B physics at superB

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Melbourne Convention and Exhibition Centre

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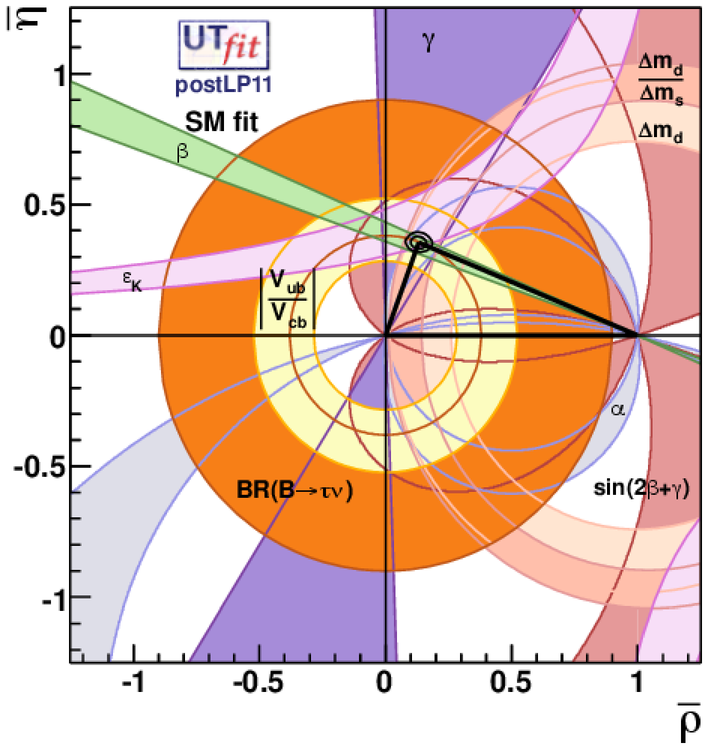
For the SuperB Collaboration

STARTING POINT…..

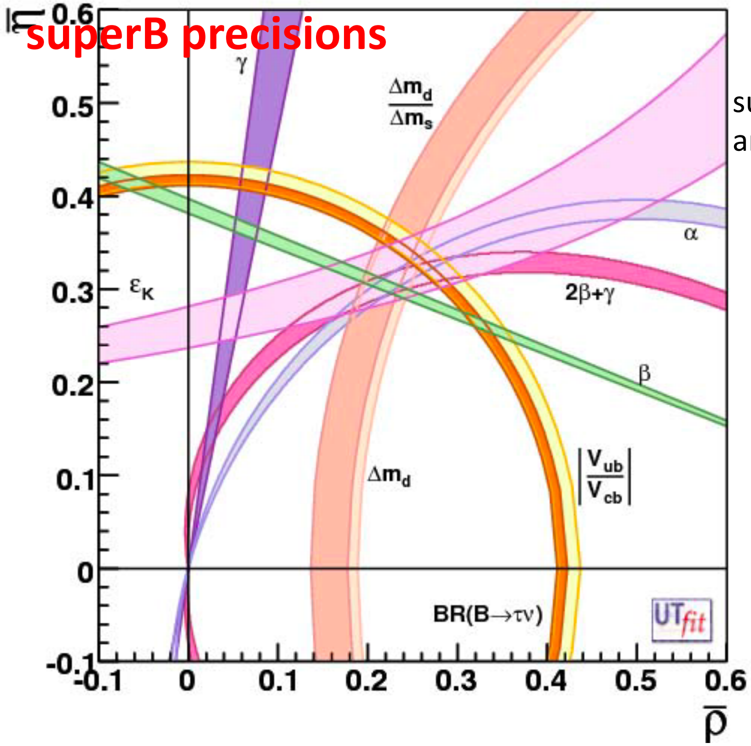
Search for evidence of physics beyond the Standard Model: main objective of HEP in this decade.
High precision measurements of HF decays allow to probe NP energy scale inaccessible at present colliders.

B-factories overconstrained Standard Model & searched for New Physics

Post LP11



75 ab-1:with actual central values and superB precisions



superB CDR
arXiv:0709.0451

If the relevant scale is 1 TeV or less, 50 to 100 ab−1 are required to make measurements precise enough to unambiguously isolate New Physics effects in the flavor sector.

GOLDEN MEASUREMENTS: comparison with LHCb

(indirect searches for NP need 1) good exp. precision & 2) good theory understanding)

Experiment: Red = No Result, Yellow = Moderate Precision, Blue = Precise, Green = Very Precise

Theory: Yellow = Moderately clean, Blue = Clean Need lattice, Green = Clean

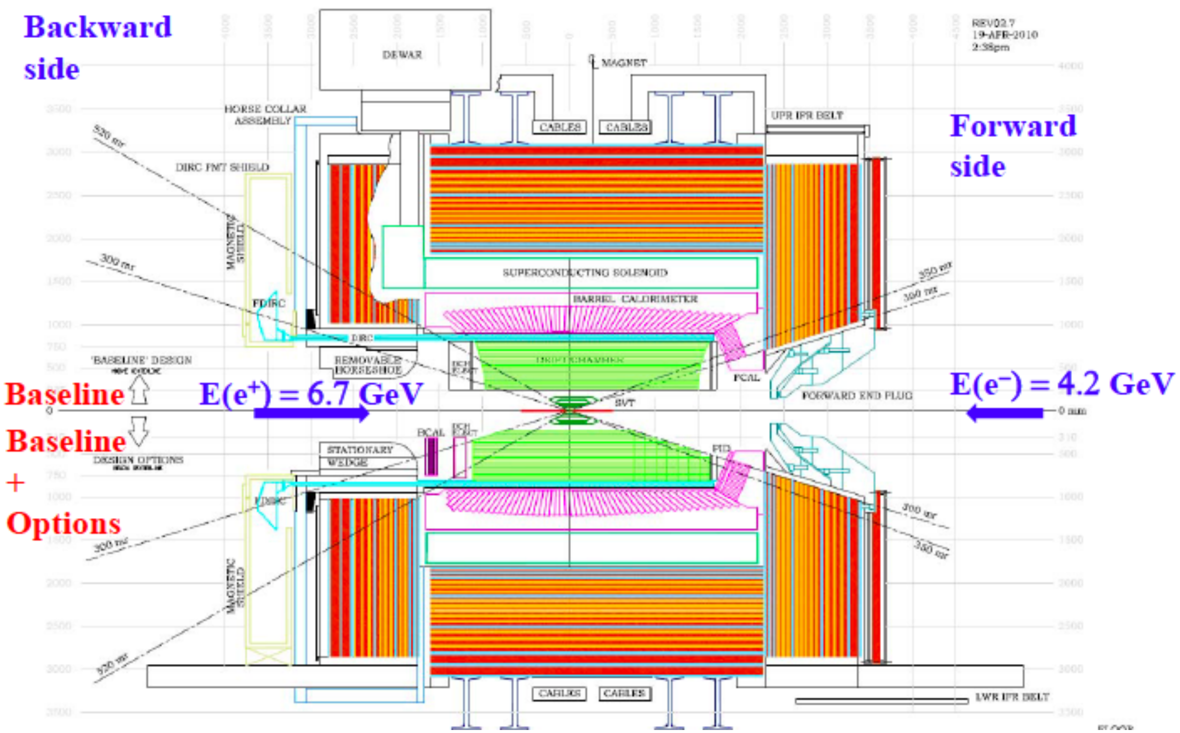
Observable/mode Luminosity	Current $\sim 1\,\text{ab}^{-1}$	LHCb (2017) $5\,\text{fb}^{-1}$	Super$B$ (5 years) $75\,\text{ab}^{-1}$	LHCb upgrade $50\,\text{fb}^{-1}$	Theory	
τ Decays						
$\tau \to \mu\gamma$	Yellow	Yellow	Green	Yellow	Green	Benefit from polarised e⁻ beam
$\tau \to e\gamma$	Yellow	Yellow	Green	Yellow	Green	
$B_{u,d}$ Decays						
$B \to \tau\nu, \mu\nu$	Yellow	Red	Blue	Red	Blue	very precise with improved detector
$B \to K^{(*)+}\nu\overline{\nu}$	Red	Red	Green	Red	Green	Statistically limited
S in $B \to K^0_S\pi^0\gamma$	Yellow	Red	Green	Red	Yellow	Right handed currents
S (other penguin modes)	Yellow	Yellow	Green	Blue	Yellow	SuperB measures many more modes
A_{CP} $(B \to X_s\gamma)$	Blue	Yellow	Green	Yellow	Green	systematic error is main challenge
BR$(B \to X_s\gamma)$	Blue	Yellow	Green	Yellow	Yellow	control systematic error with data
BR$(B \to X_s ll)$	Yellow	Red	Green	Red	Green	
BR$(B \to K^{(*)} ll)$	Yellow	Blue	Green	Green	Yellow	SuperB measures e mode well, LHCb does μ
B_s Decays						
$B_s \to \mu\mu$	Red	Blue	Red	Green	Green	
β_S from $B_s \to J/\psi\,\phi$	Red	Blue	Red	Green	Green	
$B_s \to \gamma\gamma$	Red	Red	Blue	Red	Green	
a_{sl}	Red	Blue	Green	Green	Green	
D Decays						
Mixing parameters	Yellow	Blue	Green	Green	Green	Clean NP search
CP Violation	Red	Blue	Green	Green	Green	
Precision Electroweak						
$\sin^2\theta_W$ at $\Upsilon(4S)$	Red	Red	Green	Red	Green	Theoretically clean
$\sin^2\theta_W$ at Z-Pole	Green	Blue	Red	Green	Yellow	b fragmentation limits interpretation

