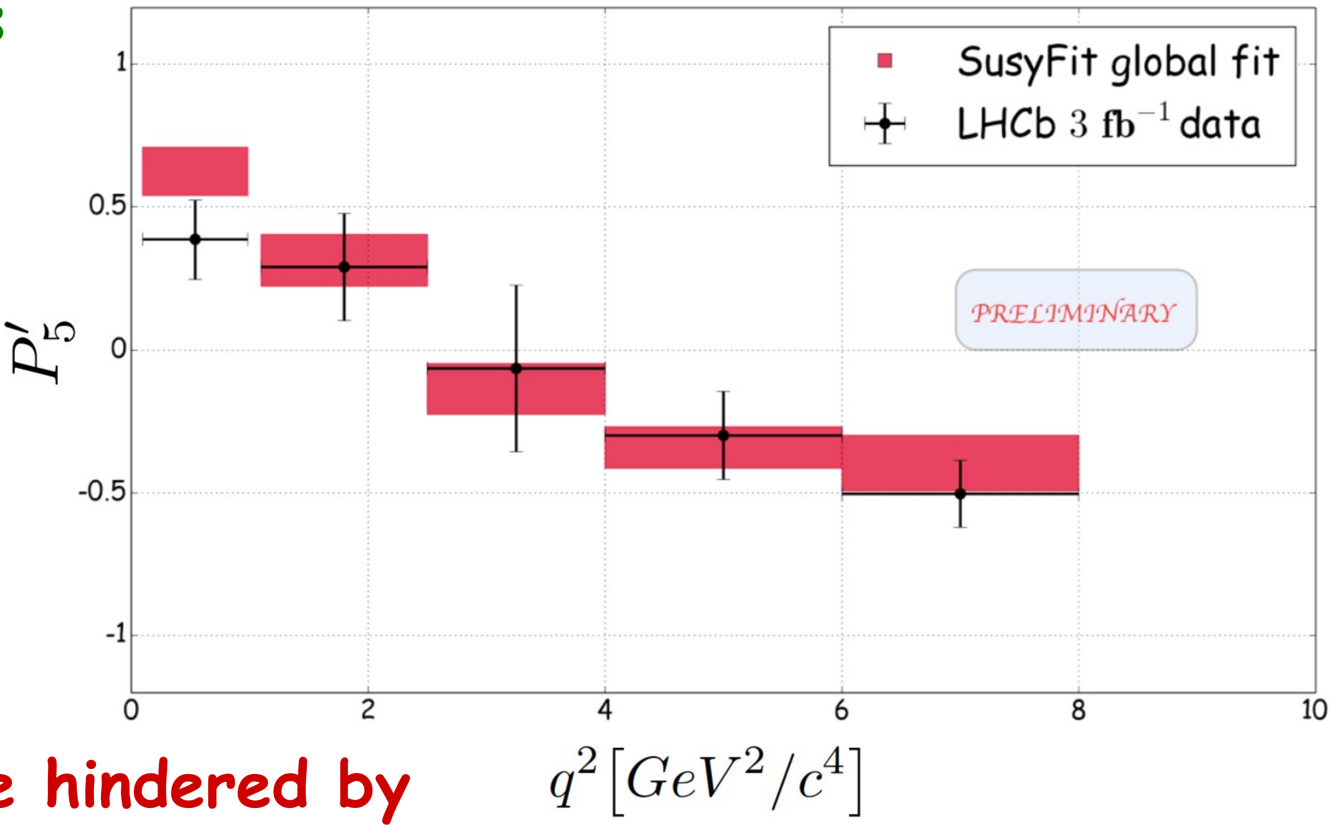
Non-factorizable terms may be important:



partly estimated in Kodjamirian et al., arXiv:1006.4945

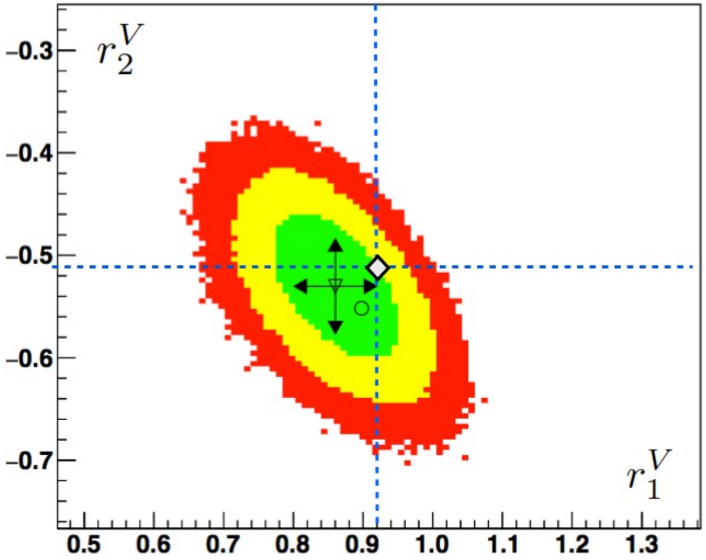
$$h_\lambda = h_\lambda^{(0)} + h_\lambda^{(1)} q^2 + h_\lambda^{(2)} q^4$$

MC, Fedele, Franco, Paul, Silvestrini, Valli, in preparation



BSM sensitivity could be hindered by hadronic uncertainties. Inclusive B→X_s $\mu^+\mu^-$ may help shedding light on this issue

Bin q² $[GeV^2/c^4]$	A_{FB}	F_L	S_3	S_4	S_5	S_7	S_8	S_9
$[0.1, 0.98]$	1.7	0.1	−0.2	0.6	−0.8	0.2	0.9	−1.1
$[1.1, 2.5]$	−0.2	−0.4	−0.9	−0.6	0.1	−2.0	−0.9	−1.3
$[2.5, 4]$	−0.8	1.4	0.6	−1.1	0.3	0.4	0.1	−0.8
$[4, 6]$	−0.8	−0.5	1.3	−1.2	−0.3	−0.2	1.5	−0.4
$[6, 8]$	0.1	0.1	0.5	−2.3	−1.3	−0.4	−1.3	0.4
$[1.1, 6]$	−1.0	0.1	1.0	−1.3	0.1	−0.9	0.2	−0.6



Belle II can also contribute competitive exclusive and inclusive measurements of b → s e^+e^- to help clarifying the issue of lepton universality recently challenged by LHCb

$$R_K = \frac{\int_{q^2_{\min}}^{q^2_{\max}} \frac{d\Gamma[B^+ \to K^+\mu^+\mu^-]}{dq^2} dq^2}{\int_{q^2_{\min}}^{q^2_{\max}} \frac{d\Gamma[B^+ \to K^+e^+e^-]}{dq^2} dq^2} = 0.745^{+0.090}_{-0.074}\,(\text{stat}) \pm 0.036\,(\text{syst})$$

