Experimental Prospects for $B \to X_{s/d}\gamma$ and $B \to X_{s/d}\ell\ell$

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CKM2010 @ Warwick

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- $BF(B \to X_s \gamma)$
- $A_{CP}(B \to X_s \gamma)$
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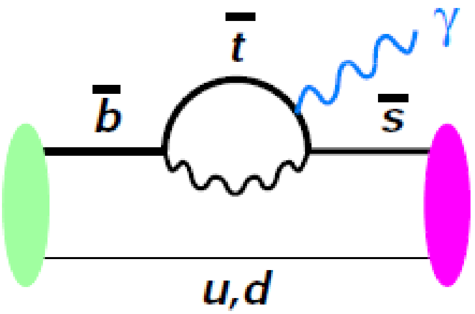
- Forward backward Asymmetry

Reference

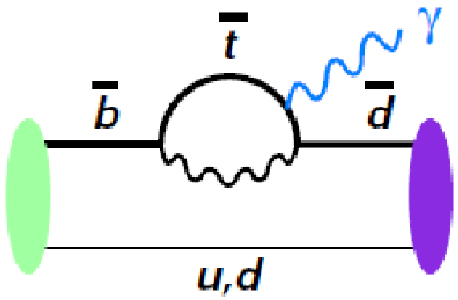
- Physics at Super B Factory [arXiv:1002.5012]
- SuperB Progress Report [arXiv:.10081541]

Introduction

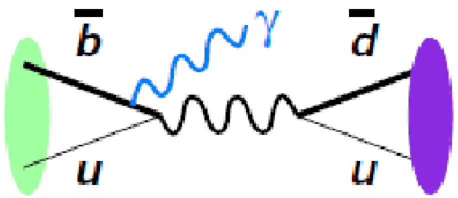
- b→s(d)γ, b→s(d)ℓℓ : FCNC process.
- Sensitive to New Physics.
- In general, inclusive $B \to X_{s/d}\gamma$, $B \to X_{s/d}\ell\ell$ are theoretically clean but experimentally challenging compared to exclusive modes.
- Many observables:
  - ✓ $BF(B \to X_s\gamma)$: limit in charged higgs mass
  - ✓ $A_{CP}(B \to X_s\gamma)$
  - ✓ $BF(B \to X_d\gamma)/BF(B \to X_s\gamma)$: extract |Vtd/Vts|.
  - ✓ $BF(B \to X_s\ell\ell)$
  - ✓ $A_{FB}(B \to X_s\ell\ell)$



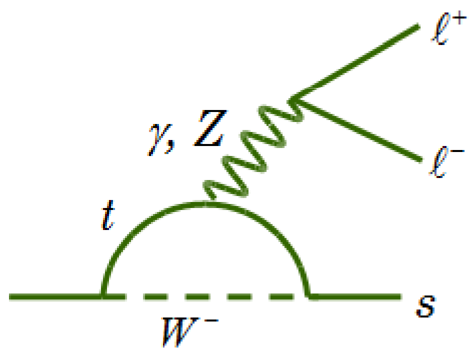
b→sγ penguin

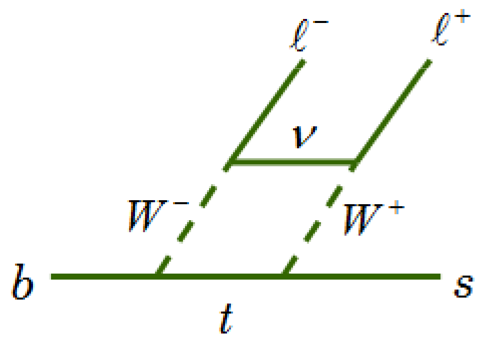


b→dγ penguin



b→dγ annihilation





BF($B \to X_s\gamma$)

Three methods for inclusive analysis for $B \to X_s\gamma$.

Fully inclusive

- Subtract the on-resonance photon energy spectrum by the continuum spectrum.
- Free from the model uncertainty of hadronic system (X_s).
- Generally, has large backgrounds.
- Lepton tag is sometimes used for background suppression and flavor tagging.

Sum of exclusive modes (semi-inclusive; pseudo-reconstruction).

- Reconstruct hadronic system (X_s) as a sum of exclusive modes.
- Signal is cleaner than using the fully inclusive method.
- Model uncertainty of hadronic system; missing modes.
- Separation of X_s and X_d.

Recoil tag (full reconstruction).

- Fully reconstruct the other side B.
- Very low efficiency (<1%), but very clean (continuum bkg becomes negligible).
- Measurement in B frame. Access to flavor information etc.

BF($B\to X_s\gamma$)

Status of $B(B\to X_s\gamma)$

Mode	$\mathcal{B}$	$E_{\min}$	$\mathcal{B}(E_\gamma > E_{\min})$	$\mathcal{B}^{\text{cnv}}(E_\gamma > 1.6)$
CLEO Inc. [3]	$321 \pm 43 \pm 27^{+18}_{-10}$	2.0	$306 \pm 41 \pm 26$	$327 \pm 44 \pm 28 \pm 6$
Belle Semi.[4]	$336 \pm 53 \pm 42^{+50}_{-54}$	2.24	–	$369 \pm 58 \pm 46^{+56}_{-60}$
BABAR Semi.[6]	$335 \pm 19^{+56+4}_{-41-9}$	1.9	$327 \pm 18^{+55+4}_{-40-9}$	$349 \pm 20^{+59+4}_{-46-3}$
BABAR Inc. [7]	–	1.9	$367 \pm 29 \pm 34 \pm 29$	$390 \pm 31 \pm 47 \pm 4$
BABAR Full [8]	$391 \pm 91 \pm 64$	1.9	$366 \pm 85 \pm 60$	$389 \pm 91 \pm 64 \pm 4$
Belle Inc.[5]	–	1.7	$345 \pm 15 \pm 40$	$347 \pm 15 \pm 40 \pm 1$
Average				$355 \pm 24 \pm 9$

fully inclusive (CLEO Inc., BABAR Inc., Belle Inc.)
sum of exclusive (Belle Semi., BABAR Semi.)
recoil tag (BABAR Full)

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

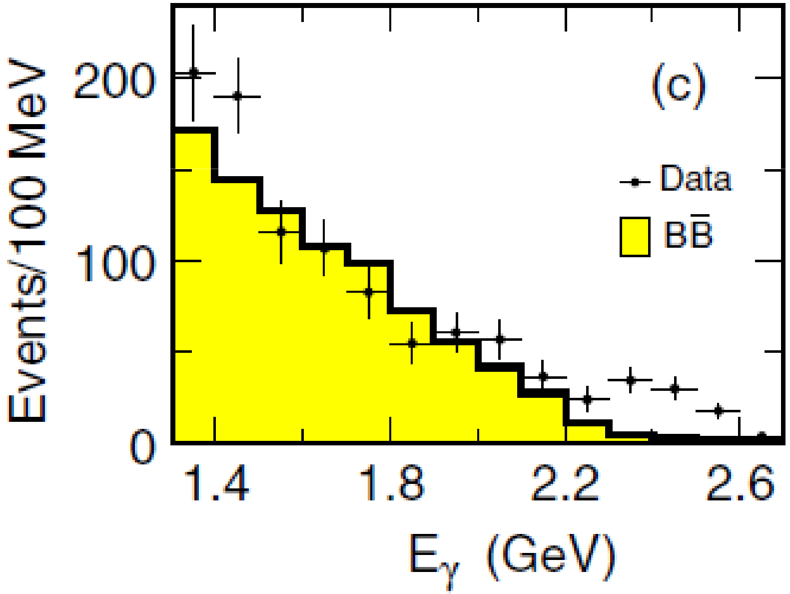
At present B factories, fully inclusive method (or sum of exclusive method) has given most precise result, but they are already systematic dominant.

In the future B factories (with > 10 ab^{-1}), recoil tag method will be most promising.

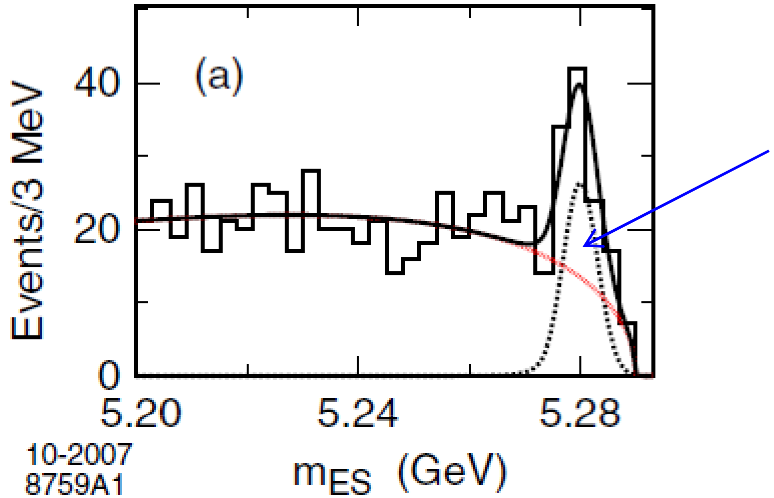
BF($B \to X_s\gamma$)

[Phys. Rev., D77, 051103 (2008)]

BaBar Analysis with 210 fb^{-1}



- 0.68 M tagged BB events with 0.3% full recon. efficiency.
- 23% statistical error.
- BB background subtraction using MC.