SuperB …SHORT INTRODUCTION

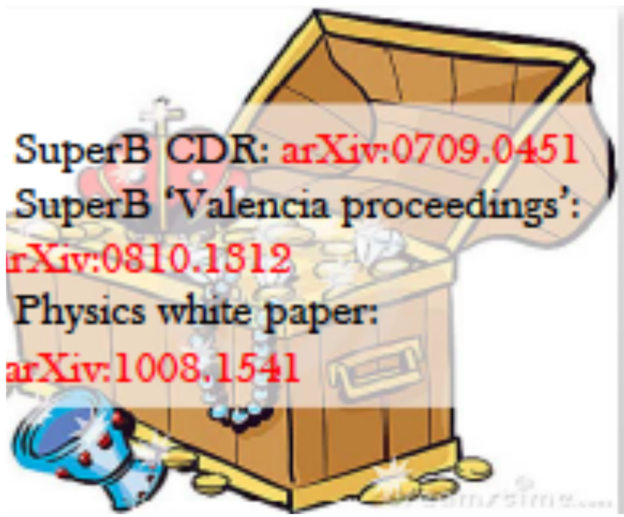
Design peak luminosity 10^{36} cm^{-2} s^{-1} @ ϒ(4S)
Integrate 15ab-1 in 1 year (1.5x10^7 s) → 75ab-1 in 5 years

Upgraded detector w.r.t. BaBar will lead to improvements in physics results
i.e. forward PID, backward EMC, new forward EMC… some still under discussion
Improvement in Δt resolution and tagging technique.

Detector Overview



Details in the talk at the future accelerator session by U. Dosselli



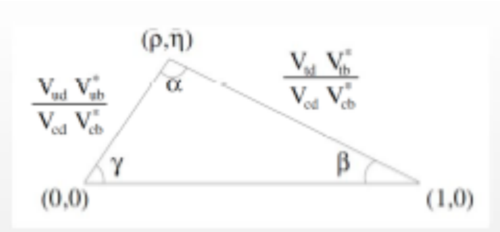
MEASUREMENT OF β

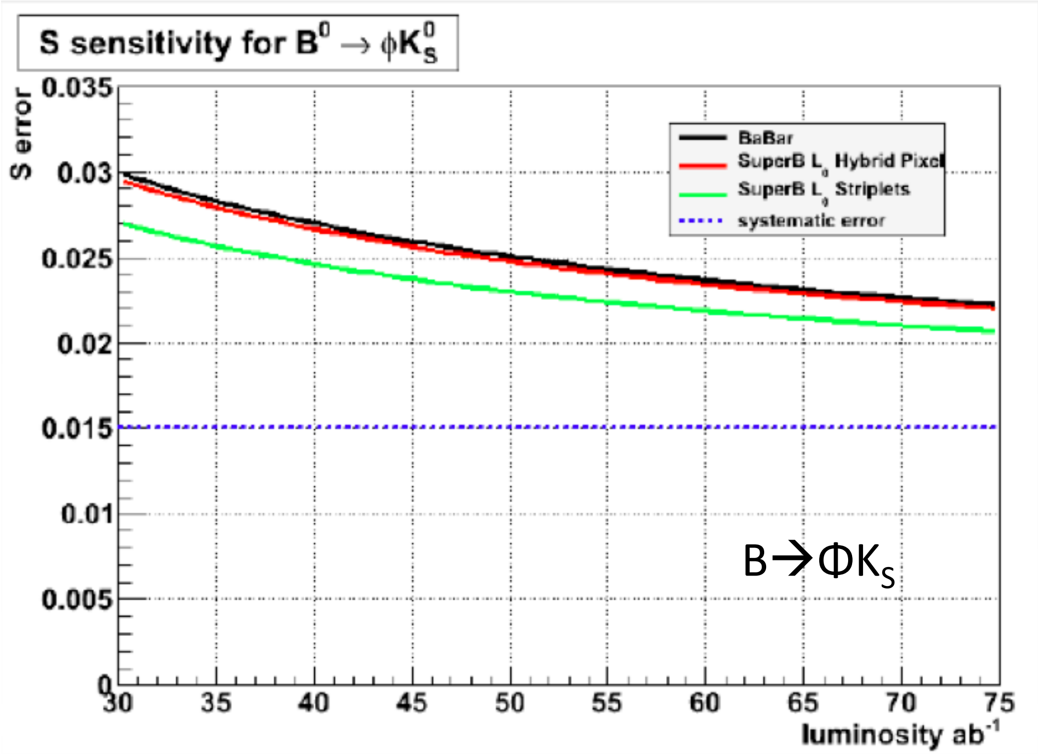
Phys.Rev.D79:072009,2009
465 million $B\bar{B}$ pairs

From golden modes

$$\beta \equiv arg[-V_{cd}V^*_{cb}/V_{td}V^*_{tb}]$$

$$sin(2\beta) = 0.687 \pm 0.028 \pm 0.012$$





SuperB with 75ab-1 → syst. down to 0.005 with only B→$J\psi K_S$

SM expectation
S=sin2β

$\phi(K^+K^-)K_s$:arXiv:0808.0700,2008
$\eta' K_s$ Phys.Rev.D79:052003,2009
465 million $B\bar{B}$ pairs

From penguins:

$\sin(2\beta)_{\Phi KS}$ = 0.26 ± 0.26 ±0.03
$\sin(2\beta)_{\eta' K0}$ = 0.57 ± 0.08 ± 0.02

Syst. Error on S reduction by a factor of 2 with 75 ab-1
stat and syst. errors comparable: σ(S) ≅ 0.02

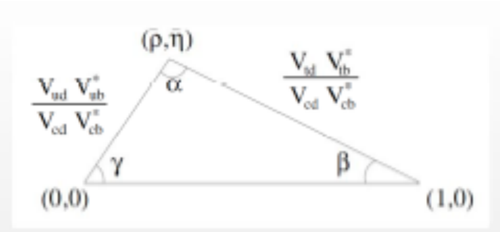
$|\sin2\beta_{\Phi KS} - \sin2\beta_{golden}| \approx O(0.01)$
$|\sin2\beta_{\eta' K0} - \sin2\beta_{golden}| \approx O(0.03 - 0.09)$