LHCb Collaboration, arXiv:1406.6482

$R_K^{SM} = 1.0003 \pm 0.0001$

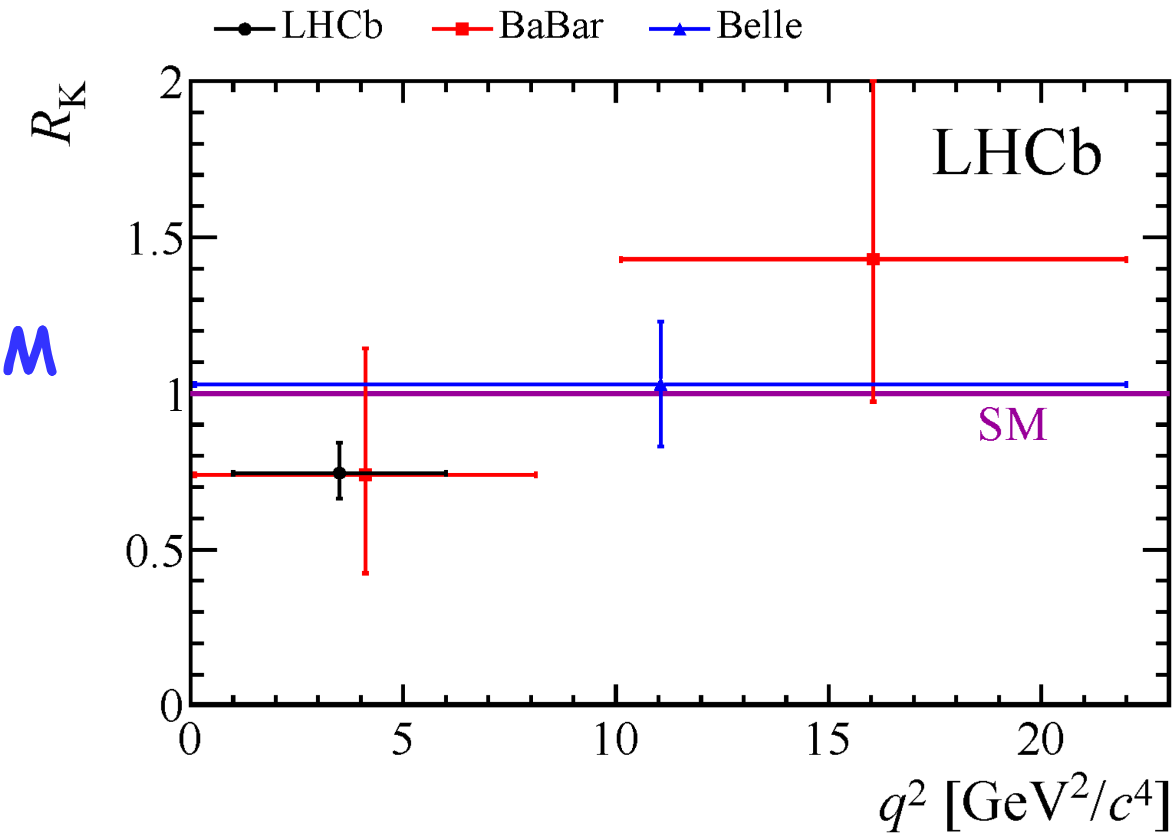
Bobeth et al., arXiv:0709.4174

2.6σ deviation from the SM

It may be correlated to large LFV in B decays

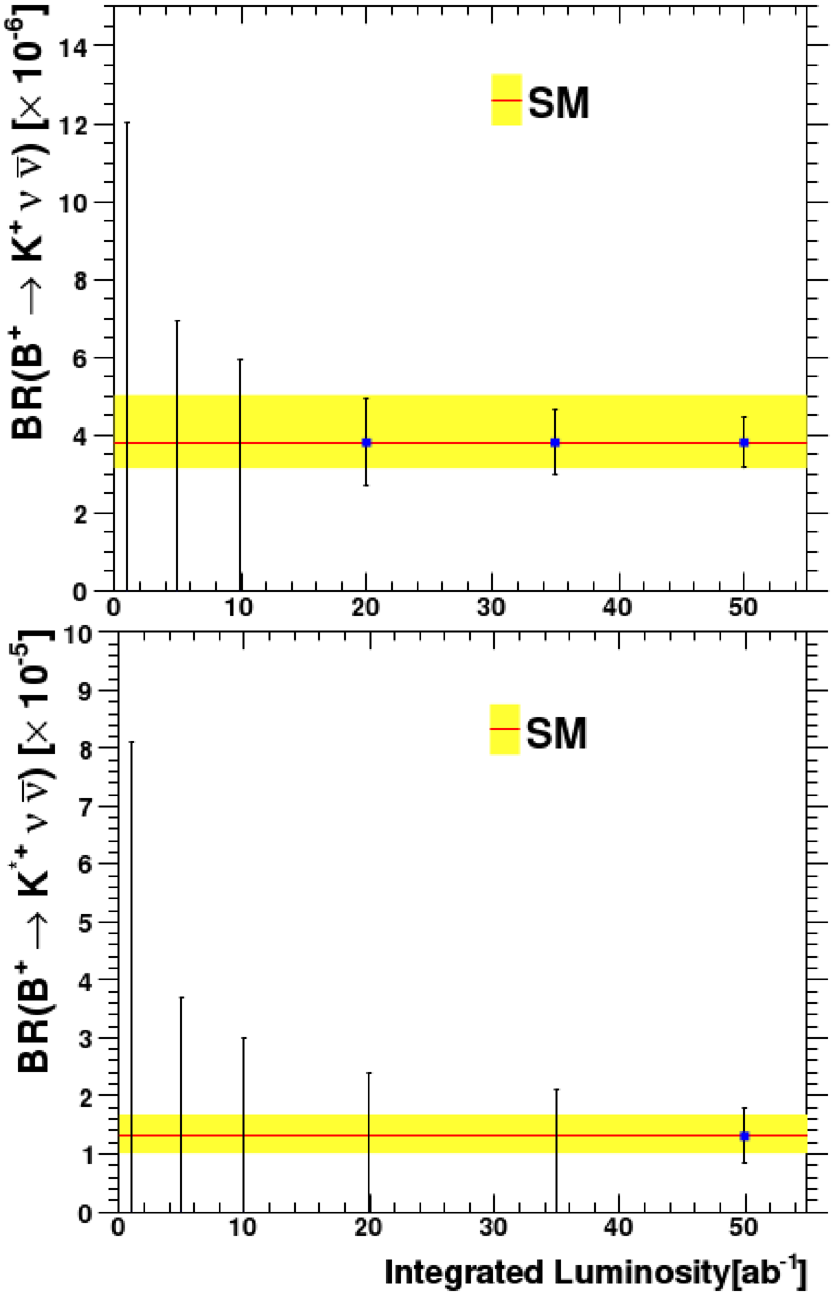
b → s $\ell_i^+ \ell_j^-$

Glashow et al., arXiv:1411.0565



B physics: $B \to K^{(*)}\nu\nu$

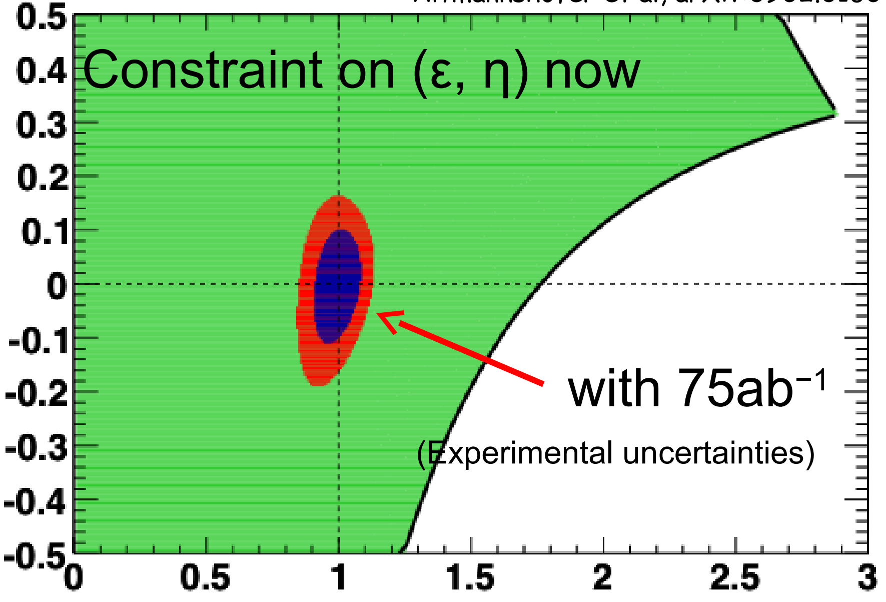
SuperB Workshop VI, arXiv:0810.1312



$$\epsilon = \frac{\sqrt{|C_L^\nu|^2 + |C_R^\nu|^2}}{|(C_L^\nu)^{\mathrm{SM}}|}$$

$$\eta = \frac{-\mathrm{Re}\,(C_L^\nu C_R^{\nu *})}{|C_L^\nu|^2 + |C_R^\nu|^2}$$

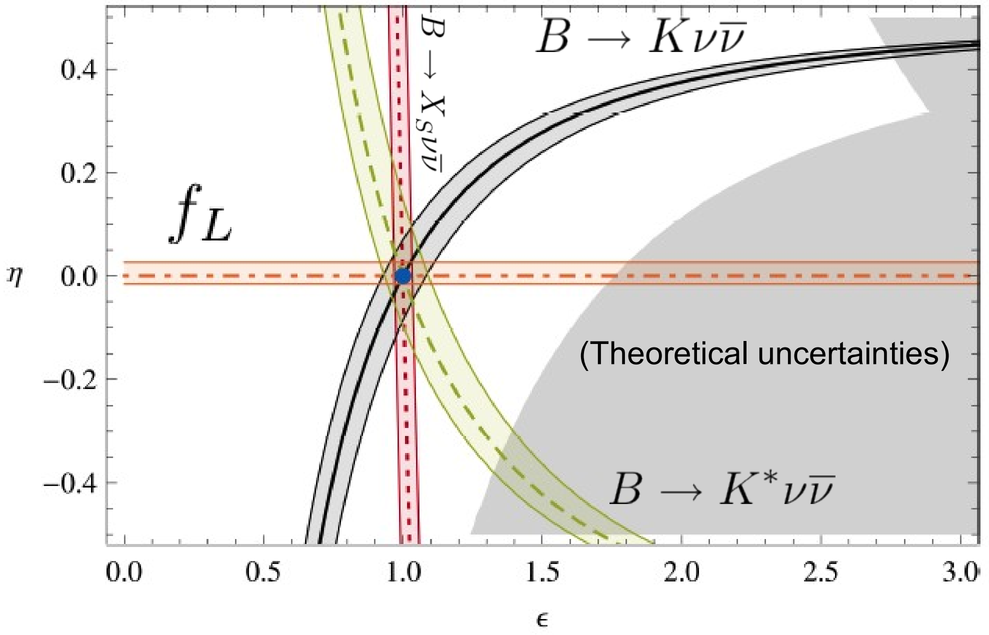
Altmannshofer et al, arXiv:0902.0160



Constraint on (ε, η) now

with 75ab^{-1}

(Experimental uncertainties)



(Theoretical uncertainties)

affected by models with Z',
RH currents and light scalars

Belle II golden channels
CPV in D mixing

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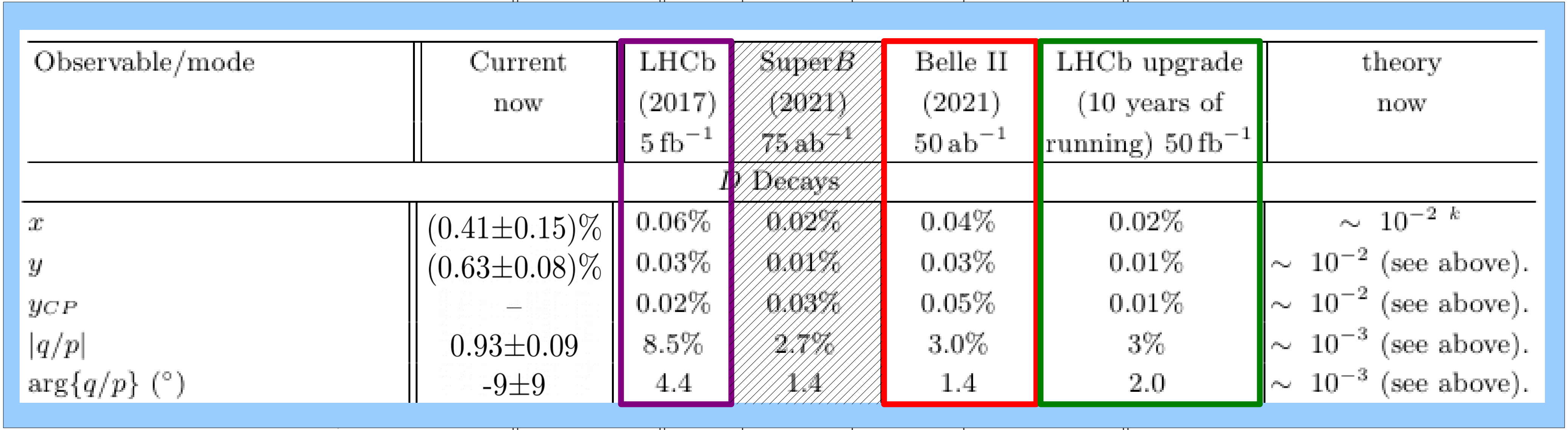
BR($B \to \tau\nu$) ($\times 10^{-4}$)	1.64 ± 0.34		0.05	0.04		1.1 ± 0.2



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x	(0.41±0.15)%	0.06%	0.02%	0.04%	0.02%	$\sim 10^{-2}$ [k]
y	(0.63±0.08)%	0.03%	0.01%	0.03%	0.01%	$\sim 10^{-2}$ (see above).
y_{CP}	–	0.02%	0.03%	0.05%	0.01%	$\sim 10^{-2}$ (see above).
$\lvert q/p \rvert$	0.93±0.09	8.5%	2.7%	3.0%	3%	$\sim 10^{-3}$ (see above).
arg$\{q/p\}$ (°)	-9±9	4.4	1.4	1.4	2.0	$\sim 10^{-3}$ (see above).

