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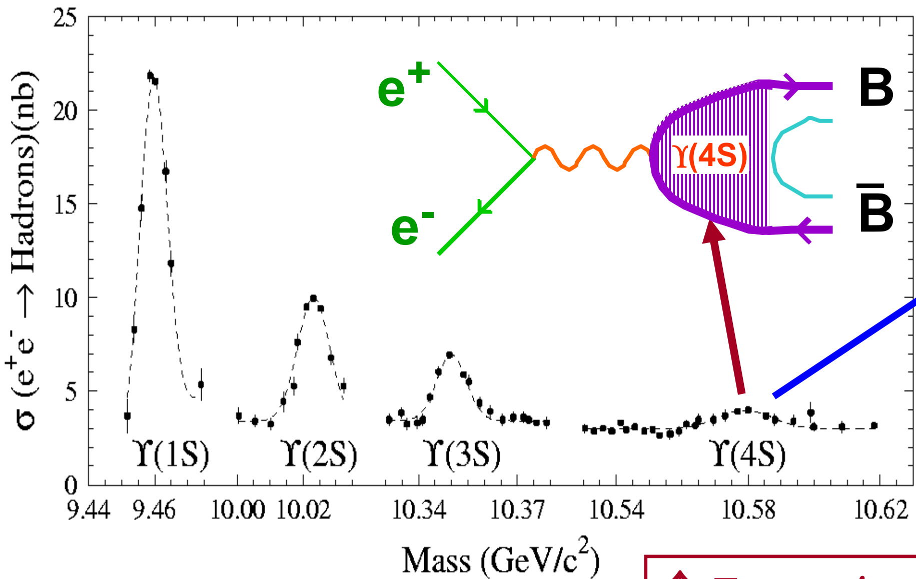
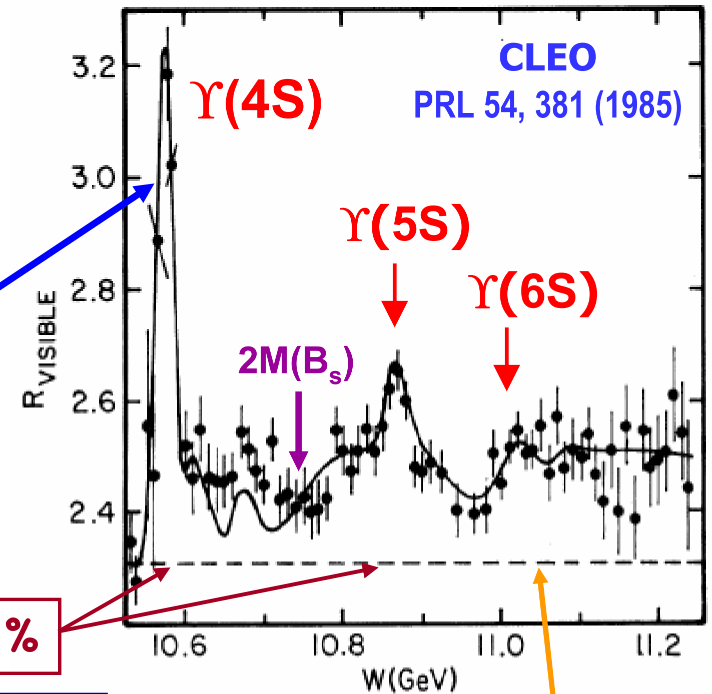
Prospects for $\Upsilon(5S)$ and B_s^0 studies at Super *B*-factories

Super B Workshop

April 4-7, 2011, Frascati, Italy.