M. Beneke, Phys.Lett.B620:143,2005; G. Buchalla et al., JHEP0509,074,2006
M. Grounau et al., Phys.Rev.D74:093003,2009; M. Beneke, Phys.Lett.B620:143,2005; S. Williamson et al., Phys.Rev.D74:014003,2006; Cheng et al., Phys.Rev.D72:014006,2005

expect small discrepancies wrt to β from golden modes

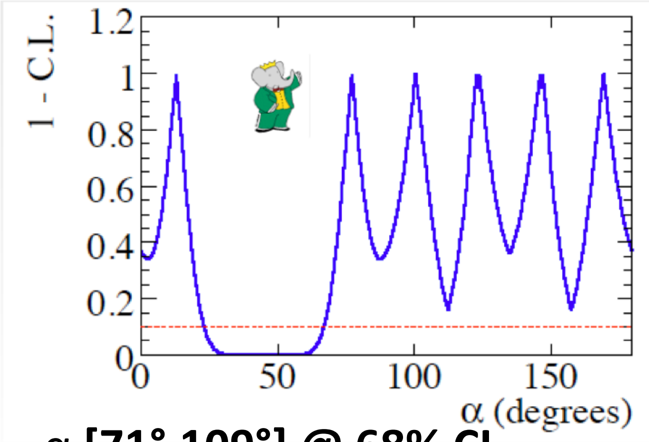
MEASUREMENT OF α

$$\alpha \equiv arg[-V_{td}V_{tb}^{*}/V_{ud}V_{ub}^{*}]$$



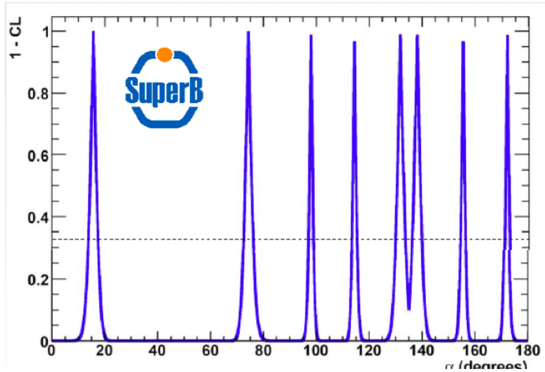
BaBar **B→ππ**

[arXiv:0807.4226]
467 million BB pairs



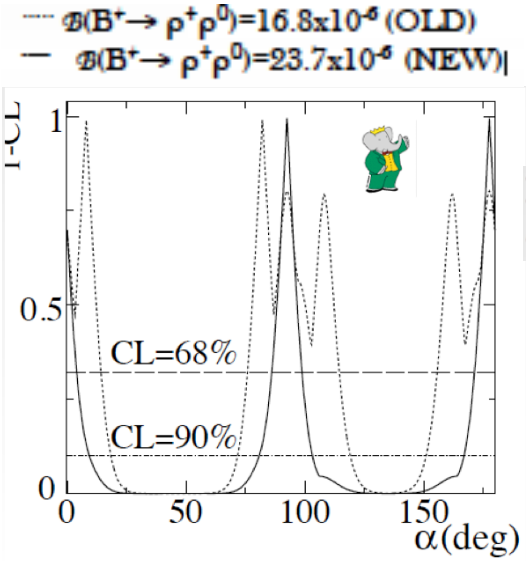
α [71°,109°] @ 68% CL
choosing SM preferred solution M Gronau, J.L. Rosner, Phys.Lett.B651:166,2007

superB 75ab-1



σ(α) = 0.9°÷1.9°

B → ρρ analysis

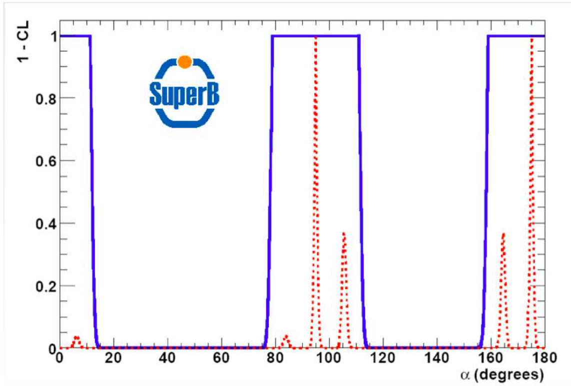


BaBar

PRD 78 (2008), 071104
465 million BB pairs

α = (92.4+6.0-6.5)° @ 68% CL

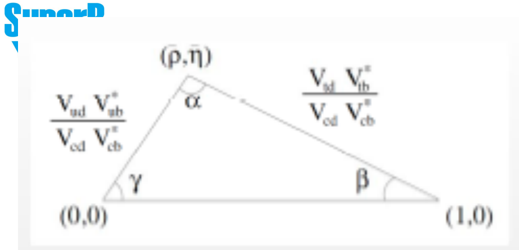
superB 75ab-1



$B(B^+\to\rho^+\rho^0)$ σ(α) ≅ 0.75°

≅ 1°level precision reachable with 75ab-1 using SU(2) ππ and ρρ analysis

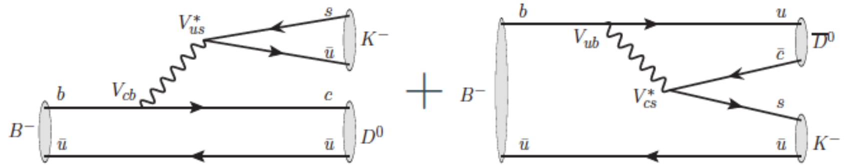
Measurement of γ



$$\gamma \equiv arg[-V_{ud}V_{ub}^{*}/V_{cd}V_{cb}^{*}]$$

B →D(*)^{0}K(*)

measure parameters of the
interference between two amplitudes: with **D0 and D0(bar).**



GGSZ

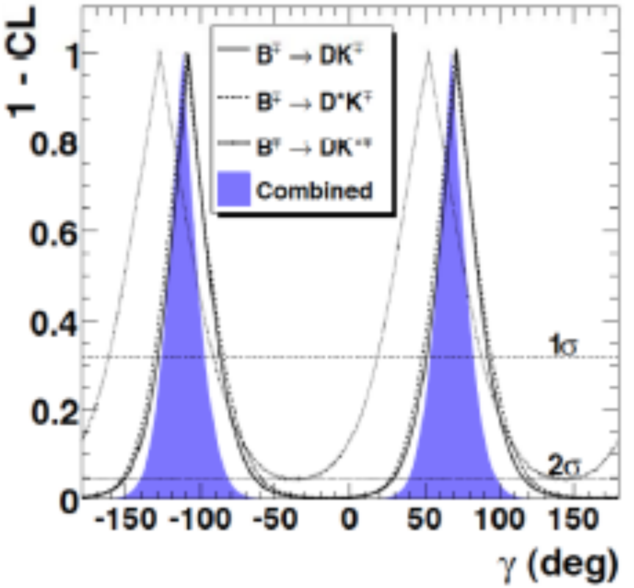
D^0→K$_s$h+h- with h = K,π

γ from Dalitz plot of D0 daughters distribution

measure (x,y) (12 params) to extract 3x(rB, δ)+ γ

$m_\pm = m(K_S h^\pm)$
$A_{D^\pm}$: $D^0/\bar{D}^0$ decay amplitudes
$\lambda = +1$ for $B \to D^0K, D^{*0}(D^0\pi^0)K, D^0K^*$
$= -1$ for $D^{*0}(D^0\gamma)K$

$x_\pm = r_B cos(\delta_B \pm \gamma)$;
$y_\pm = r_B sin(\delta_B \pm \gamma)$;
δ_B : $A(b\to u) - A(b \to c)$ strong phase difference;
$r_B^2 = (|A(b\to u)|/|A(b\to c)|)^2 = x^2 + y^2$



γ = (68 ± 14stat ± 4syst ±3model)°

hep-ex:10051096
468 million BB pairs

Expected precision σ(γ) = 2.8°

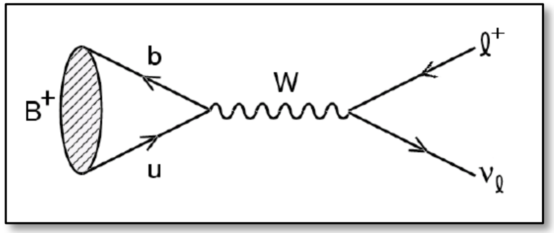
- method provides most precise constraint, main syst. due to Dalitz Model → room for improvements?