$1.6 < E_\gamma < 1.7$ [GeV] charged B

By scaling the stat. error, 3% statistical error at 10 ab^{-1}.

BF($B \to X_s \gamma$)

- Other B decays will be the main background source.
  - ✓ Decay of π^0, η : largest, but can be calibrated with control sample.
  - ✓ Other decay (ω, η', J/ψ)
  - ✓ Hadronic interactions of neutral particles in the calorimeter..

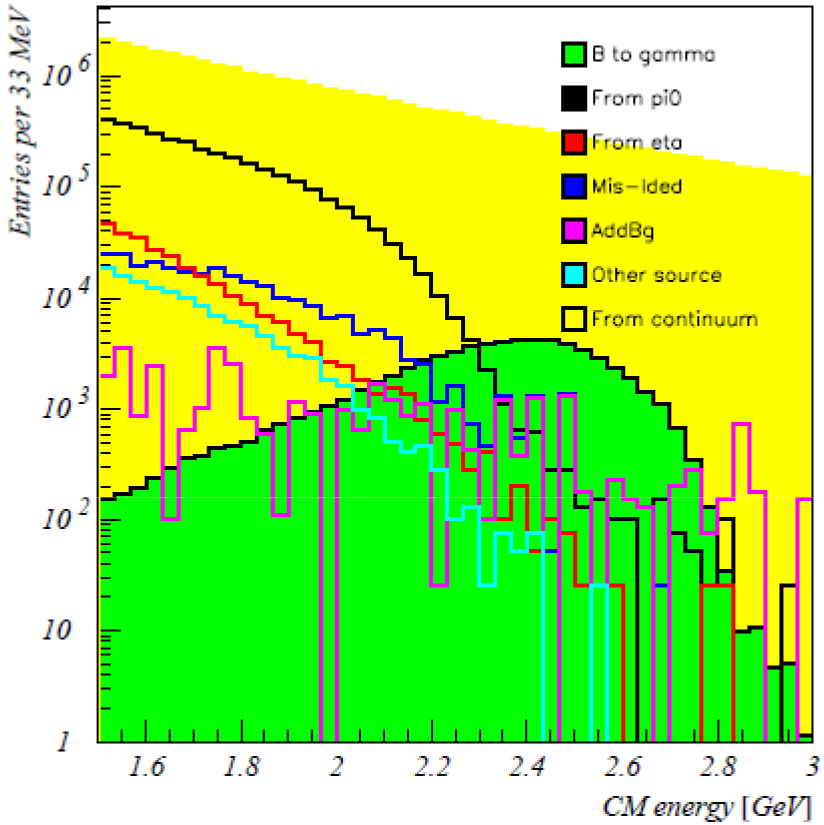
According to Belle inclusive analysis , 6-7% systematic error is assigned to B background (excluding π^0, η decay).

The effect might be less for full reconstruction analysis, but still similar level (e.g. 5%) of systematic error is expected.

- 3% in "SuperB Progress Report"

This might be adequate give current theory prediction

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



$A_{CP}(B \to X_s\gamma)$

In the SM:

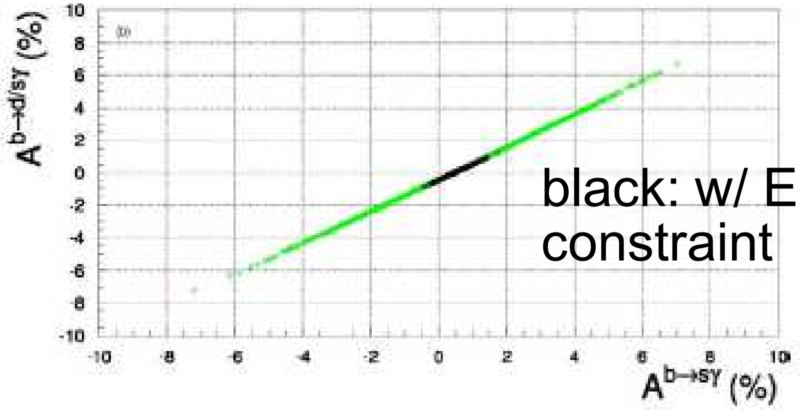
[Nucl. Phys. B704, 56 (2005)]

$A_{CP}(B \to X_s\gamma) = 0.0042^{+0.0017}_{-0.0012}$

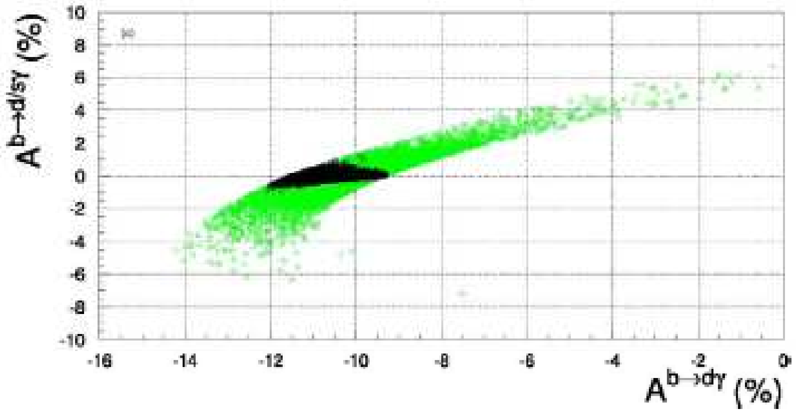
$A_{CP}(B \to X_d\gamma) \sim -0.1$

$A_{CP}(B \to X_{s/d}\gamma) = 0$

MFV scenario



black: w/ EDM constraint



Some New Physics models predict larger asymmetry for $B \to X_s\gamma$ or $B \to X_{s/d}\gamma$.

- Signature of New Physics.
- Useful to identify NP models

$A_{CP}(B \to X_s\gamma)$

Sum of exclusive modes method for $B \to X_s\gamma$

$A_{CP}(B \to X_s\gamma) = 0.002 \pm 0.050 \pm 0.030$ (Belle 140 fb^{-1})
$A_{CP}(B \to X_s\gamma) = -0.011 \pm 0.030 \pm 0.014$ (BaBar 383 M BB)

- Self-tagging (flavor tag is obtained from the reconstruction information).
- Suppression of $B \to X_d\gamma$.

Most systematic errors are limited by the control sample statistics, and can be reduced in the future.

Scaled 140 fb^{-1} from Belle results:

$\delta A_{CP}(B \to X_s\gamma)$ [@ 5ab^{-1}] = ±0.009 (stat) ± 0.006 (syst),
$\delta A_{CP}(B \to X_s\gamma)$ [@ 50ab^{-1}] = ±0.003 (stat) ± 0.002 (syst) ± 0.003 (model).

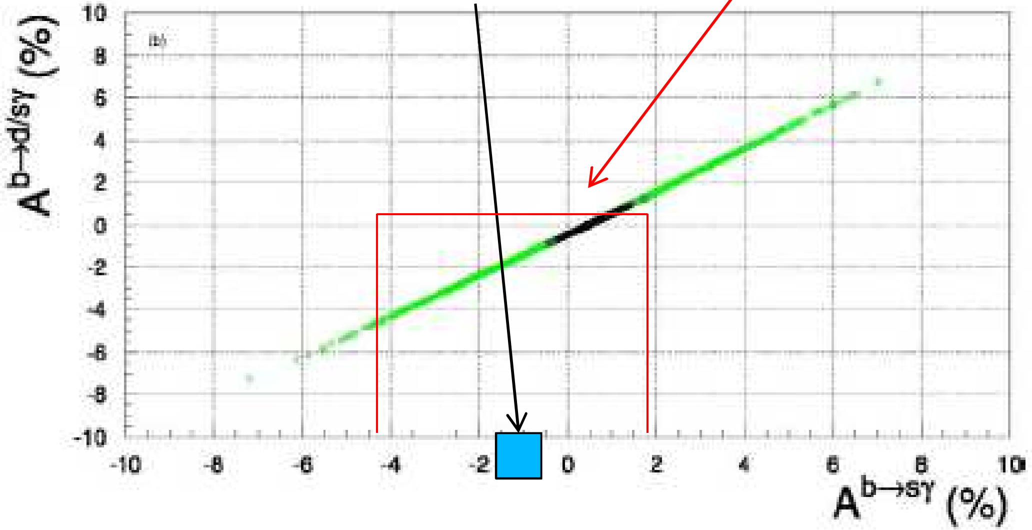
- Sensitivity to O(1%) asymmetry.
- Question: how to estimate the model error due to missing modes?