Observable/mode	Current now	LHCb (2017) 5 fb^{-1}	Super$B$ (2021) 75 ab^{-1}	Belle II (2021) 50 ab^{-1}	LHCb upgrade (10 years of running) 50 fb^{-1}	theory now
			B_s^0 Decays			
BR($B_s^0 \to \gamma\gamma$) ($\times 10^{-6}$)	< 8.7		0.3	$0.2 - 0.3$		0.4 - 1.0
A^s_{SL} ($\times 10^{-3}$)	-7.87 ± 1.96 [i]	[j]	4.	5. (est.)		0.02 ± 0.01
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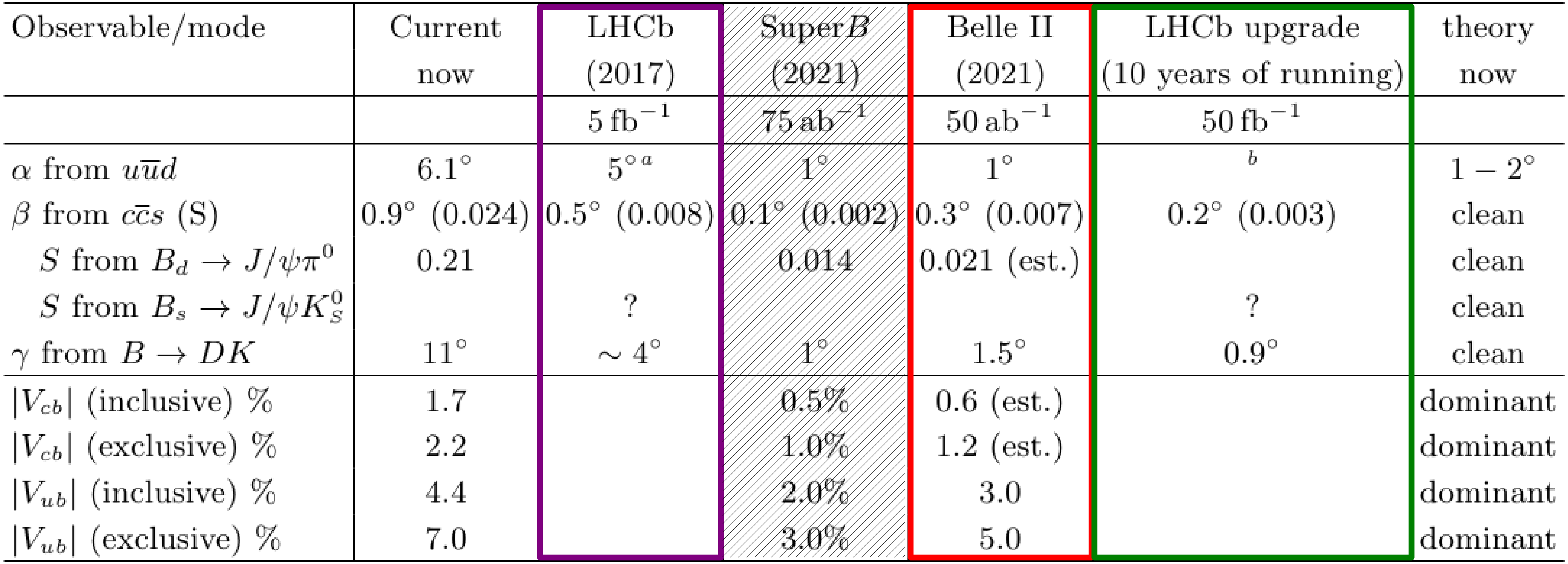
x	$(0.63 \pm 0.20\%$	0.06%	0.02%	0.04%	0.02%	$\sim 10^{-2}$ [k]
y	$(0.75 \pm 0.12)\%$	0.03%	0.01%	0.03%	0.01%	$\sim 10^{-2}$ (see above).
y_{CP}	$(1.11 \pm 0.22)\%$	0.05%	0.03%	0.05%	0.01%	$\sim 10^{-2}$ (see above).
$\lvert q/p \rvert$	$(0.91 \pm 0.17)\%$	10%	2.7%	3.0%	3%	$\sim 10^{-3}$ (see above).
arg$\{q/p\}$ (°)	-10.2 ± 9.2	5.6	1.4	1.4	2.0	$\sim 10^{-3}$ (see above).
			Other processes Decays			
$\sin^2\theta_W$ at $\sqrt{s} = 10.58\,\mathrm{GeV}/c^2$			0.0002	[l]		clean

Precision CKM measurement



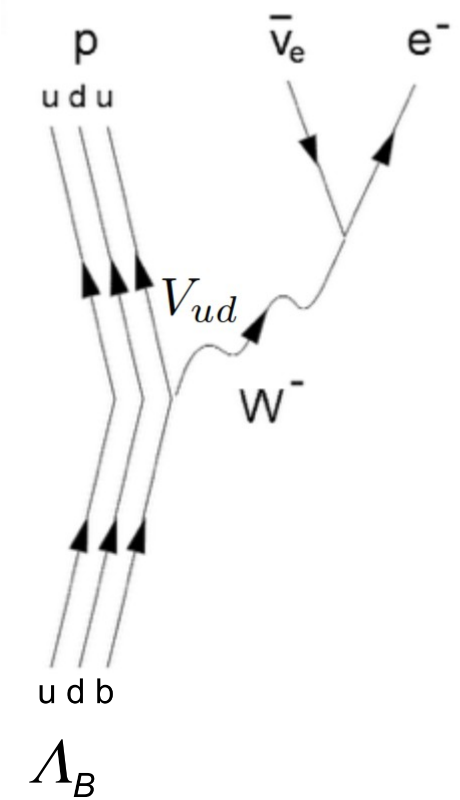
Observable/mode	Current now	LHCb (2017)	Super$B$ (2021)	Belle II (2021)	LHCb upgrade (10 years of running)	theory now
		$5\,\text{fb}^{-1}$	$75\,\text{ab}^{-1}$	$50\,\text{ab}^{-1}$	$50\,\text{fb}^{-1}$	
α from $u\bar{u}d$	6.1°	$5^{\circ\,a}$	1°	1°	^{b}	$1-2^\circ$
β from $c\bar{c}s$ (S)	0.9° (0.024)	0.5° (0.008)	0.1° (0.002)	0.3° (0.007)	0.2° (0.003)	clean
S from $B_d \to J/\psi\pi^0$	0.21		0.014	0.021 (est.)		clean
S from $B_s \to J/\psi K_S^0$		?			?	clean
γ from $B \to DK$	11°	$\sim 4^\circ$	1°	1.5°	0.9°	clean
$\lvert V_{cb}\rvert$ (inclusive) %	1.7		0.5%	0.6 (est.)		dominant
$\lvert V_{cb}\rvert$ (exclusive) %	2.2		1.0%	1.2 (est.)		dominant
$\lvert V_{ub}\rvert$ (inclusive) %	4.4		2.0%	3.0		dominant
$\lvert V_{ub}\rvert$ (exclusive) %	7.0		3.0%	5.0		dominant

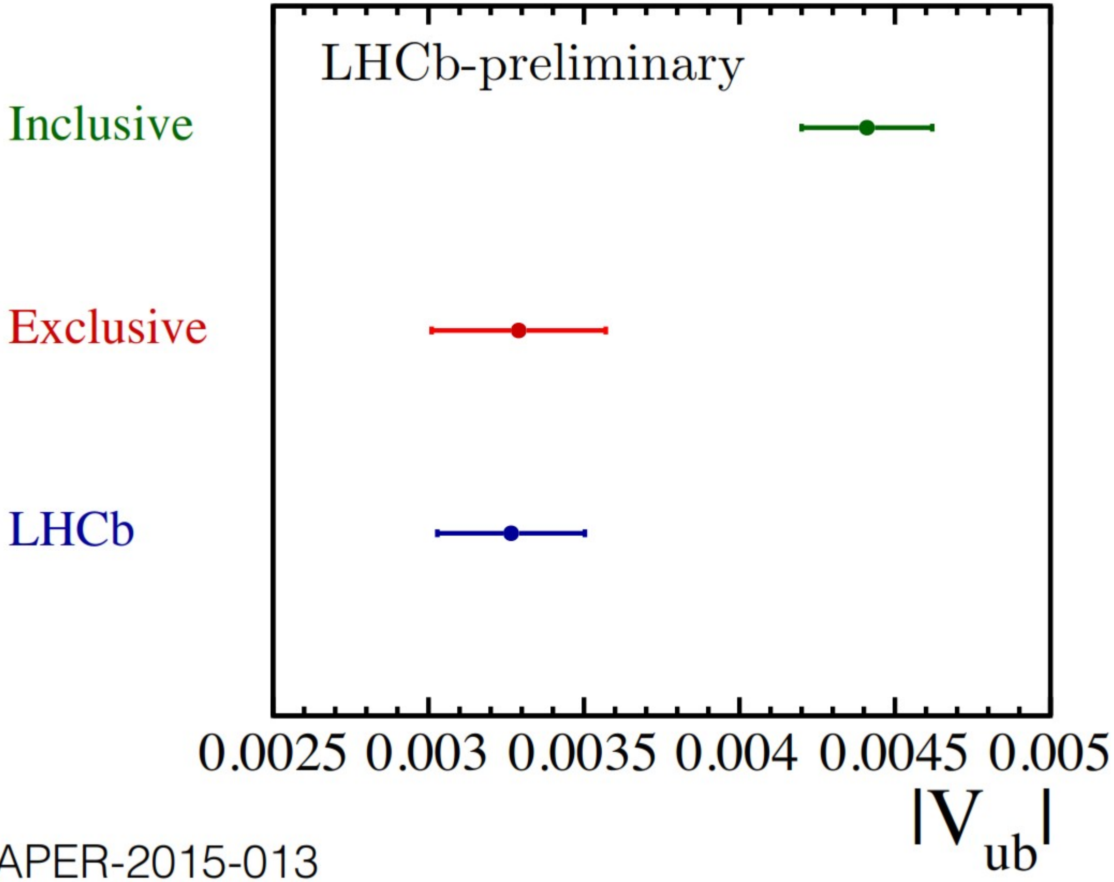
based on arXiv:1109.5028

V_{ub} @ LHCb

Great result from the β decay of the Λ_B baryon

- lattice results for baryon MEs less mature
- long-standing disagreement with inclusive results still pending