$e^+ e^-$ hadronic cross section





↑ E_{beams} by 2.7 %

$(c\bar{c}, s\bar{s}, u\bar{u}, d\bar{d})$

$e^+ e^- \to \Upsilon(4S) \to B\bar{B}$, where B is B^+ or B^0 meson

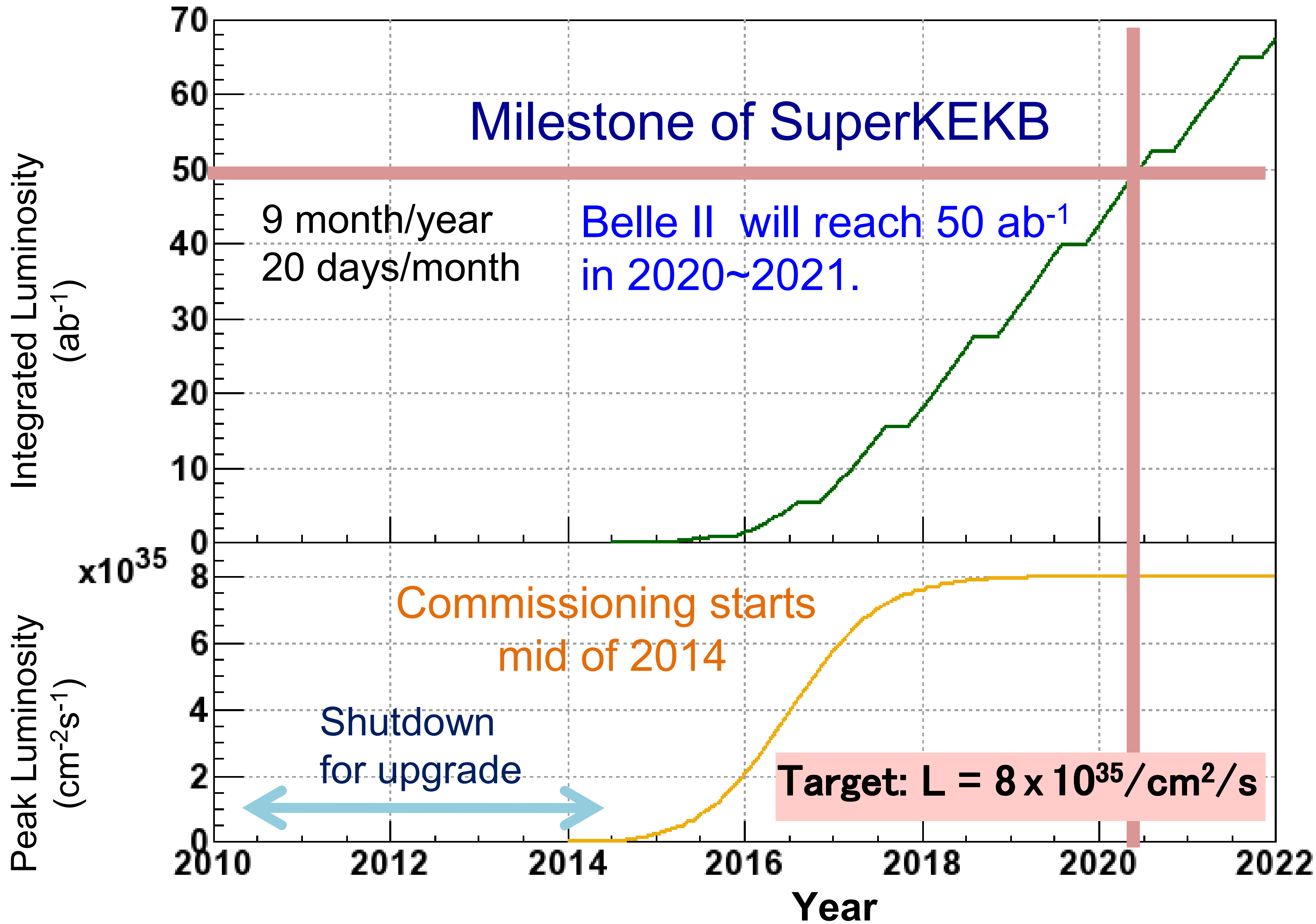
$e^+ e^- \to b\bar{b}\ (\Upsilon(5S)) \to B^{(*)}\bar{B}^{(*)}$, $B^{(*)}\bar{B}^{(*)}\pi$, $B\bar{B}\pi\pi$, $B_s^{(*)}\bar{B}_s^{(*)}$, $\Upsilon(1S)\,\pi\pi$, Υ X …

where $B^* \to B\,\gamma$ and $B_s^* \to B_s\,\gamma$

CLEO: 2003: ~0.42 fb^{-1}
Belle: 2005 1.86 fb^{-1}, 2006 21.7 fb^{-1},
2008 ~27 fb^{-1}, 2009 ~71 fb^{-1}

M ($\Upsilon(5S)$) = 10876 ± 2 MeV/c^2 Γ ($\Upsilon(5S)$) = 43 ± 4 MeV/c^2 (BaBar)

Belle II luminosity upgrade projection



As is now well known, Japan suffered a terrible earthquake and tsunami on March 11, which has caused tremendous damage, especially in the Tohoku area. Fortunately, all KEK personnel and users are safe and accounted for. The injection linac did suffer significant but manageable damage, and repairs are underway. The damage to the KEKB main rings appears to be less serious, though non-negligible. No serious damage has been reported so far at Belle. Further investigation is necessary. We would like to convey our deep appreciation to everyone for your generous expressions of concern and encouragement.