$A_{CP}(B\to X_s\gamma)$

Fully inclusive method for $B\to X_{s+d}\gamma$

$A_{CP}(B\to X_{s+d}\gamma) = -0.110 \pm 0.115 \pm 0.017$ (BaBar 89 M BB)

- Lepton tag
  - ✓ Wrong tag due to mixing (9%), and lepton from non-B (3%).
- $B\to X_d\gamma$ is included in the signal.
- By simple extrapolation, 1% statistical error @ 10 ab^{-1}

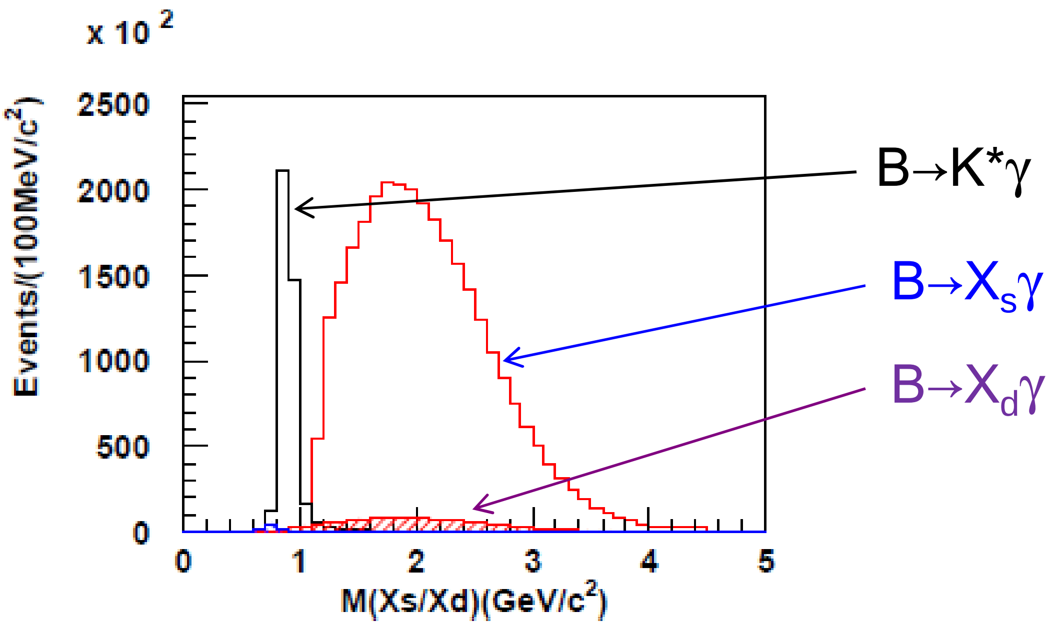


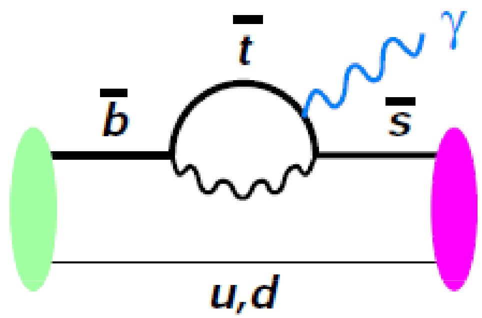
- < 1% at Belle II.
- Generally speaking, 1% is somewhat challenging (e.g. detector bias, fitting systematic).
- Recoil tag also useful for $A_{CP}(B\to X_s\gamma)$, $A_{CP}(B\to X_{s+d}\gamma)$.

BF($B \to X_d \gamma$)

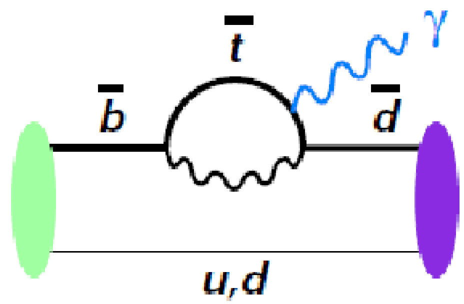
$B \to X_d \gamma$: Measurement of |Vtd/Vts|

Challenge: huge backgroud from $b \to s\gamma$

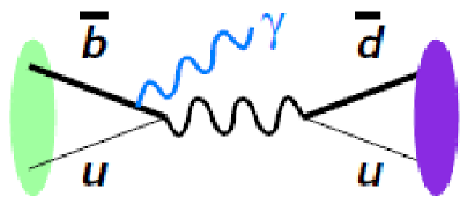




$b \to s\gamma$ penguin



$b \to d\gamma$ penguin



$b \to d\gamma$ annihilation

To suppress $b \to s\gamma$

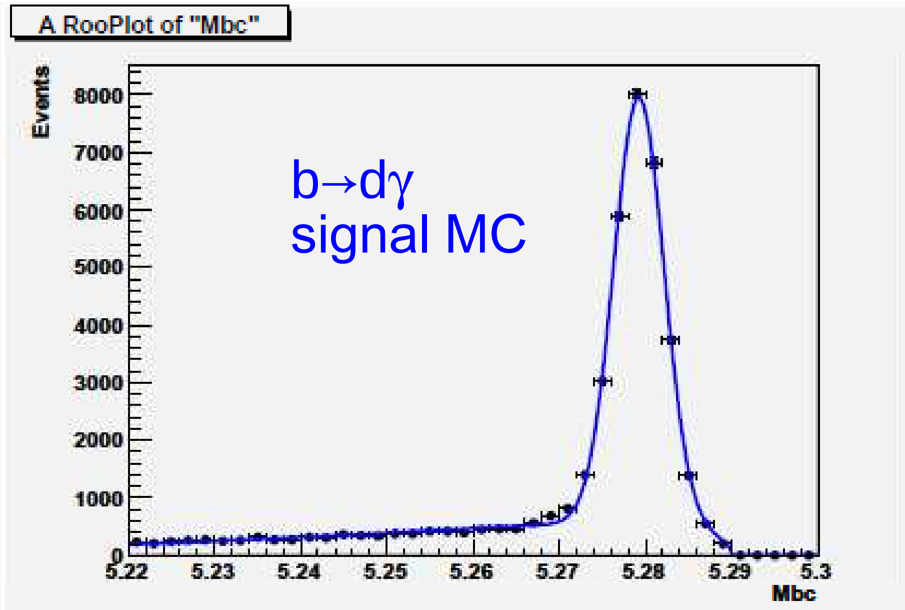
- Sum of exclusive methods.
- Strangeness tag (find K in events).

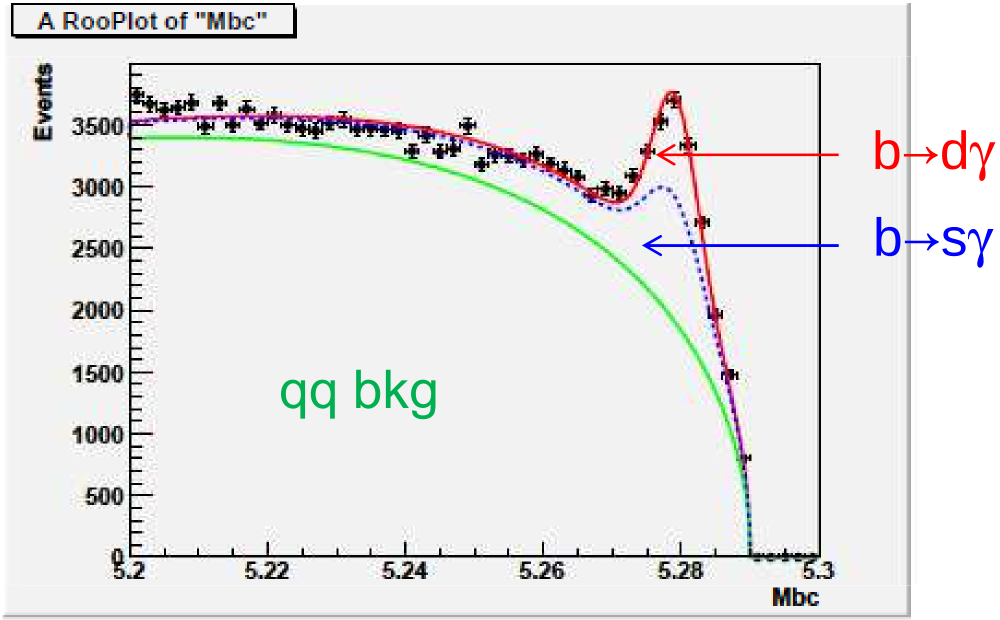
BF($B \to X_d \gamma$)