-GGSZ (multi-Dalitz analysis) + GLW (D in a CP eigenstate) + ADS (D in Cabibbo favoured and in doubly Cabibbo suppressed) : σ(γ) = 1°

Tree-level decay: branching fraction can be modified in some extension of the Standard Model

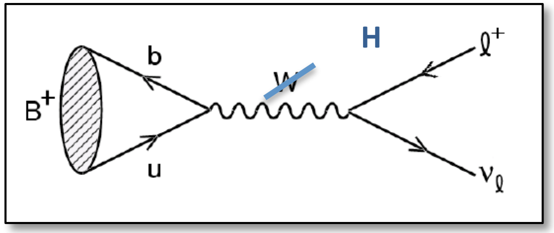
Flavour-changing neutral current process: prohibited at tree level in the Standard Model → New Physics contributions enter at same order as SM physics

B→τν



- Standard Model prediction (SM) :
- $\mathcal{B}(B\to\tau\nu)_{SM}$ = (1.20 ± 0.20) x 10^{-4}

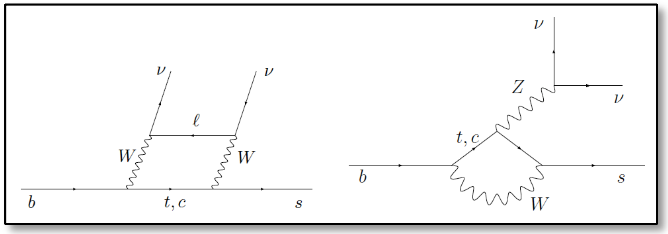
|Vub| = (4.32 ± 0.33) x 10^{-4} (HFAG, http://www.slac.stanford.edu/xorg/hfag/results/index.html), f_B = (190 ± 13) MeV (PRD 80,014503,2009), τ_B = (1.638 ± 0.011) ps (PDG)



- SM vs 2-Higgs Doublet Model-II

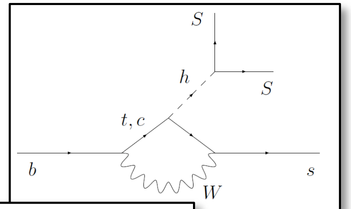
$$\frac{\mathcal{B}(B^- \to \tau^- \nu_\tau)_{2HDM}}{\mathcal{B}(B^- \to \tau^- \nu_\tau)_{SM}} = \left(1 - tan^2\beta \frac{m_B^2}{m_H^2}\right)^2$$

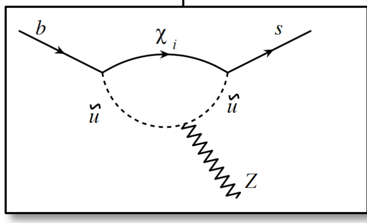
B→K^(*)νν



- SM predictions
  - B(B→Kνν)=(4.5±0.7)x10^{-6}
  - B(B→K*νν)=(6.8±1.1)x10^{-6}
  - F_L(B→K*νν)=(0.54±0.01)

- Non standard contributions





In many NP models, the SM particles in the loops are replaced by new heavy particles, new masses, new couplings → modify quantities that we can measure

B → τν at SuperB

SuperB @ 75 ab^{-1} (~ 5 years) : ~ 4%

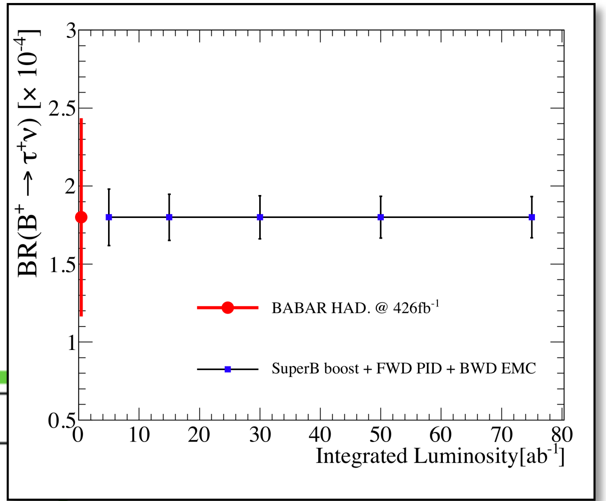
Best experimental result (Babar+Belle) :

$\mathcal{B}(B^+ \to \tau^+ \nu) = (1.67 \pm 0.30) \times 10^{-4}$

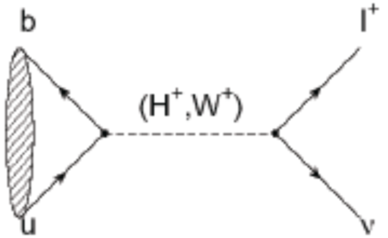
From global CKM fit

$(0.79 \pm 0.07) \times 10^{-4}$

HFAG, http://www.slac.stanford.edu/xorg/hfag/results/index.htm



Leptonic decay B → l ν



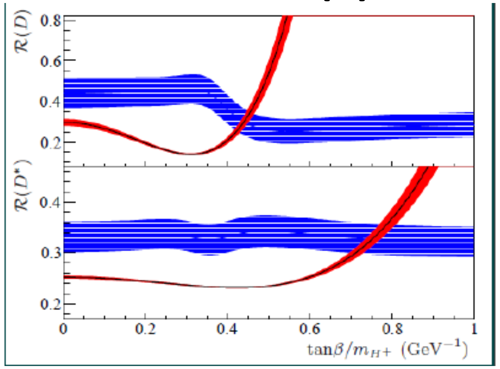
Observable	B Factories (2 ab^{-1})	SuperB
$\mathcal{B}(B \to \tau\nu)$	20%	4%
$\mathcal{B}(B \to \mu\nu)$	visible	5%
$\mathcal{B}(B \to D\tau\nu)$	10%	2%

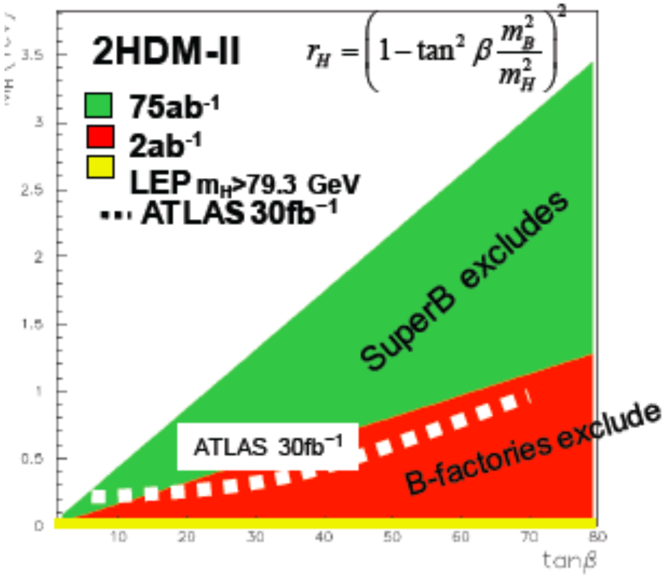
$$\mathrm{BR}(B \to \tau\nu) = \mathrm{BR}_{SM}(B \to \tau\nu)\left(1 - \frac{m_B^2}{M_H^2}\tan^2\beta\right)^2$$

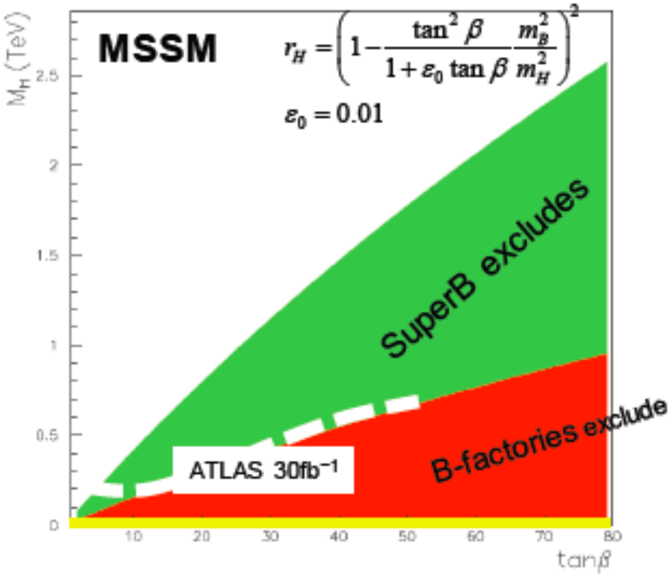
SuperB -75ab^{-1}

M_H~1.2-2.5 TeV for tanβ~30-60

NEW B→D(*)τν

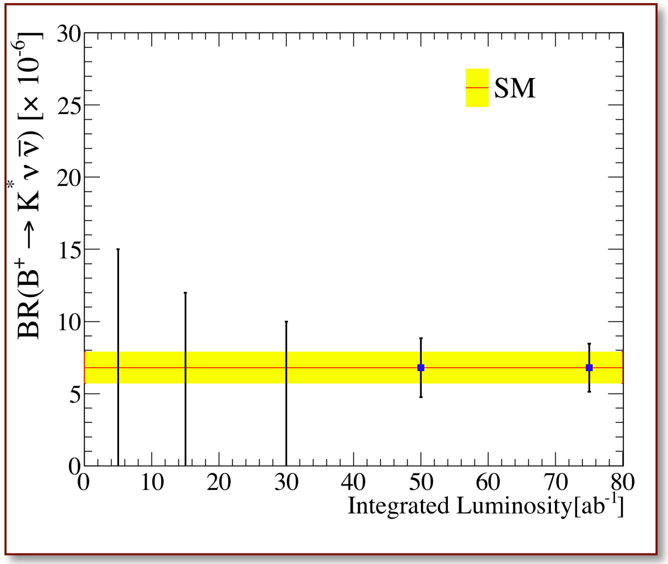






Two match points 0.44 ±0.02 & 0.75 ± 0.04 ⇒
Rule out 2HDM at 99.8% C.L. for any tanb/mH+