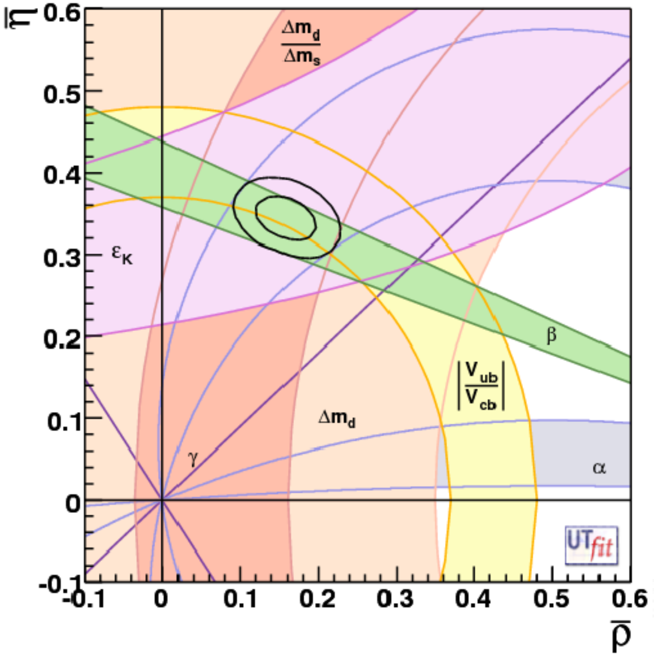




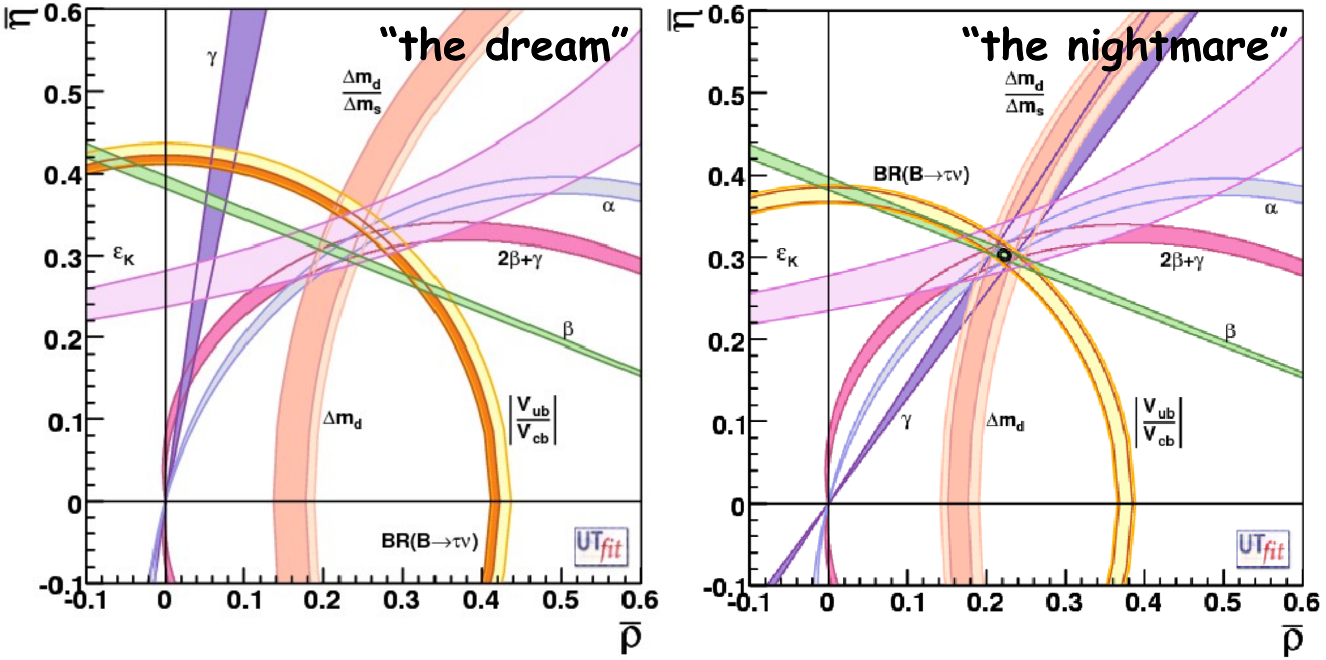
LHCb-PAPER-2015-013

CKM matrix at 1%

Today



End of next-gen expertiments

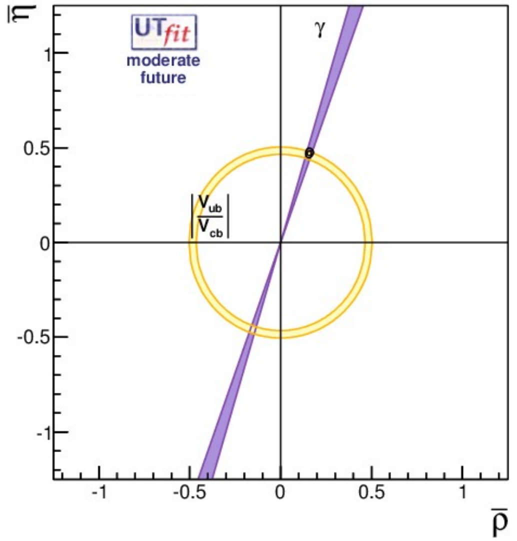


Generalized UT fits:

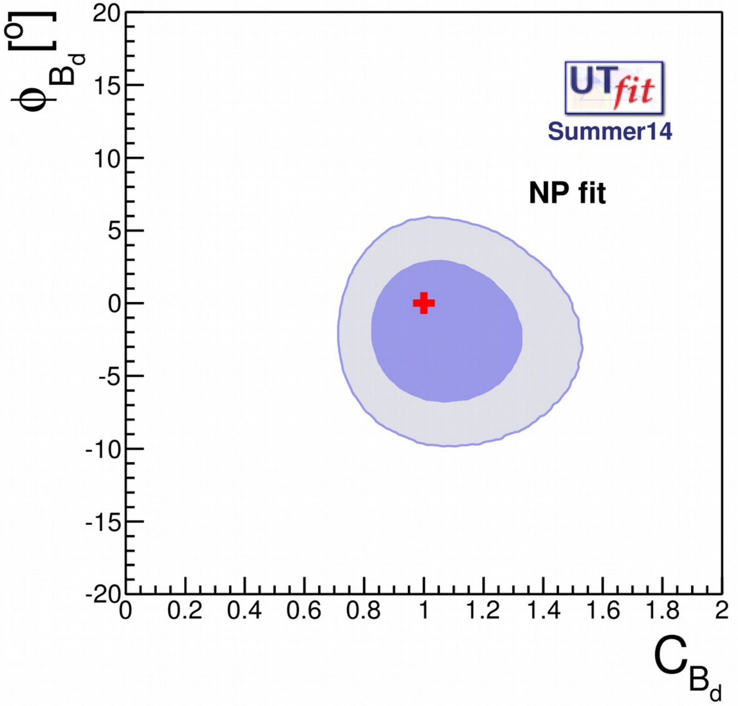
CKM at 1% in the presence of NP!

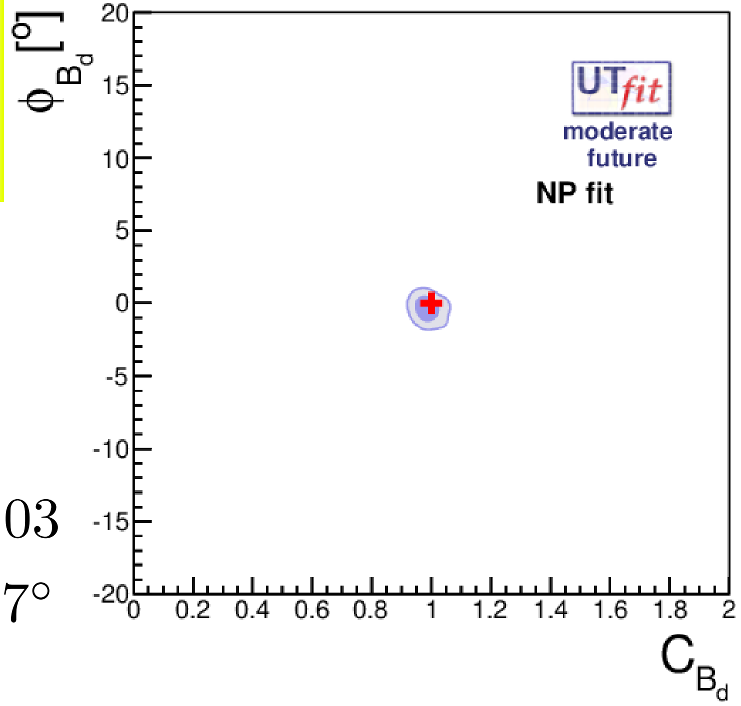
	today	future
$\bar\rho$	0.159±0.045	±0.008
$\bar\eta$	0.363±0.049	±0.010