MC study for $b \to d\gamma$ (Belle II)

summing up 2 to 4 pions including up to 1 π^0 for $M(X_d) < 2.0$ GeV

5 ab^{-1}





$(4.2 \pm 0.2(\text{stat}) \pm 0.9(\text{fit})) \times 10^3$ events

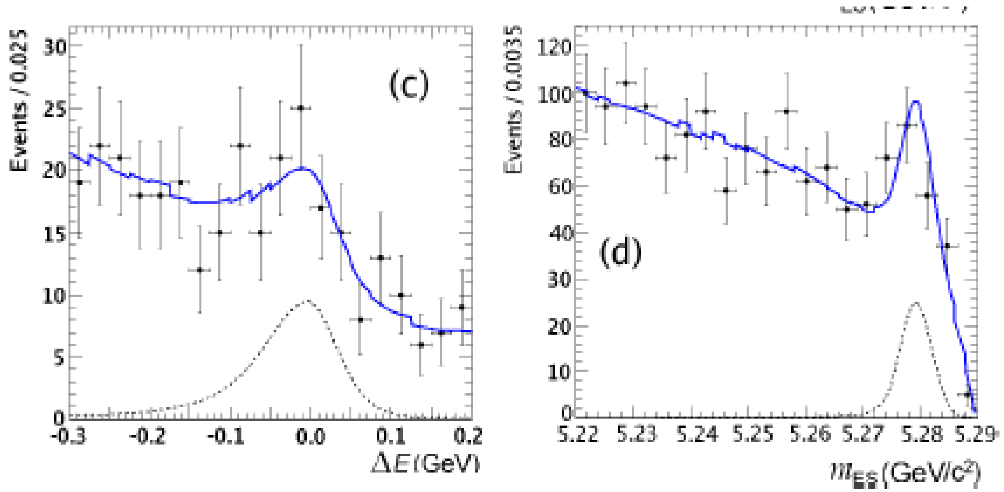
In this study, mainly from $b \to s\gamma$ normalization. → 5% statistical error @ 5 ab^{-1} 20% systematic error

BF(B→$X_d\gamma$)

BaBar 471M BB

[arXiv:1005.4087]

$B \to X_d\gamma$	$B \to X_s\gamma$
$B^0 \to \pi^+\pi^-\gamma$	$B^0 \to K^+\pi^-\gamma$
$B^+ \to \pi^+\pi^0\gamma$	$B^+ \to K^+\pi^0\gamma$
$B^+ \to \pi^+\pi^-\pi^+\gamma$	$B^+ \to K^+\pi^+\pi^-\gamma$
$B^0 \to \pi^+\pi^-\pi^0\gamma$	$B^0 \to K^+\pi^-\pi^0\gamma$
$B^0 \to \pi^+\pi^-\pi^+\pi^-\gamma$	$B^0 \to K^+\pi^-\pi^+\pi^-\gamma$
$B^+ \to \pi^+\pi^-\pi^+\pi^0\gamma$	$B^+ \to K^+\pi^-\pi^+\pi^0\gamma$
$B^+ \to \pi^+\eta\gamma$	$B^+ \to K^+\eta\gamma$



BF(B→$X_d\gamma$, 0.5<M_{Xd}<2.0) = (9.2 ± 2.0 ± 2.3) × 10^{-6},
BF(B→$X_s\gamma$, 0.5<M_{Xs}<2.0) = (23.0 ± 0.8 ± 3.0) × 10^{-5},
|Vtd/Vts| = 0.199 ± 0.022(stat) ± 0.024(syst) ± 0.002(th)

Key issue in the future: reduction of systematic error

BF($B \to X_d \gamma$)

TABLE III: Systematic errors on the measured partial and inclusive branching fractions $\mathcal{B}$. Systematic errors that do not cancel in the ratio of rates are marked with (*).

Systematic Error Source	$M(X_s)$ 0.5-1.0	$M(X_s)$ 1.0-2.0	$M(X_d)$ 0.5-1.0	$M(X_d)$ 1.0-2.0
Track selection	0.3%	0.4%	0.3%	0.4%
Photon reconstruction	1.8%	1.8%	1.8%	1.8%
π^0/η reconstruction	0.9%	1.1%	1.4%	1.6%
Neural network	1.1%	4.9%	1.1%	4.9%
B counting	0.6%	0.6%	0.6%	0.6%
PID (*)	2.0%	2.0%	2.0%	2.0%
Fit bias (*)	0.1%	0.9%	4.9%	6.5%
PDF shapes (*)	2.3%	0.6%	3.7%	3.4%
Histogram binning (*)	0.8%	0.2%	1.8%	1.8%
Background (*)	0.8%	1.2%	5.9%	7.0%
Fragmentation (*)	-	3.3%	-	5.1%
Signal model	-	5.8%	-	6.0%
Error on partial $\mathcal{B}$	4.0%	9.0%	9.3%	14.2%
Missing ≥ 5 body		9.6%		18.2%
Other missing states		7.5%		15.3%
Spectrum Model		1.8%		1.6%
Error on inclusive $\mathcal{B}$	4.0%	15.2%	9.3%	27.7%

A large part of the systematic error comes from missing modes or fragmentation.

- These will be improved by statistics (e.g. more reconstruction modes), but only slightly.
- Calibration using $B \to X_s \gamma$ may help ?

BF($B \to X_d\gamma$)

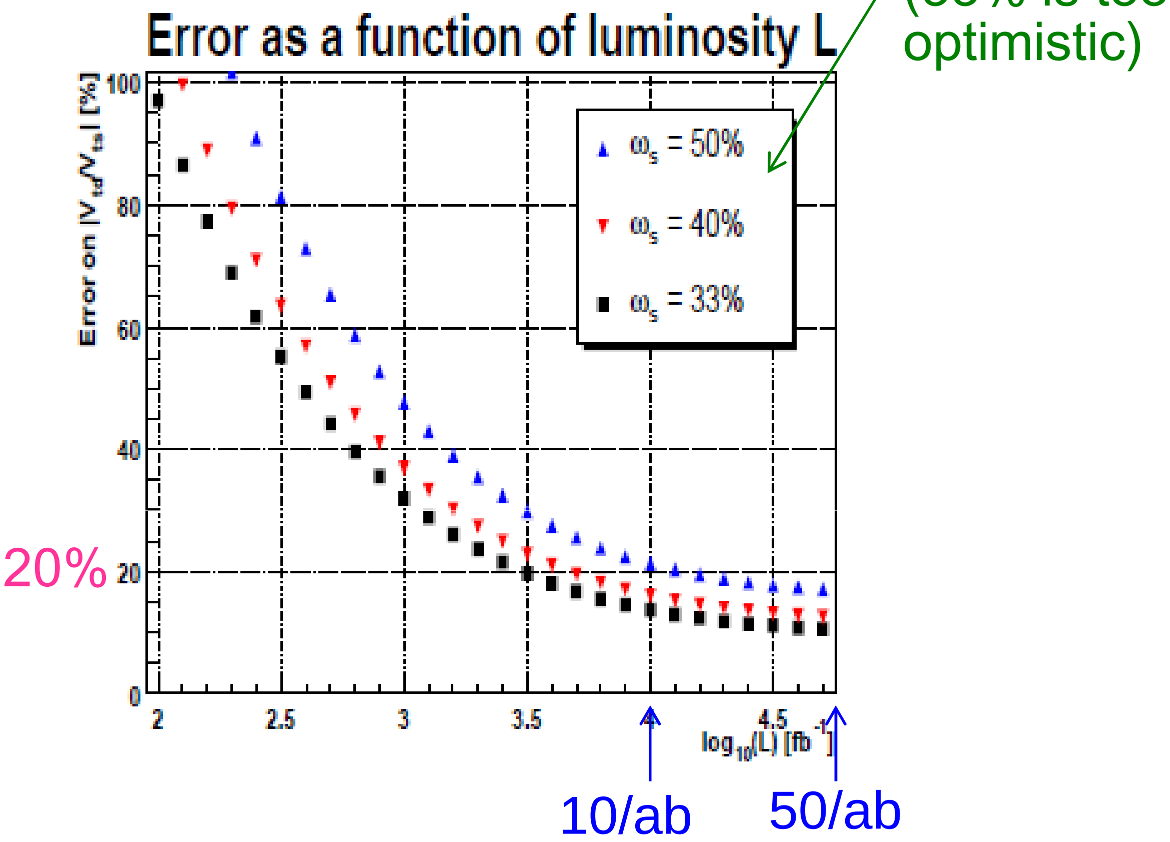
Another possibility: full reconstruction + strangeness tag