B → K*νν at SuperB



miglior risultato sperimentale: BaBar, 413 fb^{-1}

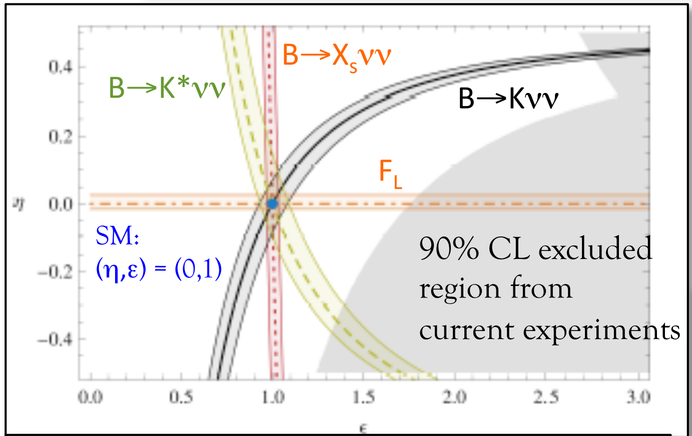
$\mathcal{B}(B^+ \to K^{*+}\nu\nu) < 8.0 \times 10^{-5}$

$\mathcal{B}(B^0 \to K^{*0}\nu\nu) < 12.0 \times 10^{-5}$

Aubert et al. (BaBar collaboration) PRD78,072007,2008

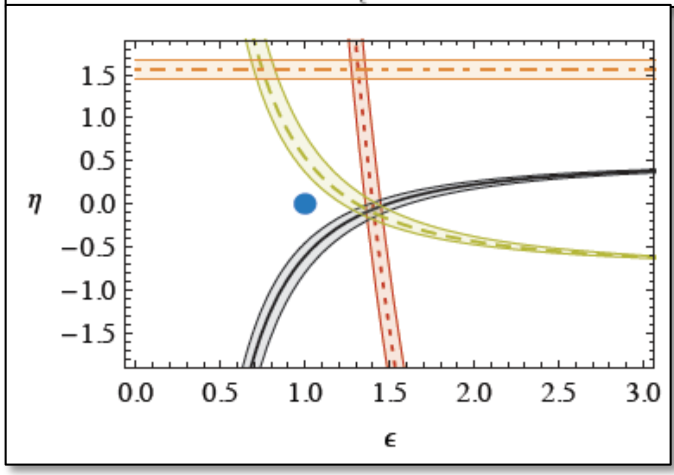
- 3σ significance at SuperB @ 42ab^{-1} with ~ 30% precision on $\mathcal{B}$
- SuperB @ 75 ab^{-1} : 25% precision on $\mathcal{B}(B \to K^*\nu\nu)$, 10% on $\mathcal{B}(B \to K\nu\nu)$, 50% on $F_L(B \to K^*\nu\nu)$ O'Leary et al. (SuperB collaboration), arXiv: 1008.1541

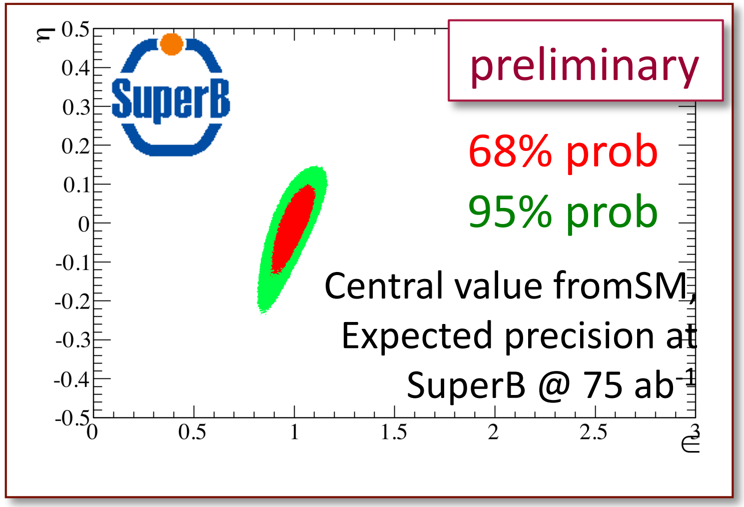
$$\mathcal{H} = -\frac{4G_F}{\sqrt{2}} V_{tb}V_{ts}^*(\mathcal{C}_L^\nu \mathcal{O}^\nu{}_L + \mathcal{C}_R^\nu \mathcal{O}^\nu{}_R) + h.c.$$



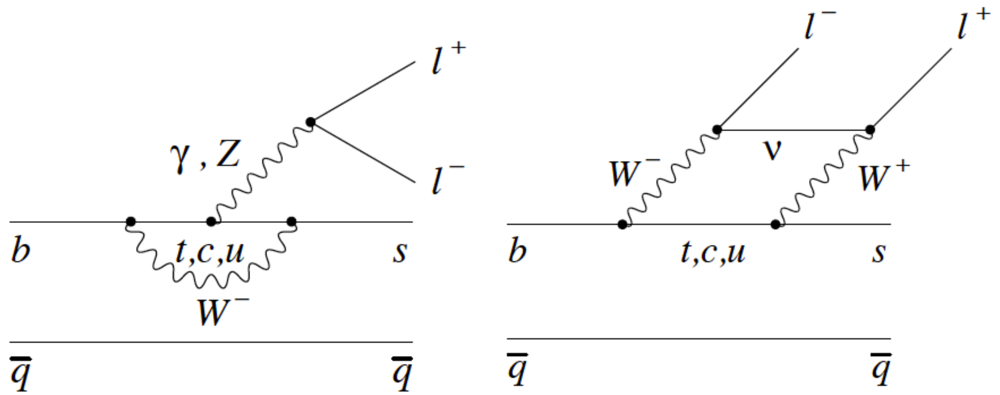
$$\epsilon = \frac{\sqrt{|C_L^\nu|^2 + |C_R^\nu|^2}}{|(C_L^\nu)^{SM}|}$$