- good place to look for % NP
- crucial for many NP searches



NP parameters in $\Delta B=2$ amplitudes

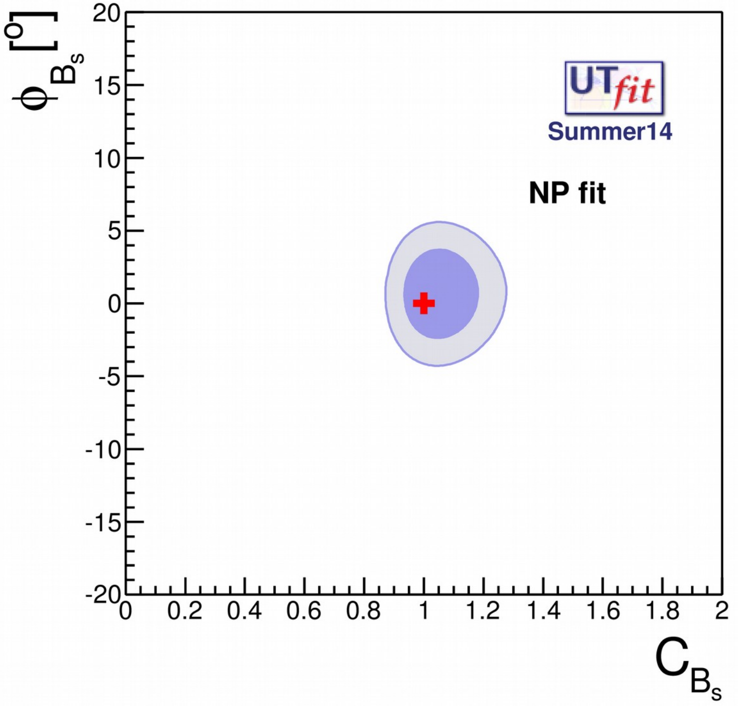


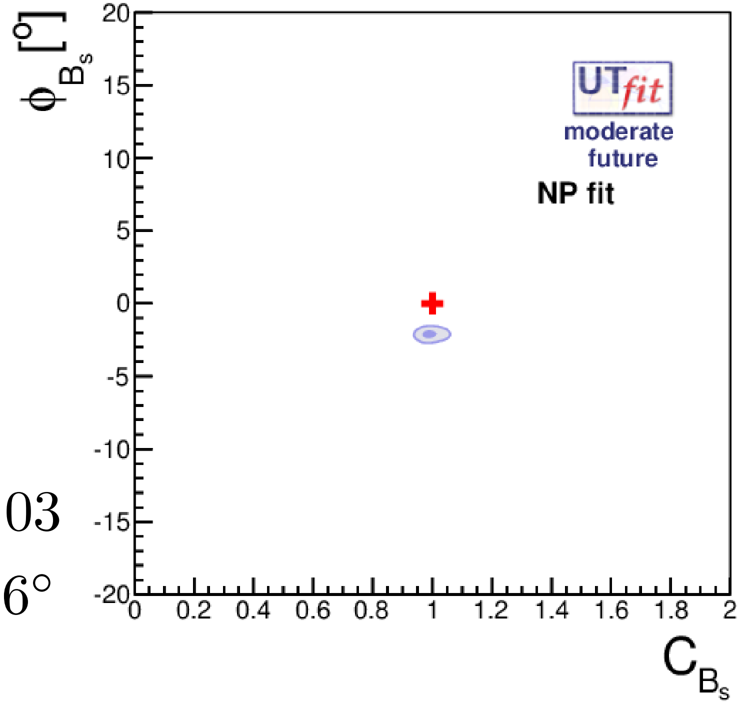


From 1D projections:

$$\sigma(C_{B_d}) \simeq 0.17 \longrightarrow 0.03$$

$$\sigma(\phi_{B_d}) \simeq 3.2^\circ \longrightarrow 0.7^\circ$$





From 1D projections:

$$\sigma(C_{B_s}) \simeq 0.08 \longrightarrow 0.03$$

$$\sigma(\phi_{B_s}) \simeq 2.1^\circ \longrightarrow 0.6^\circ$$

Conclusions

* there is a rich physics program waiting for Belle II to start taking data

* the interest of this program stays high whatever the result of direct searches will be

* as time goes by and data sample increases, LHCb starts entering domains which belonged traditionally to e^+e^- machines; yet several key measurements (inclusive modes, neutrals, open kinematics) remain Belle II domain only

* The impressive work at LHCb is producing new puzzles/tensions for Belle II to elucidate

Spare Slides

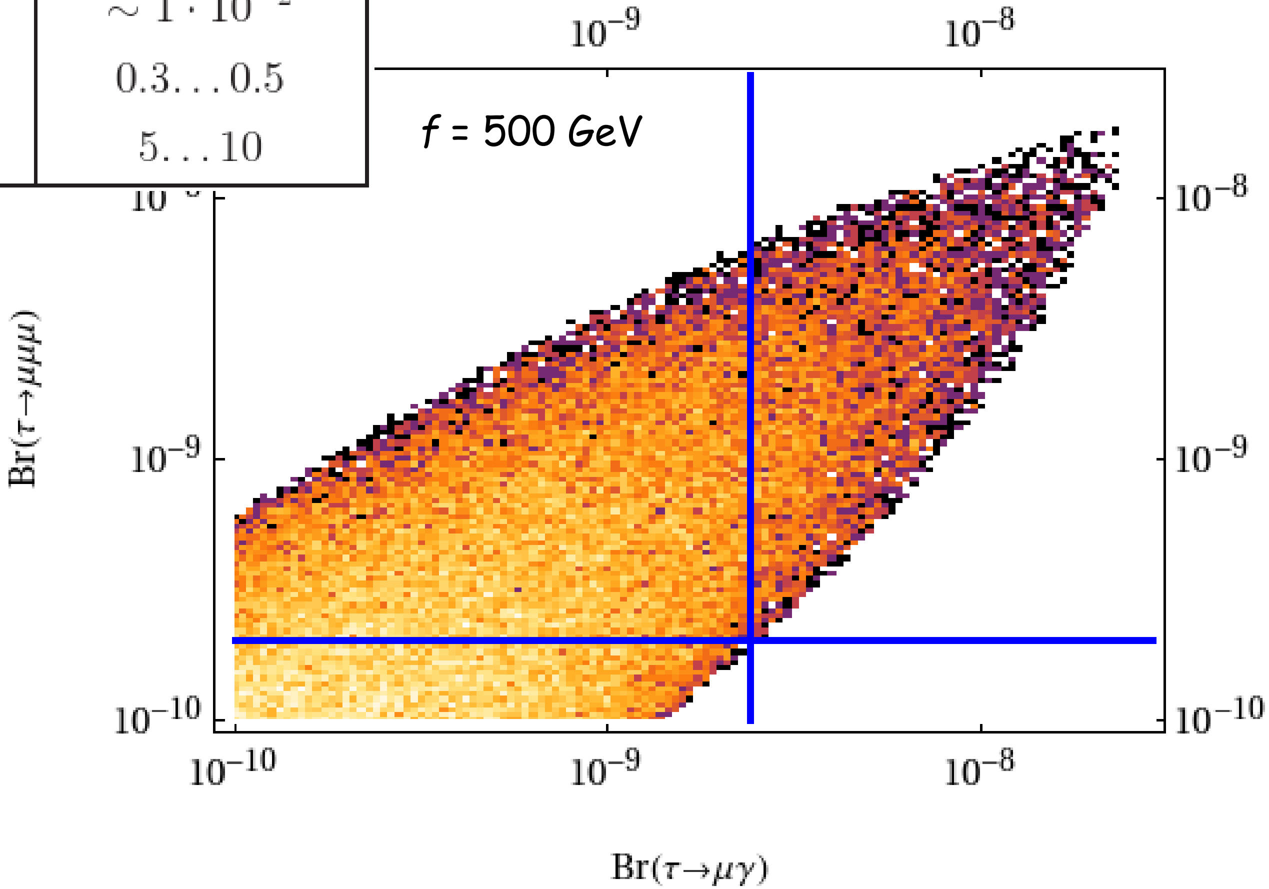
no theory improvements needed	$\beta(J/\psi\ K)$, $\gamma(DK)$, $\alpha(\pi\pi)$*, lepton FV and UV, $S(\rho^0\gamma)$ CPV in B->Xγ, D and τ decays zero of FB asymmetry B->$X_s l^+l^-$	NP insensitive or null tests of the SM or SM already known with the required accuracy
improved lattice QCD	meson mixing, B->D(*)lν, B->$\pi(\rho)$lν B->K*γ, B->$\rho\gamma$,B->lν, B_s->$\mu\mu$	target error: ~1-2% Feasible (see below)
improved OPE+HQE	B->$X_{u,c}$lν, B->Xγ	target error: ~1-2% Possibly feasible with SuperB data getting rid of the shape function. Detailed studies required
improved QCDF/SCET or flavour symmetries	S's from TD A_{CP} in b -> s transitions	target error: ~2-3% large and hard to improve uncertainties on small corrections. FS+data can bound the th. error

τFV in the Littlest Higgs model with T-parity

ratio	LHT	MSSM (dipole)	MSSM (Higgs)
$\frac{\mathcal{B}(\tau^-\to e^-e^+e^-)}{\mathcal{B}(\tau\to e\gamma)}$	$0.4\ldots2.3$	$\sim 1\cdot10^{-2}$	$\sim 1\cdot10^{-2}$
$\frac{\mathcal{B}(\tau^-\to \mu^-\mu^+\mu^-)}{\mathcal{B}(\tau\to \mu\gamma)}$	$0.4\ldots2.3$	$\sim 2\cdot10^{-3}$	$0.06\ldots0.1$
$\frac{\mathcal{B}(\tau^-\to e^-\mu^+\mu^-)}{\mathcal{B}(\tau\to e\gamma)}$	$0.3\ldots1.6$	$\sim 2\cdot10^{-3}$	$0.02\ldots0.04$
$\frac{\mathcal{B}(\tau^-\to \mu^-e^+e^-)}{\mathcal{B}(\tau\to \mu\gamma)}$	$0.3\ldots1.6$	$\sim 1\cdot10^{-2}$	$\sim 1\cdot10^{-2}$
$\frac{\mathcal{B}(\tau^-\to e^-e^+e^-)}{\mathcal{B}(\tau^-\to e^-\mu^+\mu^-)}$	$1.3\ldots1.7$	~ 5	$0.3\ldots0.5$
$\frac{\mathcal{B}(\tau^-\to \mu^-\mu^+\mu^-)}{\mathcal{B}(\tau^-\to \mu^-e^+e^-)}$	$1.2\ldots1.6$	~ 0.2	$5\ldots10$