Strangeness tag : not so straightforward

- Will fail for $K_S \to \pi^0\pi^0$, K_L : 33% of K
- Barionic decay (Λ:ok, but Σ ?)
- ssbar popping (e.g. $B \to KK\gamma$)

A study at SLAC-R-709 “The Discovery Potential of a Super B Factory”

- Semi-leptonic tag is assumed.
- 10-20% for |Vtd/Vts| @ 10 ab^{-1}.
- If full reconstruction is necessary, need one order of magnitude more statistics (program @ 50 ab^{-1})



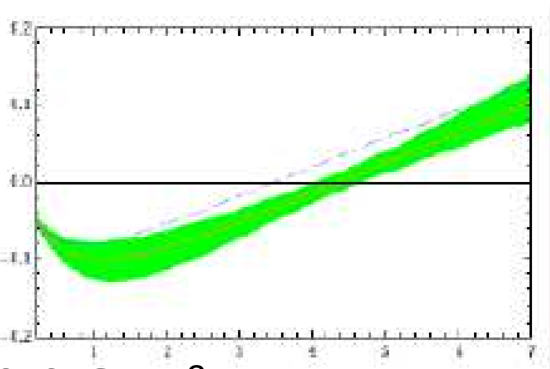
$B \to X_{s/d}\ell\ell$

Inclusive $B \to X_{s/d}\ell\ell$

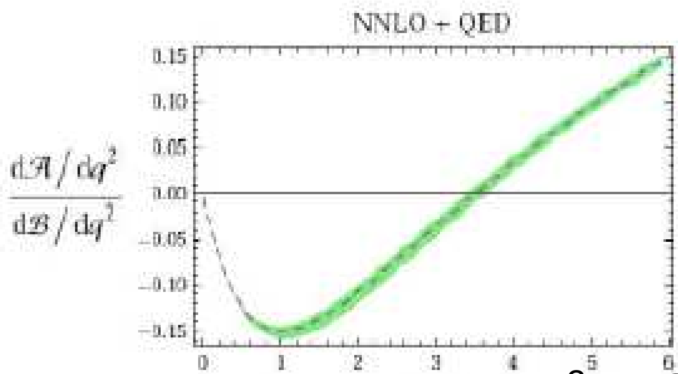
- More challenging than $B \to X_{s/d}\gamma$ (two orders of magnitudes lower B.F.).
- Branching fraction, forward backward asymmetry etc. (similar to exclusive $B \to K^*\ell\ell$).
- "theoretically clean" compared to the exclusive mode.
- Study possible only in e^+e^- B factories.

So far, all the analyses at BaBar and Belle are based on the sum of exclusive modes method.

$B \to K^*\ell^+\ell^-$
(Feldmann CKM2008)



$B \to X_s\ell^+\ell^-$
(Huber et al 2008)



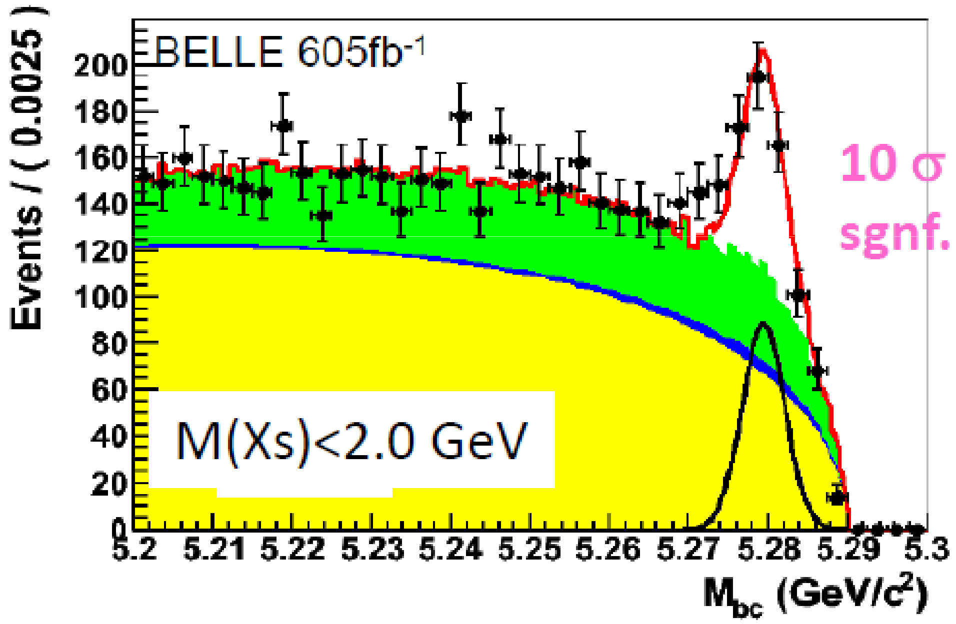
$q^2_0 = 4.2 \pm 0.6$ GeV^2

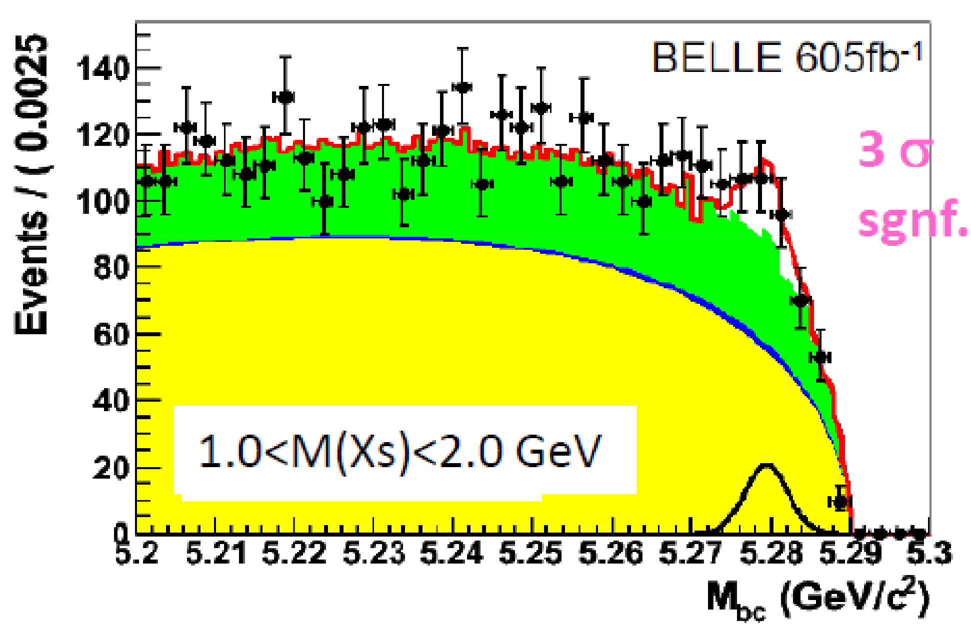
$q^2_0 = 3.5 \pm 0.1$ GeV^2

$B \to X_{s/d}\ell\ell$

Belle 605 fb^{-1} result

[LP09]