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

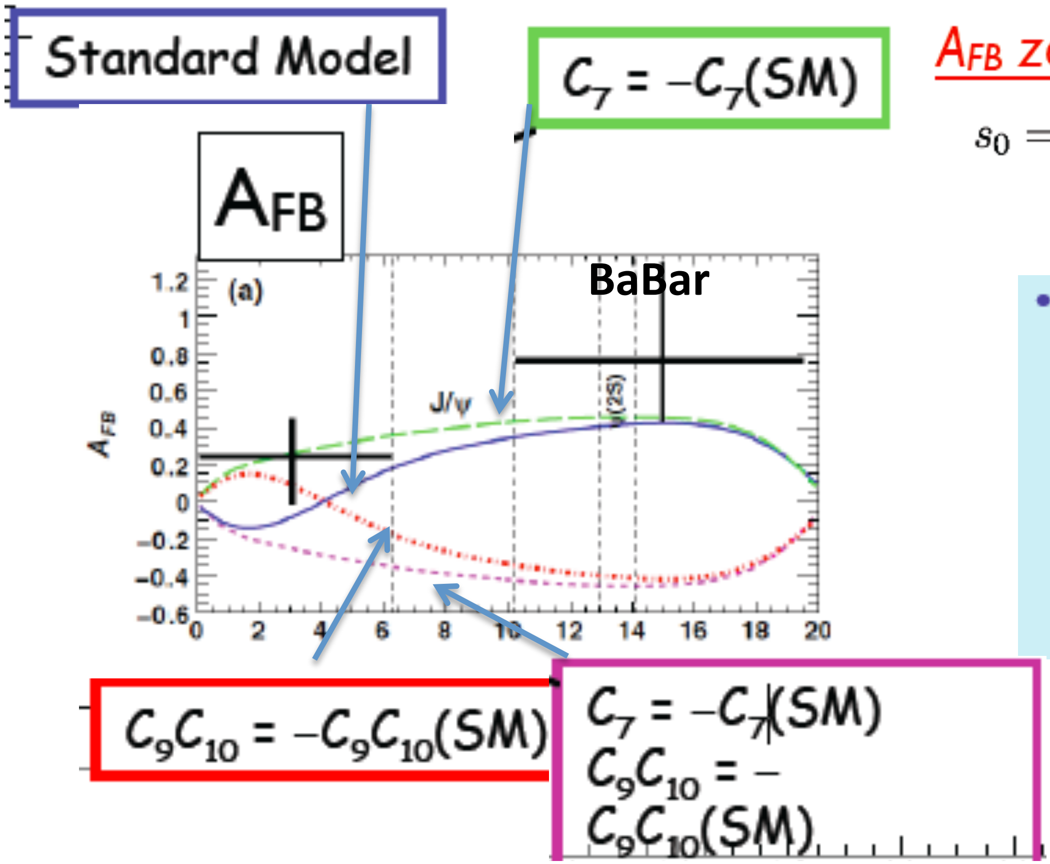




$B \to K^*ll$ at SuperB



- Theory predicts observables as functions of $q^2=m^2_{ll}$ → experiment aim to measure as function of q^2→strong tool for revealing NP
- Very small BF: ≈ 1.5×10^{-6} →
  - current experimental results are limited to small statistics
  - most exp. Focus has been on exclusive states: $B \to K^{(*)} l^+ l^-$



A_{FB} zero crossing: SM

$$s_0 = (4.2 \pm 0.6)\ \mathrm{GeV}^2$$

- **Lepton forward/backward asymmetry** A_{FB} → θ_l angle between l^+ (l^-) and B ($\bar{B}$) in l^+l^- rest frame

$$\frac{1}{\Gamma}\frac{d\Gamma}{d\cos\theta_\ell} = \frac{3}{4}F_L(1-\cos^2\theta_\ell) + \frac{3}{8}(1-F_L)(1+\cos^2\theta_\ell) + A_{FB}\cos\theta_\ell$$

F_L = K* longitudinal polarization

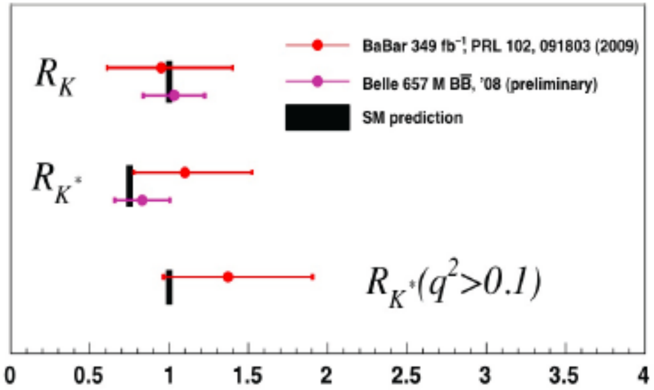
[PRD 79 031102(R) (2009)]

B → K*ll at SuperB

- With both lepton flavours measured, we can determine the lepton flavor ratios:

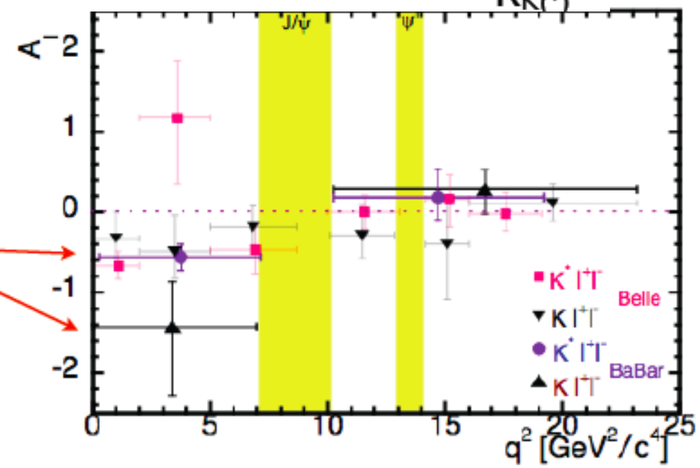
$$R_K \equiv \frac{B(B\to K\mu^+\mu^-)}{B(B\to Ke^+e^-)} \qquad R^*_K \equiv \frac{B(B\to K^*\mu^+\mu^-)}{B(B\to K^*e^+e^-)}$$

- In the SM, R_K=1 and R_{K^*}=0.75 (if pole region is excluded, R_{K^*}=1), but these can be substantially altered in NP models (2HDM, presence of neutral Higgs boson)
- To date, Babar and Belle measure RK(*) values that are consistent with the SM



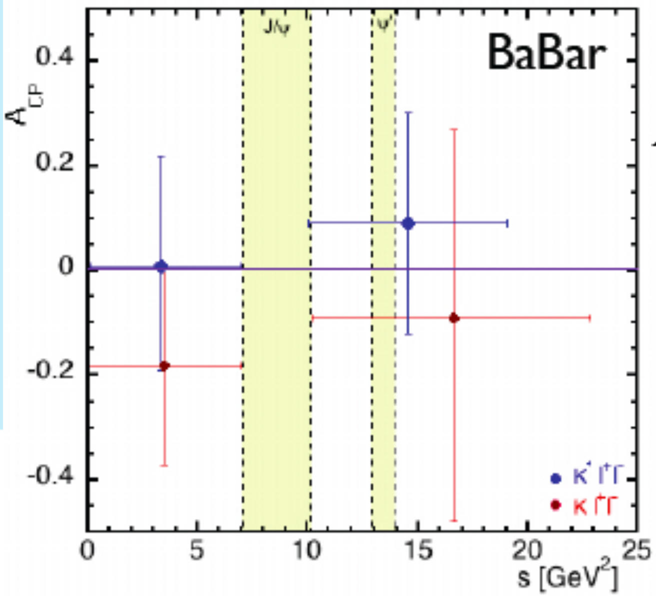
- Define: $$A_{CP} = \frac{B(\bar{B}\to \bar{X}_s\ell^+\ell^-) - B(B\to X_s\ell^+\ell^-)}{B(\bar{B}\to \bar{X}_s\ell^+\ell^-) + B(B\to X_s\ell^+\ell^-)}$$

large negative A_I



$$A_I^i = \frac{B_i(B^0\to K^{(*)0}\ell^+\ell^-) - rB_i(B^+\to K^{(*)+}\ell^+\ell^-)}{B_i(B^0\to K^{(*)0}\ell^+\ell^-) + rB_i(B^+\to K^{(*)+}\ell^+\ell^-)}$$

- In SM, A_{CP} < 1% level, can be significantly enhanced with NP
- Charged modes and $B\to K^+\pi^- l^+ l^-$ are self-tagging, no need for additional tags
- Current measurements from Babar and Belle consistent with A_{CP}=0 with rather larger errors.