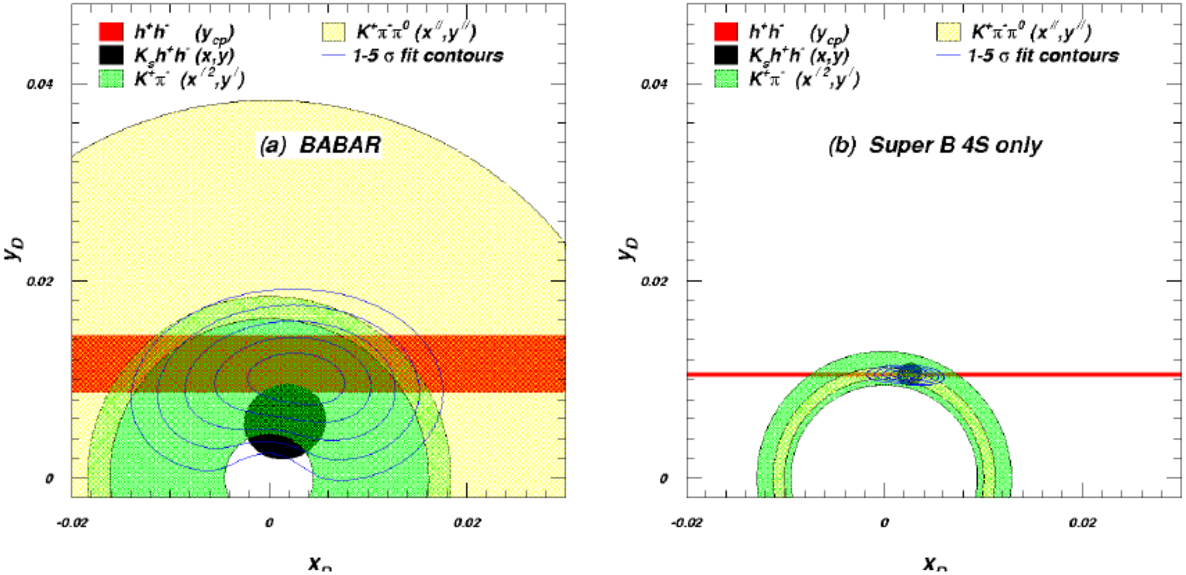
M. Blanke et al. arXiv:0906.5454

BR($\tau\to\ell\ell\ell$)/BR($\tau\to\ell\gamma$) is not suppressed by α_e in LHT

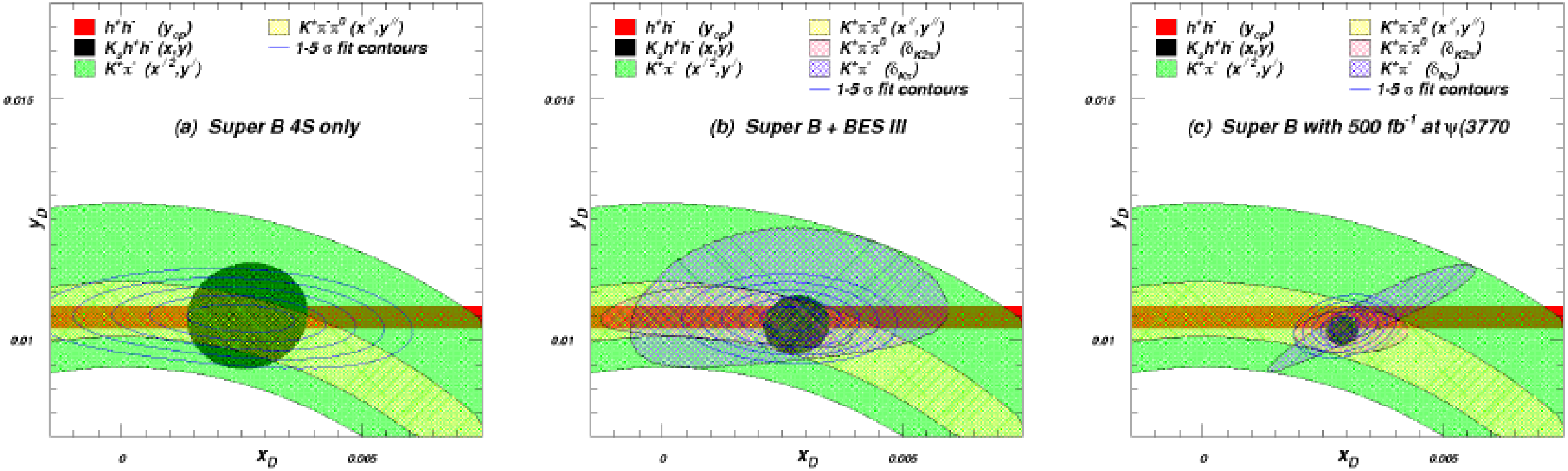


LFV is a powerful tool to disentangle e.g. LHT and MSSM

Charm mixing



Fit	$x \times 10^3$	$y \times 10^3$	$\delta^\circ_{K^+\pi^-}$	$\delta^\circ_{K^+\pi^-\pi^0}$
(a)	$3.01^{+3.12}_{-3.39}$	$10.10^{+1.69}_{-1.72}$	$41.3^{+22.0}_{-24.0}$	43.8 ± 26.4
Stat.	(2.76)	(1.36)	(18.8)	(22.4)
(b)	$xxx^{+0.72}_{-0.75}$	$xxx \pm 0.19$	$xxx^{+3.7}_{-3.4}$	$xxx^{+4.6}_{-4.5}$
Stat.	(0.18)	(0.11)	(1.3)	(2.9)
(c)	$xxx \pm 0.42$	$xxx \pm 0.17$	$xxx \pm 2.2$	$xxx^{+3.3}_{-3.4}$
Stat.	(0.18)	(0.11)	(1.3)	(2.7)
(d)	$xxx \pm 0.20$	$xxx \pm 0.12$	$xxx \pm 1.0$	$xxx \pm 1.1$
Stat.	(0.17)	(0.10)	(0.9)	(1.1)



MSSM: flavour violation in the squark sector

LHCb, SuperB

$$M^2_{\tilde d} \approx \begin{pmatrix} m^2_{\tilde d_L} & m_d(A_d - \mu \tan\beta) & (\Delta^d_{12})_{LL} & (\Delta^d_{12})_{LR} & (\Delta^d_{13})_{LL} & (\Delta^d_{13})_{LR} \\ & m^2_{\tilde d_R} & (\Delta^d_{12})_{RL} & (\Delta^d_{12})_{RR} & (\Delta^d_{13})_{RL} & (\Delta^d_{13})_{RR} \\ & & m^2_{\tilde s_L} & m_s(A_s - \mu \tan\beta) & (\Delta^d_{23})_{LL} & (\Delta^d_{23})_{LR} \\ & & & m^2_{\tilde s_R} & (\Delta^d_{23})_{RL} & (\Delta^d_{23})_{RR} \\ & & & & m^2_{\tilde b_L} & m_b(A_b - \mu \tan\beta) \\ & & & & & m^2_{\tilde b_R} \end{pmatrix}$$

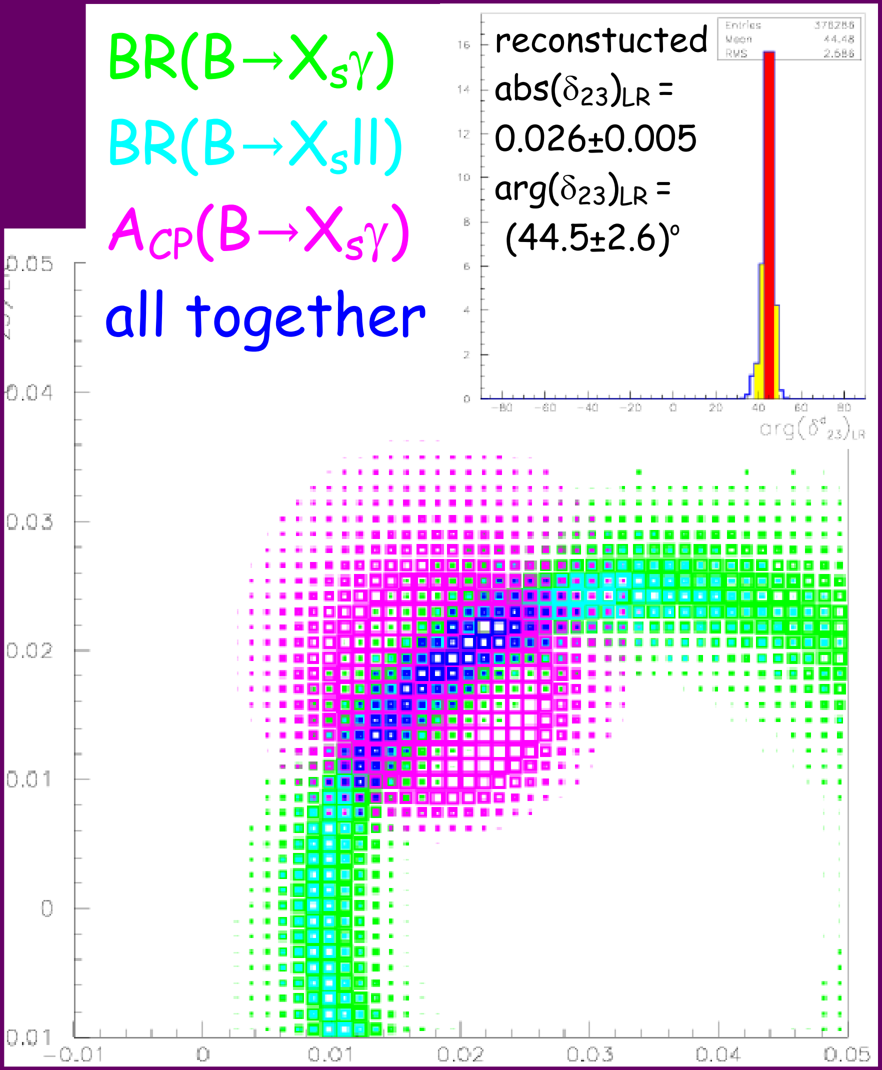
LHC, ILC - HE frontier

and similarly for $M^2_{\tilde u}$

NP scale: $m_{\tilde q}$

FV & CPV couplings: $(\delta^d_{ij})_{AB} = (\Delta^d_{ij})_{AB}/m_{\tilde q}^2$

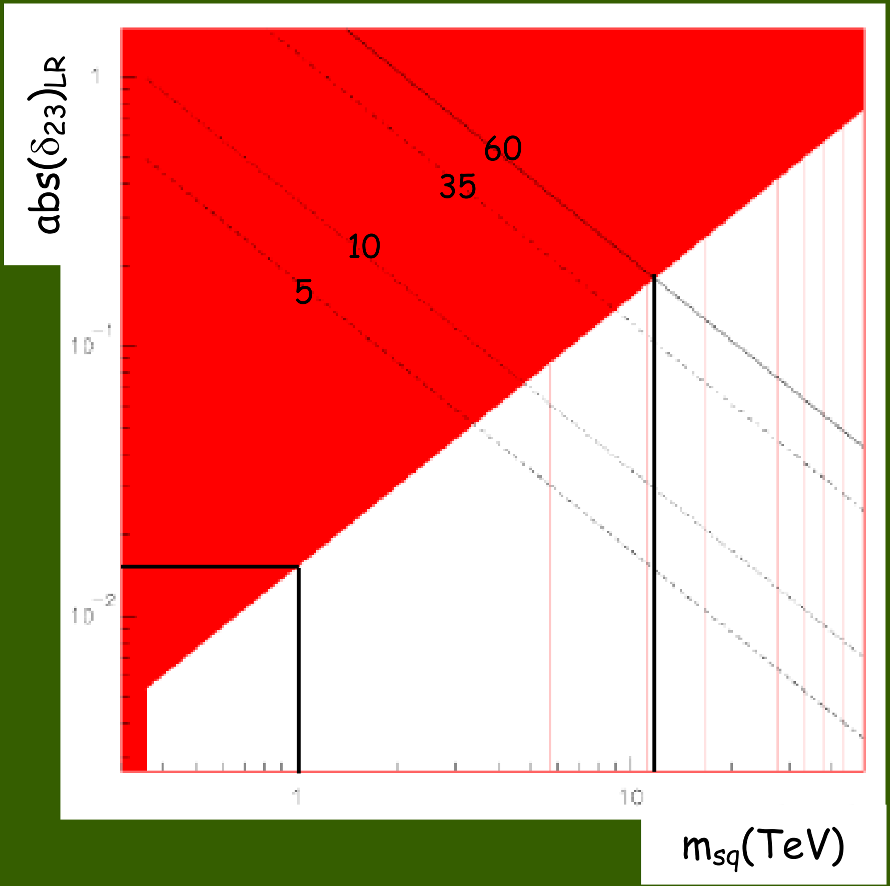
Determination of $(\delta^d_{23})_{LR}$ using SuperB data