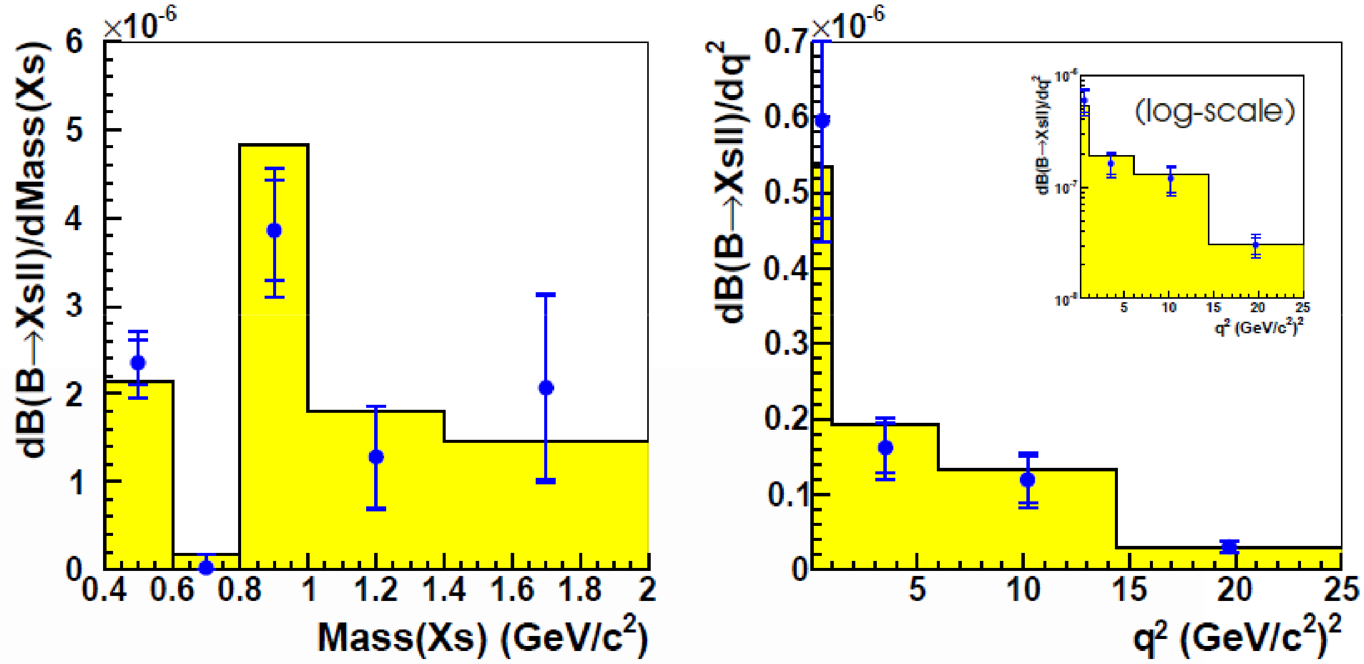
238.3 ± 26.4 ± 2.3 events

$$\mathcal{B}(B \to X_s\ell^+\ell^-) = (3.33 \pm 0.80\,^{+0.19}_{-0.24}) \times 10^{-6}$$

c.f.) SM (Ali et al): $\mathcal{B}_{SM} = (4.2 \pm 0.7) \times 10^{-6}$

C_7 sign-flip (Gambino et al): $\mathcal{B}_{C_7>0} = (8.8 \pm 1.0) \times 10^{-6}$

B→$X_{s/d}\ell\ell$



- So far, M_{Xs} and q^2 dependence for a few bins are obtained.
- Still statistics dominated.
- Main systematic error sources
  - ✓ assumed $K\ell\ell$, $K^*\ell\ell$ fraction (6%) ← analysis improves with statistics
  - ✓ hadronization + missing mode (5%) ← comparison with $Xs\gamma$

$B \to X_{s/d}\ell\ell$

Estimation in arXiv:1008.1541

$X_s\ell\ell$

Sum of exclusive

Recoil Mass

		BABAR (425 fb^{-1})				SuperB (75 ab^{-1})			
Observable	q^2 region [GeV^2/c^4]	Stat. SE	Sys. SE	Stat. RM	Sys. RM	Stat. SE	Sys. SE	Stat. RM	Sys. RM
$\sigma\mathcal{B}/\mathcal{B}$	all	0.11	0.056	0.26	0.06	0.008	0.03-0.05	0.019	0.03-0.05
$\sigma\mathcal{B}/\mathcal{B}$	0.1–1	0.29	0.07	0.69	0.07	0.022	0.04-0.06	0.052	0.04-0.06
$\sigma\mathcal{B}/\mathcal{B}$	1–4	0.23	0.06	0.53	0.06	0.017	0.03-0.05	0.040	0.03-0.05
$\sigma\mathcal{B}/\mathcal{B}$	4–7.84	0.18	0.06	0.43	0.06	0.014	0.03-0.05	0.032	0.03-0.05
$\sigma\mathcal{B}/\mathcal{B}$	10.24–12.96	0.31	0.07	0.73	0.07	0.024	0.04-0.06	0.055	0.04-0.06
$\sigma\mathcal{B}/\mathcal{B}$	>14.06	0.29	0.07	0.69	0.07	0.022	0.04-0.06	0.052	0.04-0.06

(hadronic uncertainty ~10% not included)

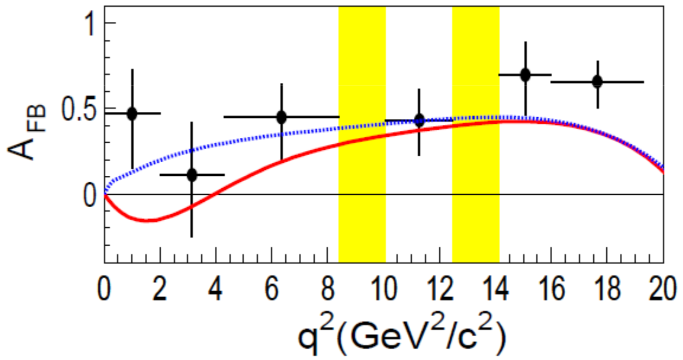
Measurement with a few % precision possible at 75 ab^{-1}

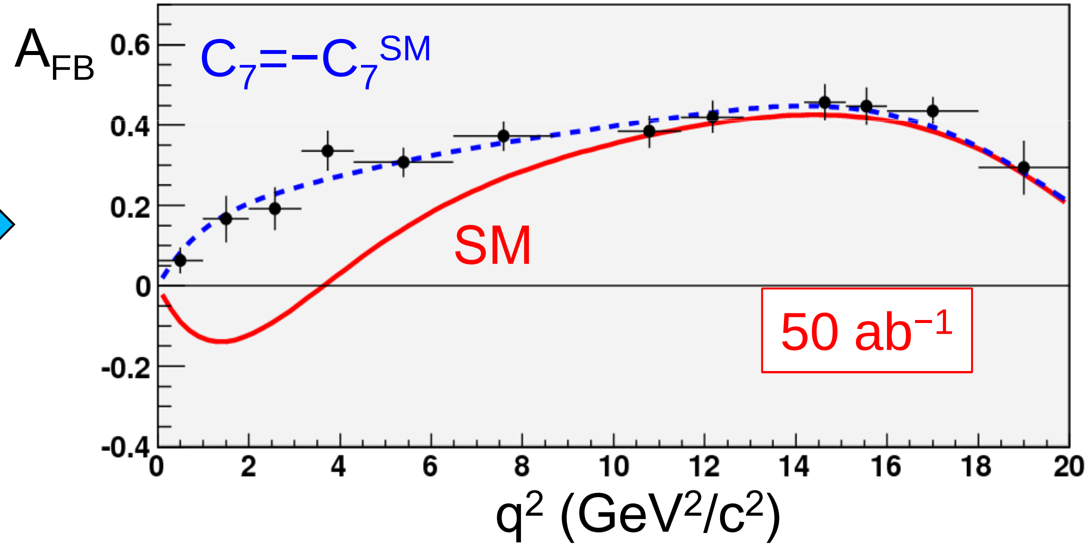
$B \to X_{s/d}\,\ell\ell$

Next Step: Forward-backward asymmetry

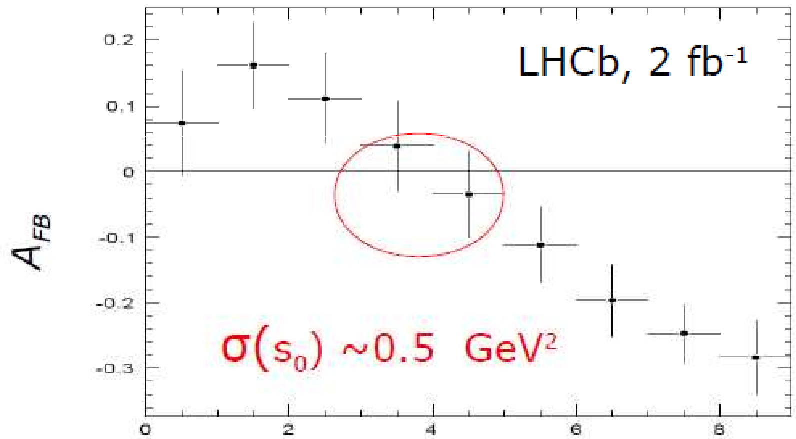
But, results & feasibility study exist only for exclusive modes:

exclusive $K^*\ell\ell$





opposite sign convention wrt B factories



LHCb 2 fb^{-1} : 13%
LHCb 100 fb^{-1} : 2%
Belle 50 ab^{-1} : 5%

$B \to X_{s/d} \ell\ell$

- Forward backward asymmetry for inclusive modes
  - No estimation of forward backward asymmetry for inclusive mode.
  - One order of magnitude more luminosity is necessary compared to exclusive modes (?)
  - Considering the theoretical precision, not competitive to exclusive modes at early stage.
- $X_s\ell\ell$ with recoil method
- $X_d\ell\ell$

Summary

- Recoild tag method is promising for $B \to X_s \gamma$.
  - ✓ $\delta BF(B \to X_s \gamma) \sim 6\%$ @ 50 ab^{-1} (Belle2); maybe less.
  - ✓ $\delta BF(B \to X_s \gamma) \sim 3\%$ @ 75 ab^{-1} (SuperB)
  - ✓ Theoretical prediction
- Less than 1% precision for $A_{CP}(B \to X_s \gamma)$
  - ✓ $\delta A_{CP}(B \to X_s \gamma) \sim 0.005$ @ 50 ab^{-1} (Belle2)
  - ✓ $\delta A_{CP}(B \to X_{s+d} \gamma) \sim 0.01$ (?)
- Sum of exclusive modes for $X_d \gamma$, $X_s \ell\ell$.
  - ✓ Hadronic uncertainty, missing modes are the issue.
  - ✓ Calibration using $B \to X_s \gamma$.
- Many of them are quite challenging, but only possible at B factories.
  - ✓ Need (MC) study.