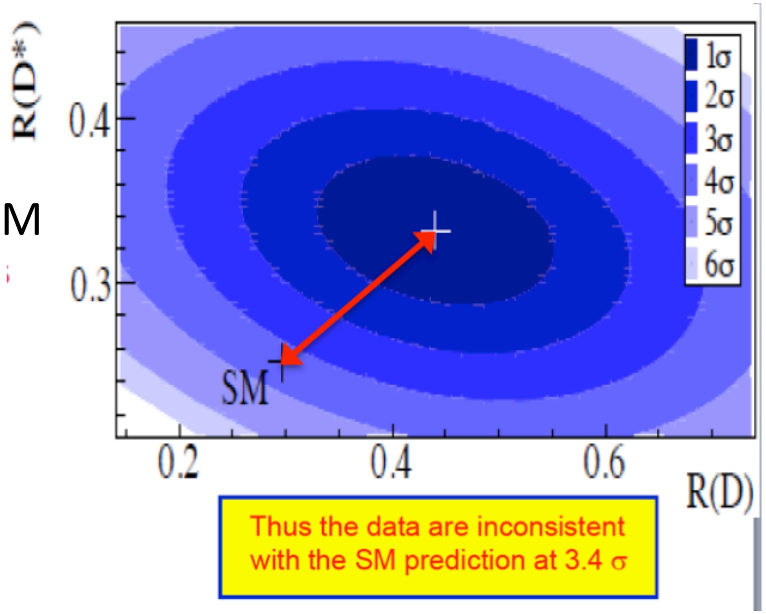


- Taking K*ll and Kll together, this is a 3.9σ effect.
- Belle's results are consistent with SM (and also with BaBar results)
- Need more data to sort this out (updated Babar measurement coming within weeks)

Smoking guns

$B \to D^{(*)}\tau\nu$ arXiv:1205.5442

- Recent measurements incompatible with SM

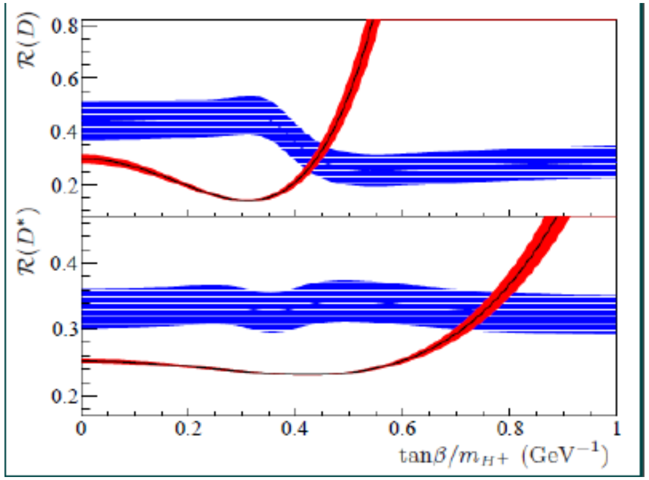


BaBar (2012)	SM calc.
$\mathcal{R}^*_{\tau/\ell} \equiv \frac{\mathcal{B}(B\to D^*\tau\nu)}{\mathcal{B}(B\to D^*\ell\nu)} = 0.332 \pm 0.030\,,$	0.252 ± 0.003
$\mathcal{R}_{\tau/\ell} \equiv \frac{\mathcal{B}(B\to D\tau\nu)}{\mathcal{B}(B\to D\ell\nu)} = 0.440 \pm 0.072\,,$	0.296 ± 0.016

- Violation of Lepton Flavour Universality?

$V_{ub}: \quad b \to u\ell\nu$

- Discrepancy: inclusive V_{ub} vs. exclusive V_{ub}
- Inclusive V_{ub} in tension with sin 2β from CKM fits



Two match points 0.44 ±0.02 & 0.75 ± 0.04 ⇒ Rule out 2HDM at 99.8% C.L. for any tanb/mH+

- Together these results raise questions about possible NP (see e.g. arXiv:1206.1872, 1206.2634)
- More precise experimental measurements needed ➔ SuperB

Super$B$ $\Upsilon(5S)$ B_s Physics reach

Observable	Error with 1 ab^{-1}	Error with 30 ab^{-1}
$\Delta\Gamma$	$0.16\ ps^{-1}$	$0.03\ ps^{-1}$
Γ	$0.07\ ps^{-1}$	$0.01\ ps^{-1}$
β_s from angular analysis	20°	8°
A_{SL}^{s}	0.006	0.004
A_{CH}	0.004	0.004
$\mathcal{B}(B_s \to \mu^+\mu^-)$	-	$< 8 \times 10^{-9}$
$\|V_{td}/V_{ts}\|$	0.08	0.017
$\mathcal{B}(B_s \to \gamma\gamma)$	38%	7%
β_s from $J/\psi\phi$	10°	3°
β_s from $B_s \to K^0\overline{K}^0$	24°	11°

- LHCb in general is more competitive for B_s measurements, but there are a few exceptions

CONCLUSIONS

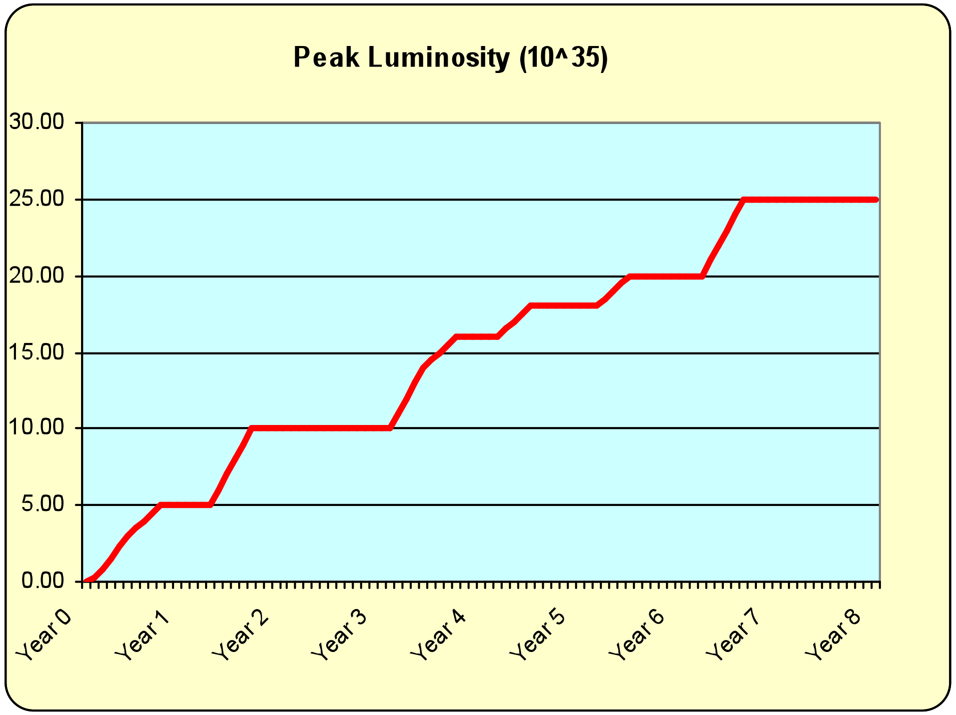
- SuperB will search for New Physics effects in the B physics sector in a competitive and complementary way with the current experiment and future facilities

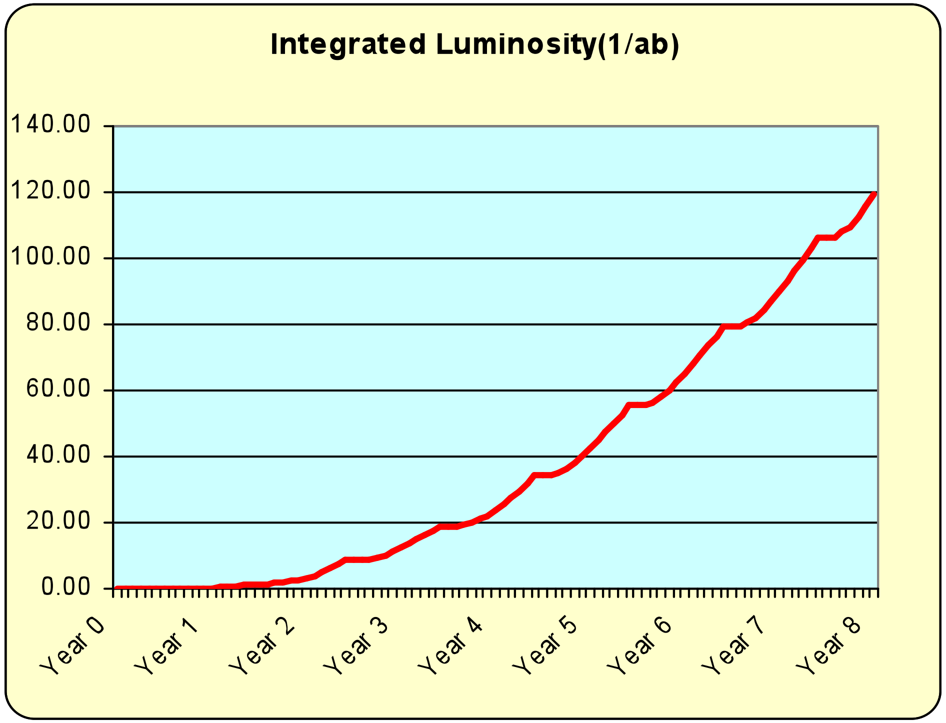
-SuperB is designed with very high versatility with the possibility of running around the Y(4S) peak, the ϒ(5S) and the charm threshold