$Im(\delta^d_{23})_{LR}$ vs $Re(\delta^d_{23})_{LR}$

reconstruction of $(\delta^d_{23})_{LR}=0.028\ e^{i\pi/4}$ for $\Lambda = m_{\tilde g} = m_{\tilde q} =$ 1 TeV

"3σ" sensitivity plot



i) sensitive to $m_{\tilde q}$ < 20 TeV

ii) sensitive to $|(\delta^d_{23})_{LR}|$ > 10^{-2} for $m_{\tilde q}$ < 1 TeV

An explicit example: hierarchical soft terms

Nardecchia, Giudice, Romanino, arXiv:0812.3610
Cohen, Kaplan, Nelson, hep-ph/9607394
Dine, Kagan, Samuel, PLB243 (1990)

Sparticles at the EW scale

but for 1st and 2nd generation squarks and sleptons

- no "unnatural" correction to the Higgs mass
- alleviate the flavour problem
- indicate "natural" values for the δ's:

$$\hat{\delta}^{LL}_{db} \approx V^*_{td} \sim 0.01 \qquad \hat{\delta}^{LL}_{sb} \approx V^*_{ts} \sim 0.05$$

$$\hat{\delta}^{LR}_{i3} \equiv \frac{\mathcal{M}^2_{L3,R3}}{\tilde{m}^2}\hat{\delta}^{LL}_{i3} \qquad i,j=1,2$$

$$\hat{\delta}^{LL}_{ij} \equiv \hat{\delta}^{LL}_{i3}\hat{\delta}^{LL*}_{j3} \qquad \hat{\delta}^{LR}_{ij} \equiv \frac{\mathcal{M}^2_{L3,R3}}{\tilde{m}^2}\hat{\delta}^{LL}_{i3}\hat{\delta}^{RR*}_{j3}$$

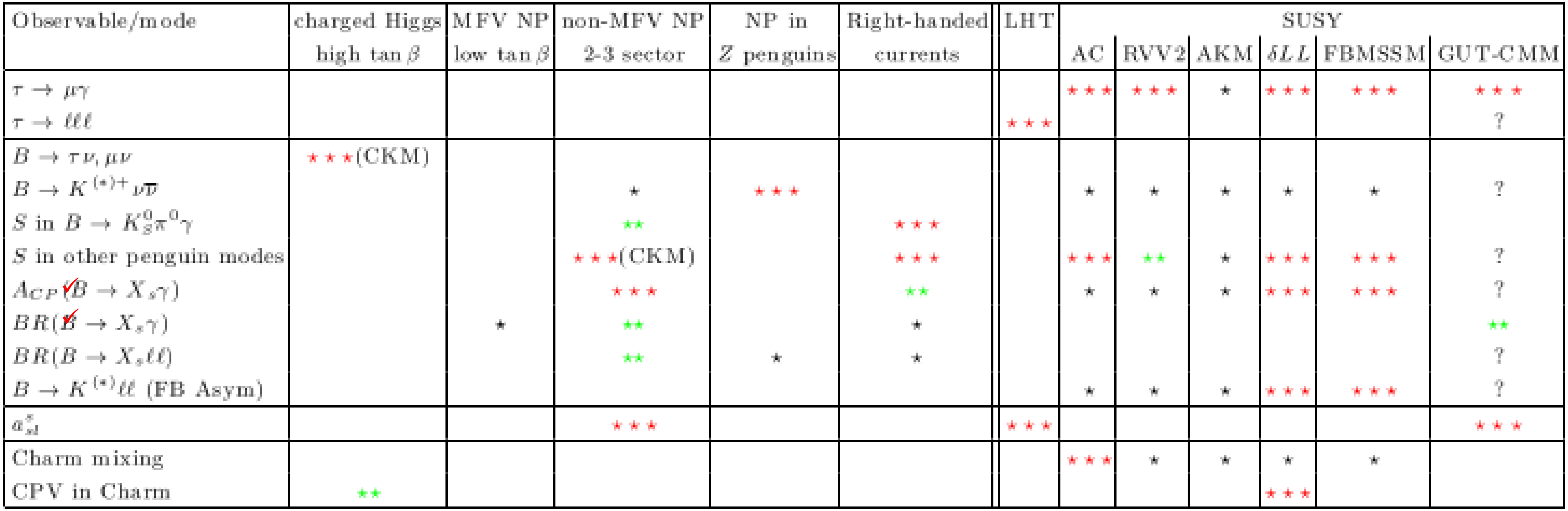
these figures are in the ballpark of SuperB sensitivities

OVERALL SUSY ASSESSMENT

Studying correlations in flavour observables, together with high-p_t info, we can learn about:

- **the SUSY-breaking mechanism**
- **the flavour breaking mechanism**
- **the underlying presence of a GUT structure**
- **the origin of lepton flavour violation**

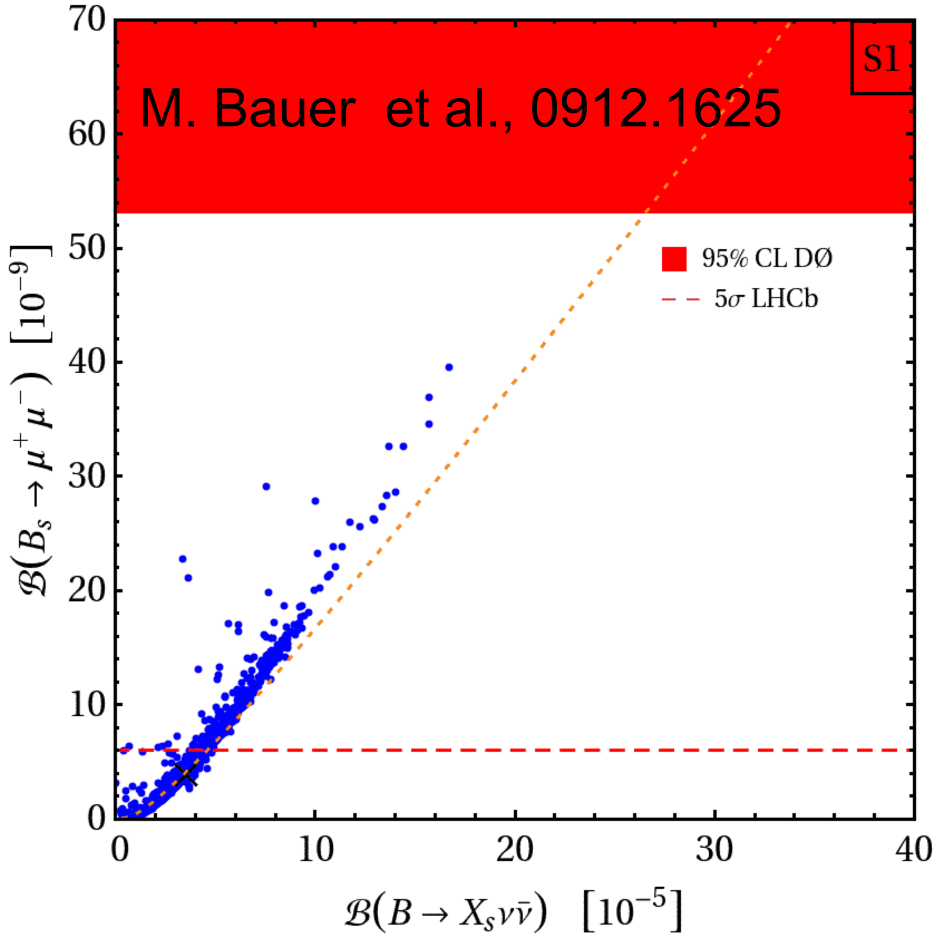
more information in arXiv:1008.1541, arXiv:0909.1333, and arXiv:0810.1312