Backup

BaBar B→$X_d\gamma$

TABLE II: Signal yields (N_S), efficiencies (ϵ), partial branching fractions ($\mathcal{PB}$), inclusive branching fractions ($\mathcal{B}$) and the ratio of inclusive branching fractions for the measured decay modes. The first error is statistical and second is systematic (including an error from extrapolation to missing decay modes, for the inclusive $\mathcal{B}$).

	$M(X_s)0.5-1.0$	$M(X_d)0.5-1.0$	$M(X_s)1.0-2.0$	$M(X_d)1.0-2.0$	$M(X_s)0.5-2.0$	$M(X_d)0.5-2.0$
N_S	804 ± 33	35 ± 9	990 ± 42	56 ± 14	-	-
ϵ	4.5%	3.1%	1.6%	1.9%	-	-
$\mathcal{PB}(\times10^{-6})$	$19\pm1\pm1$	$1.2\pm0.3\pm0.1$	$66\pm3\pm6$	$3.2\pm0.8\pm0.5$	-	-
$\mathcal{B}(\times10^{-6})$	$38\pm2\pm2$	$1.3\pm0.3\pm0.1$	$192\pm8\pm29$	$7.9\pm2.0\pm2.2$	$230\pm8\pm30$	$9.2\pm2.0\pm2.3$
$\frac{\mathcal{B}(b\to d\gamma)}{\mathcal{B}(b\to s\gamma)}$	$0.033\pm0.009\pm0.003$		-		$0.040\pm0.009\pm0.010$	

[arXiv:1005.4087]

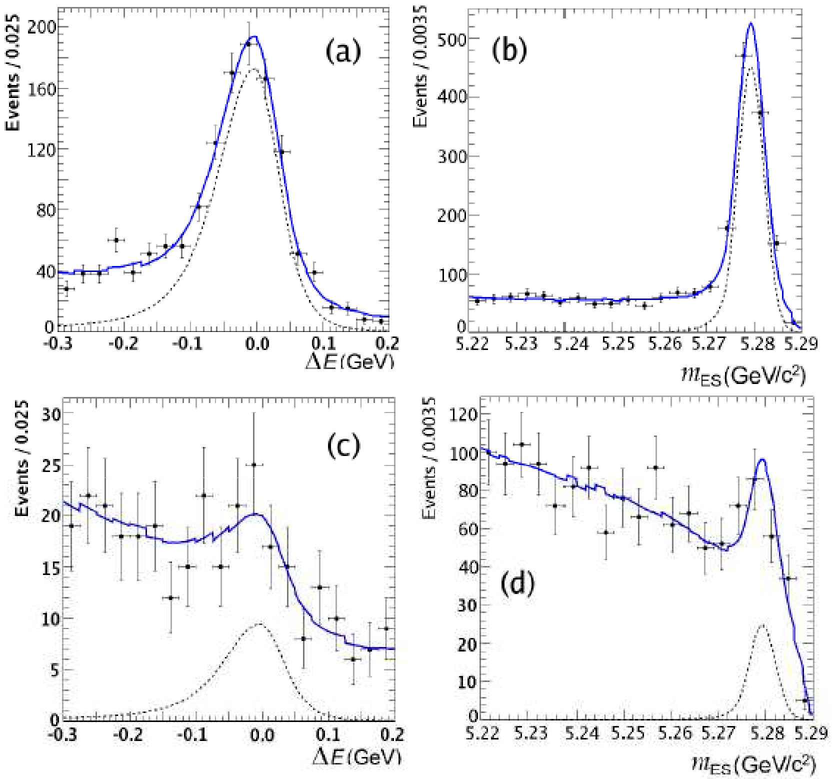
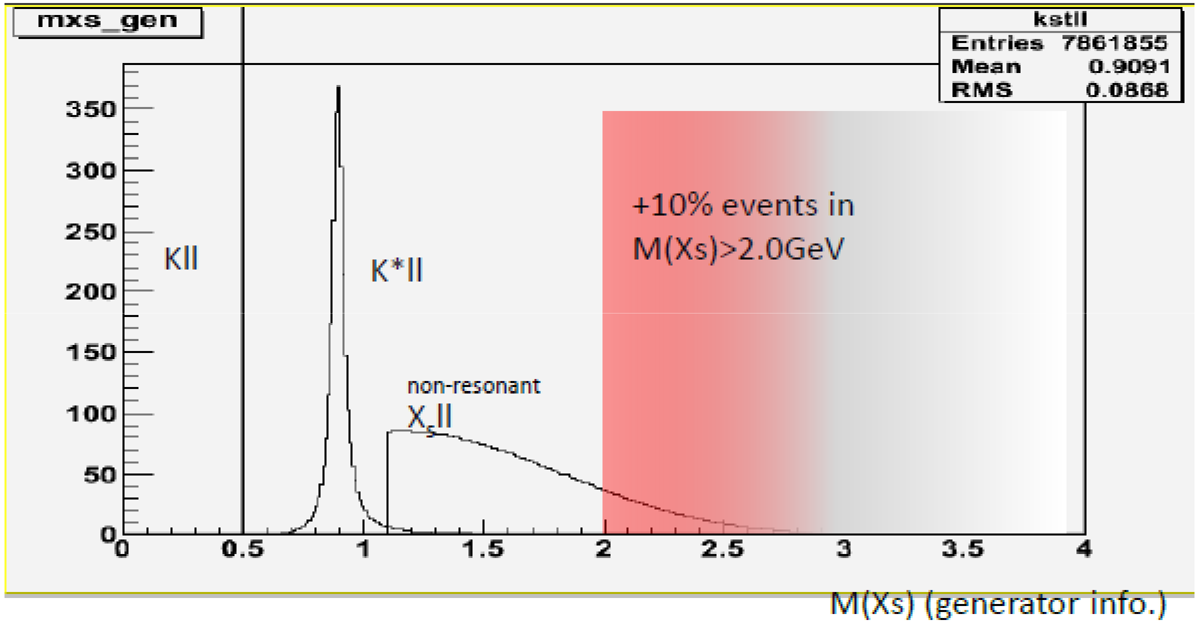


TABLE III: Systematic errors on the measured partial and inclusive branching fractions $\mathcal{B}$. Systematic errors that do not cancel in the ratio of rates are marked with (*).

Systematic	$M(X_s)$		$M(X_d)$	
Error Source	0.5-1.0	1.0-2.0	0.5-1.0	1.0-2.0
Track selection	0.3%	0.4%	0.3%	0.4%
Photon reconstruction	1.8%	1.8%	1.8%	1.8%
π^0/η reconstruction	0.9%	1.1%	1.4%	1.6%
Neural network	1.1%	4.9%	1.1%	4.9%
B counting	0.6%	0.6%	0.6%	0.6%
PID (*)	2.0%	2.0%	2.0%	2.0%
Fit bias (*)	0.1%	0.9%	4.9%	6.5%
PDF shapes (*)	2.3%	0.6%	3.7%	3.4%
Histogram binning (*)	0.8%	0.2%	1.8%	1.8%
Background (*)	0.8%	1.2%	5.9%	7.0%
Fragmentation (*)	-	3.3%	-	5.1%
Signal model	-	5.8%	-	6.0%
Error on partial $\mathcal{B}$	4.0%	9.0%	9.3%	14.2%
Missing ≥ 5 body		9.6%		18.2%
Other missing states		7.5%		15.3%
Spectrum Model		1.8%		1.6%
Error on inclusive $\mathcal{B}$	4.0%	15.2%	9.3%	27.7%

$B \to X_{s/d} \ell\ell$



$B \to X_{s/d}\ell\ell$

Table 13: Results of the simultaneous fit to the 605fb^{-1} of $B \to X_s\ell^+\ell^-$ sample and 605fb^{-1} of $B \to X_s e^\pm\mu^\mp$ sample. signal yield ($N_{\rm sig}$), significance, total signal efficiency ϵ (including the fraction of X_s states considered in this analysis) and branching fraction ($\mathcal{B}$).