-Its features makes it uniquely suited for a large range of New Physic searches and for precision tests of the Standard Model

BACKUP

SuperB expected LUMI





After 7th year integrated Luminosity can grow at rate of ~40 ab^{-1}/year

Overview on β measurements with current precision and SuperB projection @ 75ab^{-1}

- scale stat and reducible syst uncertainties by luminosity
- detector performance improvements not accounted for

Mode	Current Precision			Predicted Precision ($75\,\mathrm{ab}^{-1}$)		
	Stat.	Syst.	Th.	Stat.	Syst.	Th.
$J/\psi K^0_S$	0.022	0.010	< 0.01	0.002	0.005	< 0.001
$\eta' K^0_S$	0.08	0.02	0.014	0.006	0.005	0.014
$\phi K^0_S \pi^0$	0.28	0.01	–	0.020	0.010	–
$f_0 K^0_S$	0.18	0.04	0.02	0.012	0.003	0.02
$K^0_S K^0_S K^0_S$	0.19	0.03	0.013	0.015	0.020	0.013
ϕK^0_S	0.26	0.03	0.02	0.020	0.010	0.005
$\pi^0 K^0_S$	0.20	0.03	0.025	0.015	0.015	0.025
ωK^0_S	0.28	0.02	0.035	0.020	0.005	0.035
$K^+ K^- K^0_S$	0.08	0.03	0.05	0.006	0.005	0.05
$\pi^0 \pi^0 K^0_S$	0.71	0.08	–	0.038	0.045	–
ρK^0_S	0.28	0.07	0.14	0.020	0.017	0.14
$J/\psi \pi^0$	0.21	0.04	–	0.016	0.005	–
$D^{*+} D^{*-}$	0.16	0.03	–	0.012	0.017	–
$D^+ D^-$	0.36	0.05	–	0.027	0.008	–

arXiv:1008.1541 (2010)

Comparing SuperB, LHCb & Belle-2

Observable/mode	Current now	LHCb (2017) $5\,\mathrm{fb}^{-1}$	Super$B$ (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]	
			$B_{u,d}$ 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)	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}	$(1.11 \pm 0.22)\%$	0.02%	0.03%	0.05%	0.01%	$\sim 10^{-2}$ (see above).
$\lvert q/p \rvert$	$(0.91 \pm 0.17)\%$	8.5%	2.7%	3.0%	3%	$\sim 10^{-3}$ (see above).
$\arg\{q/p\}$ $(^\circ)$	-10.2 ± 9.2	4.4	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

THEORY AND MEASURMENTS

SuperB scope	Observable/mode	H^+ high $\tan\beta$	MFV	non-MFV	NP Z penguins	Right-handed currents	LTH	SUSY AC	SUSY RVV2	SUSY AKM	SUSY δLL	SUSY FBMSSM
✓	$\tau \to \mu\gamma$							★★★	★★★	★	★★★	★★★
✓	$\tau \to \ell\ell\ell$						★★★					
✓	$B \to \tau\nu, \mu\nu$	★★★(CKM)										
✓	$B \to K^{(*)+}\nu\overline{\nu}$			★	★★★			★	★	★	★	★
✓	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)							★	★	★	★★★	★★★
	$B_s \to \mu\mu$							★★★	★★★	★★★	★★★	★★★
	β_s from $B_s \to J/\psi\phi$							★★★	★★★	★★★	★	★
✓	a_{sl}						★★★					
✓	Charm mixing							★★★	★	★	★	★
✓	CPV in Charm	★★									★★★	

NP enhancement:
- ★ Observable effect
- ★★ Moderately large effect
- ★★★ Very large effect

- Combine measurements to elucidate NP structure
  → Decoding NP won't be easy
  - As many measurements as possible needed

MORE INFO CAN BE FOUND IN arXiv:1008.1541, arXiv:0909.1333, and arXiv:0810.1312.

* **With 75ab-1 we expect to accumulate large samples in all relevant channels**

* **Good measurements of interesting observables (LHCb very good on μμ, not on ee)**

Channel	No. events (1000s)
$B \to K^* \mu\mu$	10-15
$B \to K^* ee$	10-15
$B \to K \mu\mu$	8-12
$B \to Kee$	8-12
$B \to X_s ll$	6-9

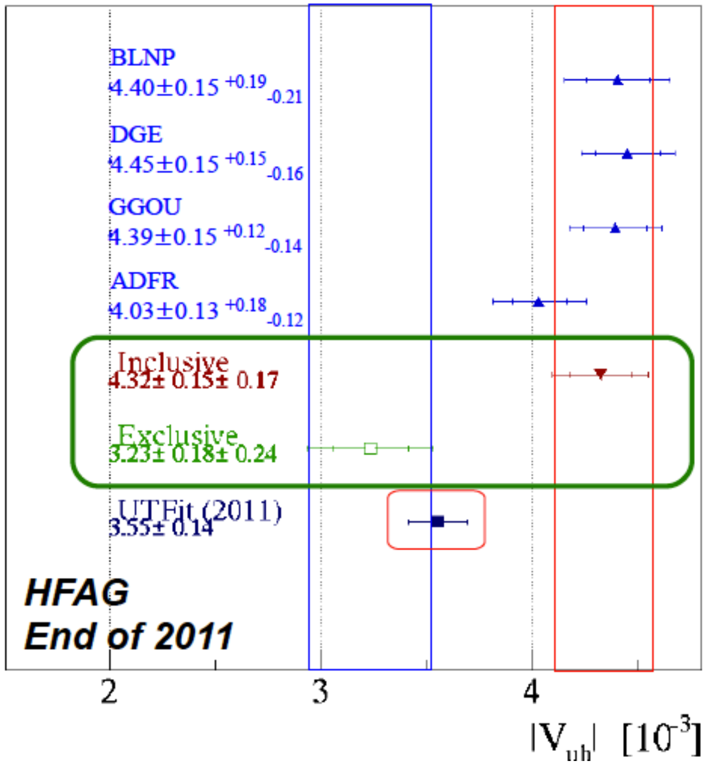
More details: arXiv:1008:1541, arXiv:1109.5028

	Observable	Uncertainty	Theo. uncertainty
Exclusive	$A_{FB}(K^*ll)$	0.04	0.02
	$A_I(K^*ll)$	0.02	~0.01
	$A_{CP}(Kll)$	0.02	~0.01
	R_K	0.04	<0.01
	R_{K^*}	0.05	<0.01
Inclusive	$BF(X_s ll)$	0.05	0.07
	R_{X_s}	0.06	<0.01
	$A_{CP}(X_s ll)$	0.02	~0.01
	$A_I(X_s ll)$	0.05	?
	$A_{FB}(X_s ll)$	0.04	?

Based on BaBar extrapolation, fast-sim studies are underway

$V_{ub}: \quad b \to u \ell \nu$

- Discrepancy: inclusive V_{ub} vs. exclusive V_{ub}
- Inclusive V_{ub} in tension with sin 2β from CKM fits



- Together these results raise questions about possible NP (see e.g. arXiv:1206.1872, 1206.2634)
- More precise experimental measurements needed ➔ SuperB

Complementarity of SuperB

- SuperB physics program largely complementary to the LHCb program
- SuperB will make many essential measurements not possible (or less precise) at hadron machines
- Consider few examples where SuperB measurements complement and enhance measurements made at LHCb…

$$B \to X_s \ell^+ \ell^- \quad B \to \tau\nu \quad B \to D^{(*)}\tau\nu \quad b \to ul\nu$$

- LHCb already making beautiful measurements of

$$B^0 \to K^{*0}\mu^+\mu^-$$

- SuperB will complement with additional precision measurements
  - $R_{K*} = B(B \to K^*\mu\mu)/B(B \to K^*ee)$
  - Isopin violating asymmetries
  - fully inclusive channel $B \to X_s \ell^+ \ell^- \ (\ell = \{\mu, e\})$
- SuperB + LHCb = much greater sensitivity to NP