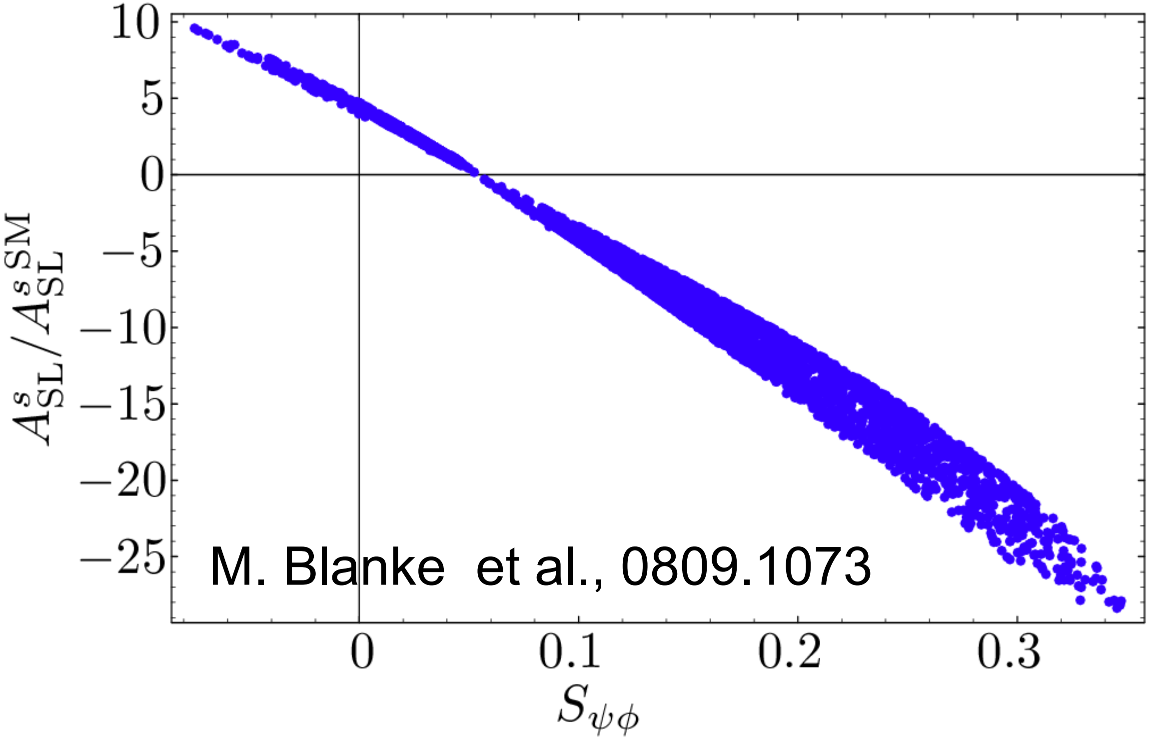


Observable/mode	charged Higgs	MFV NP	non-MFV NP	NP in	Right-handed	LHT	SUSY					
	high tan β	low tan β	2-3 sector	Z penguins	currents		AC	RVV2	AKM	δLL	FBMSSM	GUT-CMM
$\tau \to \mu\gamma$							★★★	★★★	★	★★★	★★★	★★★
$\tau \to \ell\ell\ell$						★★★						?
$B \to \tau\nu, \mu\nu$	★★★(CKM)											
$B \to K^{(*)+}\nu\bar{\nu}$			★	★★★			★	★	★	★	★	?
S in $B \to K_S^0\pi^0\gamma$			★★		★★★							
S in other penguin modes			★★★(CKM)		★★★		★★★	★★	★	★★★	★★★	?
A_{CP}(✓$B \to X_s\gamma$)			★★★		★★		★	★	★	★★★	★★★	?
BR(✓$B \to X_s\gamma$)		★	★★		★							★★
$BR(B \to X_s\ell\ell)$			★★	★	★							?
$B \to K^{(*)}\ell\ell$ (FB Asym)							★	★	★	★★★	★★★	?
a_{sl}^s			★★★			★★★						★★★
Charm mixing							★★★	★	★	★	★	
CPV in Charm	★★									★★★		

R-S models

- flavour in extra-dim. is severely constrained by ε_K
- large B/Bs effect are still possible



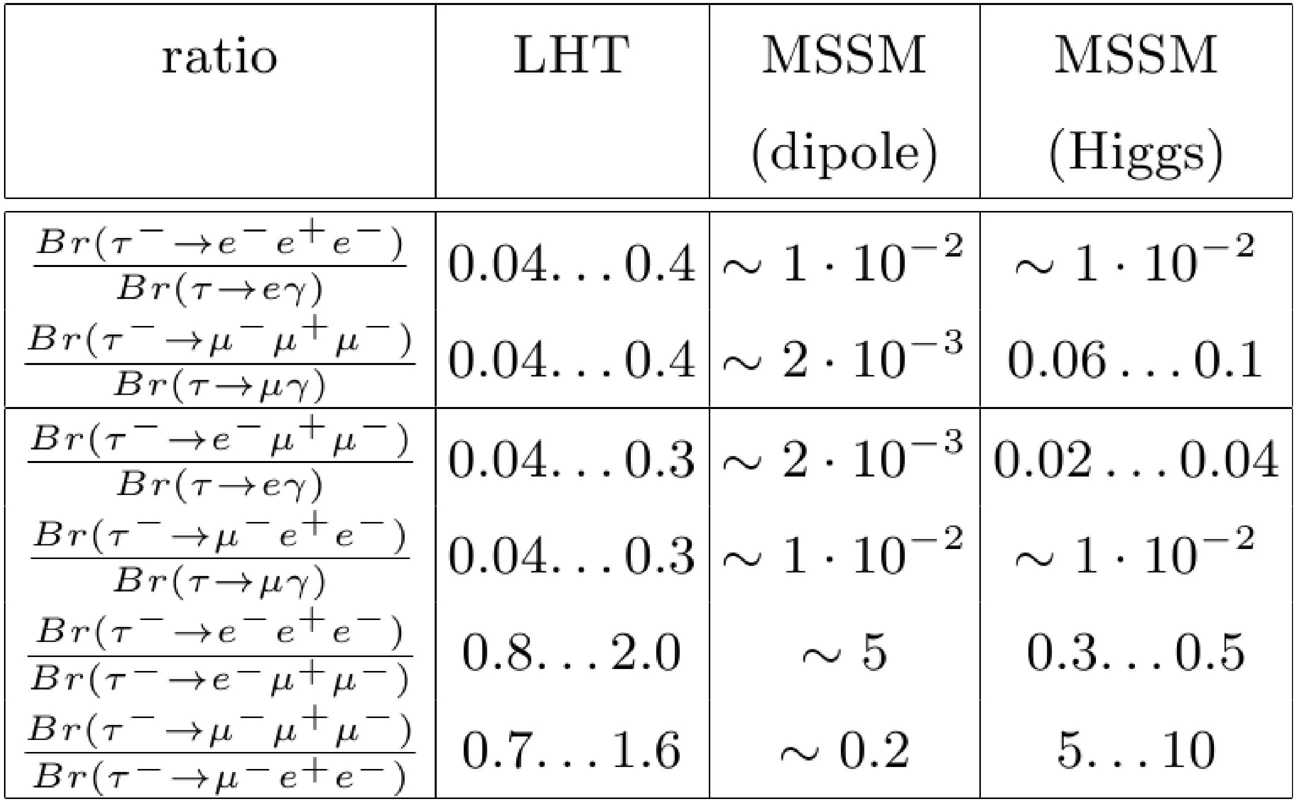


there are R-S models where effects in B(s) are confined to the mixing amplitudes

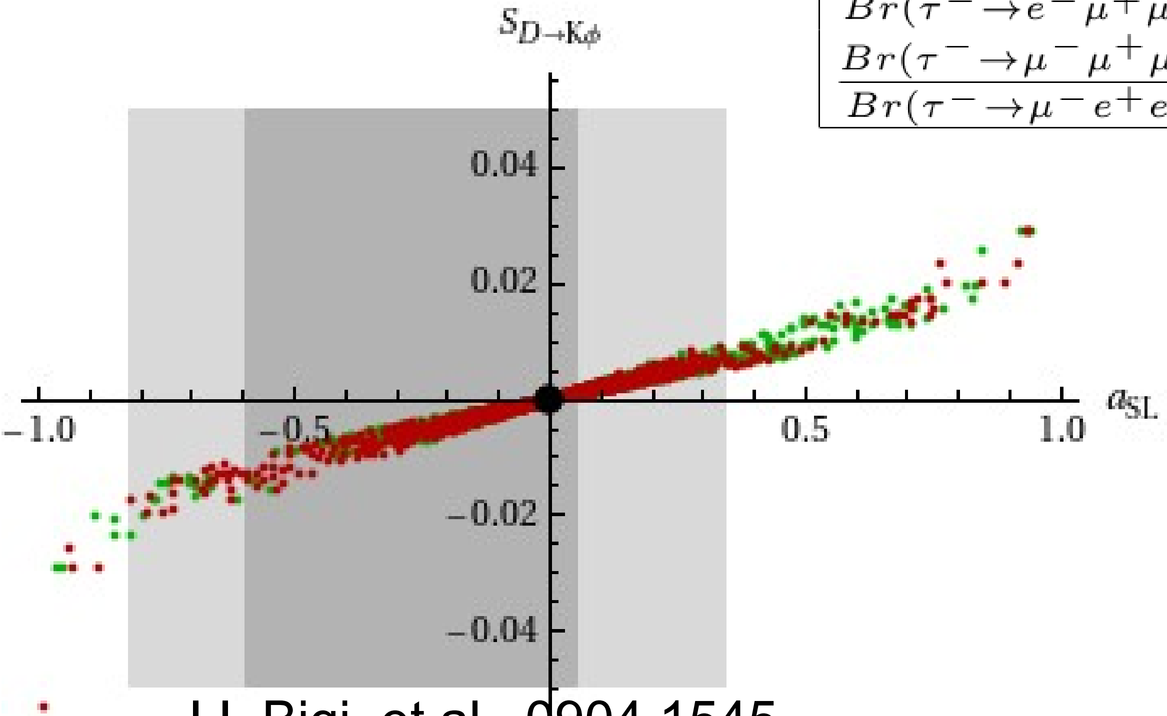
M. Blanke et al., 0906.5454

LHT model

- LFV: τ → μγ vs τ → ℓℓℓ
- semileptonic asymmetries



ratio	LHT	MSSM (dipole)	MSSM (Higgs)
$\frac{Br(\tau^-\to e^-e^+e^-)}{Br(\tau\to e\gamma)}$	$0.04\ldots0.4$	$\sim 1\cdot 10^{-2}$	$\sim 1\cdot 10^{-2}$
$\frac{Br(\tau^-\to \mu^-\mu^+\mu^-)}{Br(\tau\to \mu\gamma)}$	$0.04\ldots0.4$	$\sim 2\cdot 10^{-3}$	$0.06\ldots0.1$
$\frac{Br(\tau^-\to e^-\mu^+\mu^-)}{Br(\tau\to e\gamma)}$	$0.04\ldots0.3$	$\sim 2\cdot 10^{-3}$	$0.02\ldots0.04$
$\frac{Br(\tau^-\to \mu^-e^+e^-)}{Br(\tau\to \mu\gamma)}$	$0.04\ldots0.3$	$\sim 1\cdot 10^{-2}$	$\sim 1\cdot 10^{-2}$
$\frac{Br(\tau^-\to e^-e^+e^-)}{Br(\tau^-\to e^-\mu^+\mu^-)}$	$0.8\ldots2.0$	~ 5	$0.3\ldots0.5$
$\frac{Br(\tau^-\to \mu^-\mu^+\mu^-)}{Br(\tau^-\to \mu^-e^+e^-)}$	$0.7\ldots1.6$	~ 0.2	$5\ldots10$



I.I. Bigi et al., 0904.1545

Recently: large and correlated CPV effects in D mixing