Mode	$N_{\rm sig}$	Significance	ϵ (%)	$\mathcal{B}$ ($\times 10^{-6}$)
$B \to X_s e^+e^-$	$121.6 \pm 19.3 \pm 2.0$	7.0	$2.56 \pm 0.01^{+0.35}_{-0.40}$	$3.61 \pm 0.57^{+0.50}_{-0.57}$
$B \to X_s \mu^+\mu^-$	$118.5 \pm 17.3 \pm 1.5$	7.9	$2.75 \pm 0.01^{+0.37}_{-0.43}$	$3.28 \pm 0.48^{+0.45}_{-0.52}$
$B \to X_s \ell^+\ell^-$	$238.3 \pm 26.4 \pm 2.3$	10.1	$2.66 \pm 0.00^{+0.36}_{-0.42}$	$3.42 \pm 0.38^{+0.47}_{-0.54}$

Table 14: Bin-by-Bin results of the simultaneous fit to the 605fb^{-1} of $B \to X_s\ell^+\ell^-$ sample and 605fb^{-1} of $B \to X_s e^\pm\mu^\mp$ sample. Signal yields ($N_{\rm sig}$), signal efficiency (ϵ) and Branching fractions ($\mathcal{B}$) for each bin of M_{X_s}, $M_{\ell^+\ell^-}$ and q^2.

bin	N_{sig}	Significance	ϵ (%)	$\mathcal{B}$ ($\times 10^{-6}$)
M_{X_s}(GeV/c^2)				
$= [0.4, 0.6]$	$104.4 \pm 11.5 \pm 1.8$	12.6	$8.58 \pm 0.01^{+0.88}_{-1.11}$	$0.46 \pm 0.05^{+0.05}_{-0.06}$
$= [0.6, 0.8]$	$0.4 \pm 3.0 \pm 0.2$	0.3	$3.92 \pm 0.04^{+0.40}_{-0.51}$	$0.00 \pm 0.03^{+0.00}_{-0.00}$
$= [0.8, 1.0]$	$79.0 \pm 11.6 \pm 0.5$	8.5	$3.96 \pm 0.01^{+0.40}_{-0.51}$	$0.76 \pm 0.11^{+0.08}_{-0.10}$
$= [1.0, 1.4]$	$23.7 \pm 10.5 \pm 0.3$	2.4	$1.71 \pm 0.01^{+0.17}_{-0.22}$	$0.53 \pm 0.23^{+0.05}_{-0.07}$
$= [1.4, 2.0]$	$32.5 \pm 16.5 \pm 0.9$	2.0	$1.01 \pm 0.01^{+0.10}_{-0.13}$	$1.23 \pm 0.62^{+0.13}_{-0.16}$
q^2((GeV/c^2)^2)				
$= [0.04, 1.0]$	$36.1 \pm 7.8 \pm 0.1$	5.6	$1.99 \pm 0.01^{+0.27}_{-0.31}$	$0.69 \pm 0.15^{+0.09}_{-0.11}$
$= [1.0, 6.0]$	$74.0 \pm 15.3 \pm 0.4$	5.4	$2.85 \pm 0.01^{+0.39}_{-0.45}$	$0.99 \pm 0.20^{+0.14}_{-0.16}$
$= [6.0, 14.4]$	$64.9 \pm 16.6 \pm 0.3$	4.2	$1.89 \pm 0.01^{+0.26}_{-0.30}$	$1.31 \pm 0.33^{+0.18}_{-0.21}$
$= [14.4, 25.0]$	$62.8 \pm 11.0 \pm 2.3$	6.5	$7.26 \pm 0.02^{+0.99}_{-1.14}$	$0.33 \pm 0.06^{+0.05}_{-0.05}$

Source	$X_s\, e^+e^-$	$X_s\, \mu^+\mu^-$
Signal Gaussian shape	± 0.3	± 0.1
J/ψ,$\psi(2S)$ peaking background	± 1.2	± 0.9
Higher ψ peaking background	± 0.9	± 0.9
Hadronic peaking background	${}^{+0.4}_{-0.5}$	${}^{+0.2}_{-0.3}$
Self Cross-feed error	± 0.1	± 0.1
Signal yield total	± 1.6	± 1.3
Tracking efficiency	± 3.6	± 3.6
Lepton identification efficiency	± 2.1	± 2.2
Kaon identification efficiency	± 0.4	± 1.0
$\pi^\pm$ identification efficiency	± 3.4	± 3.0
K_S^0 efficiency	± 0.9	± 0.9
π^0 efficiency	± 0.5	± 0.5
$\mathcal{R}$ cut efficiency	± 5.3	± 2.6
Detector model subtotal	± 7.6	± 6.0
Fermi motion model	${}^{-4.9}_{+1.3}$	${}^{-2.0}_{+0.6}$
$\mathcal{B}(B \to K\ell^+\ell^-)$	± 6.0	± 6.8
$\mathcal{B}(B \to K^*\ell^+\ell^-)$	± 6.8	± 6.8
K^*–X_s transition	${}^{-6.8}_{+2.3}$	${}^{-7.1}_{+2.7}$
Hadronization	± 5.8	± 5.5
Missing modes	± 1.7	± 1.7
Signal model subtotal	${}^{+11.2}_{-13.7}$	${}^{+11.5}_{-13.4}$
Monte Carlo statistics	< 0.1	< 0.1
$B\bar{B}$ counting	± 1.4	± 1.4
Total	${}^{+13.6}_{-15.8}$	${}^{+13.1}_{-14.8}$

$B \to X_{s/d} \ell\ell$

		BABAR (425 fb^{-1})				SuperB (75 ab^{-1})			
Observable	q^2 region [GeV^2/c^4]	Stat. SE	Sys. SE	Stat. RM	Sys. RM	Stat. SE	Sys. SE	Stat. RM	Sys. RM
$\sigma\mathcal{B}/\mathcal{B}$	all	0.11	0.056	0.26	0.06	0.008	0.03-0.05	0.019	0.03-0.05
$\sigma\mathcal{B}/\mathcal{B}$	0.1–1	0.29	0.07	0.69	0.07	0.022	0.04-0.06	0.052	0.04-0.06
$\sigma\mathcal{B}/\mathcal{B}$	1–4	0.23	0.06	0.53	0.06	0.017	0.03-0.05	0.040	0.03-0.05
$\sigma\mathcal{B}/\mathcal{B}$	4–7.84	0.18	0.06	0.43	0.06	0.014	0.03-0.05	0.032	0.03-0.05
$\sigma\mathcal{B}/\mathcal{B}$	10.24–12.96	0.31	0.07	0.73	0.07	0.024	0.04-0.06	0.055	0.04-0.06
$\sigma\mathcal{B}/\mathcal{B}$	>14.06	0.29	0.07	0.69	0.07	0.022	0.04-0.06	0.052	0.04-0.06
$\mathcal{R}_{X_s}$	all	0.21	0.06	0.50	0.06	0.016	0.03-0.05	0.038	0.03-0.05
$\mathcal{R}_{X_s}$	0.1–7.84	0.25	0.06	0.58	0.06	0.019	0.03-0.05	0.044	0.03-0.05
$\mathcal{A}_{CP}$	all	0.06	0.01	0.14	0.01	0.004	0.005-0.008	0.011	0.005-0.008
$\mathcal{A}_{CP}$	0.1–7,84	0.07	0.01	0.16	0.01	0.005	0.005-0.008	0.012	0.005-0.008
$\mathcal{A}_I$	all	0.05	0.06	0.12	0.06	0.004	0.03-0.05	0.009	0.03-0.05
$\mathcal{A}_I$	0.1–7.84	0.06	0.06	0.14	0.06	0.005	0.03-0.05	0.011	0.03-0.05
$\mathcal{H}_L$	0.1–1	0.17	0.04	0.40	0.04	0.013	0.02-0.03	0.030	0.02-0.03
$\mathcal{H}_L$	1–4	0.17	0.04	0.40	0.04	0.013	0.02-0.03	0.030	0.02-0.03
$\mathcal{H}_L$	4–7.84	0.13	0.04	0.27	0.04	0.009	0.02-0.03	0.021	0.02-0.03
$\mathcal{H}_A$	0.1–1	0.22	0.06	0.51	0.06	0.016	0.03-0.05	0.039	0.03-0.05
$\mathcal{H}_A$	1–4	0.22	0.06	0.51	0.06	0.016	0.03-0.05	0.039	0.03-0.05
$\mathcal{H}_A$	4–7.84	0.15	0.06	0.35	0.06	0.011	0.03-0.05	0.026	0.03-0.05