Hadronic event classification at $\Upsilon(5S)$

~10^5 B_s / 1 fb^{-1} at $\Upsilon(5S)$

hadronic events at $\Upsilon(5S)$

$\Upsilon(5S)$ events

bb continuum

u,d,s,c continuum

bb events

***bb* cross-section**

$\sigma(bb) = (0.302 \pm 0.014)$nb

B_s events

B^0, B^+ events

$\Upsilon(1,2S)$ X

$f_s = N(B_s^{(*)} B_s^{(*)}) / N(bb)$

$f_s = (19.5 \pm ^{3.0}_{2.3})\%$

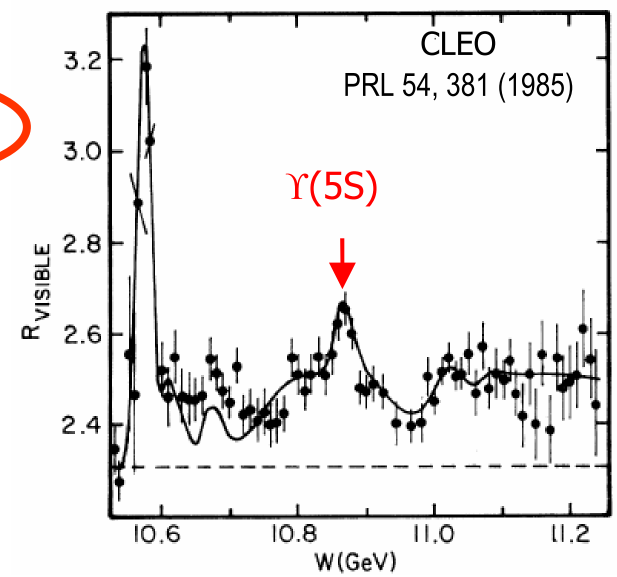
$f(B_s^* B_s^*)$

~90 %

$B_s^* B_s^*$ channel

$B_s^* B_s$

$B_s B_s$



B_s^0 and $B^{0/+}$ production rates at $\Upsilon(5S)$ (at E_{cm}=10867 MeV)

B_s^0 $(19.5 \pm ^{3.0}_{2.3})$ %

$f(B_s^*\bar{B}_s^*)$ = $(90.1 \pm ^{3.8}_{4.0} \pm 0.2)$%

$f(B_s^*\bar{B}_s)$ = $(7.3 \pm ^{3.3}_{3.0} \pm 0.1)$%

$f(B_s\bar{B}_s)$ = $(2.6 \pm ^{2.6}_{2.5})$%

B (73.7 ± 3.2 ± 5.1) %

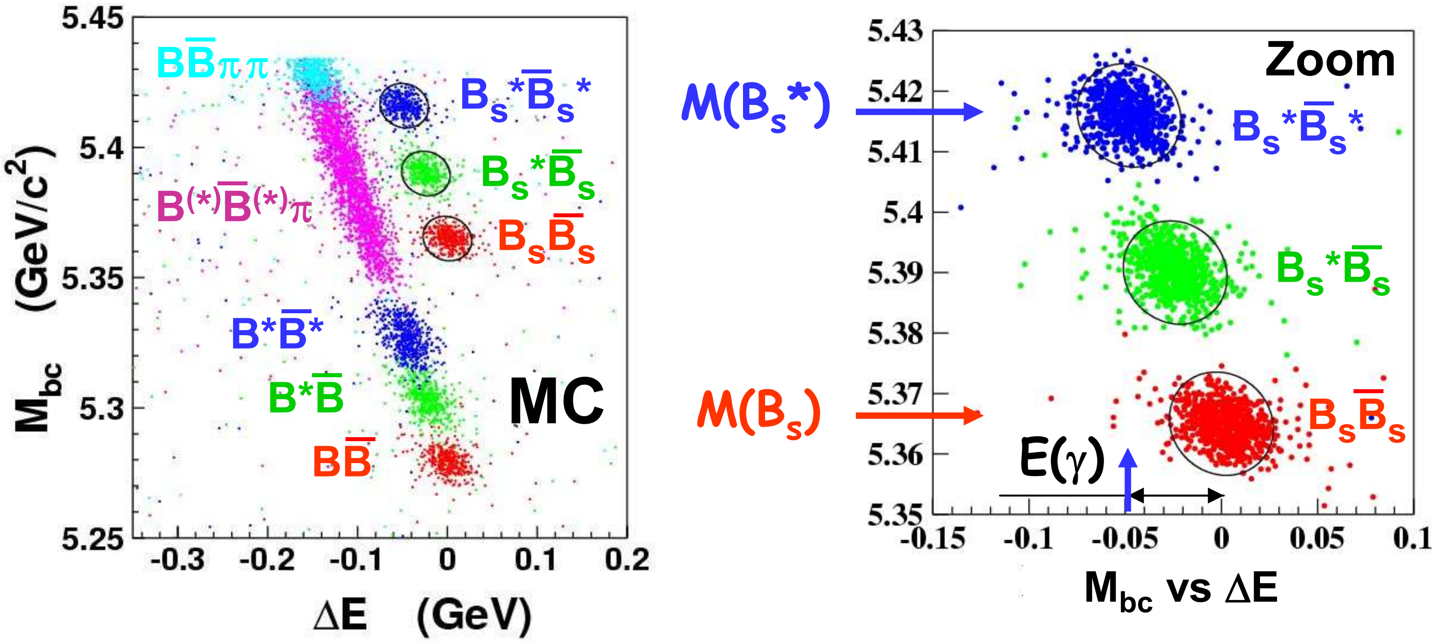
B^0 $(77.0 \pm ^{5.8}_{5.6} \pm 6.1)$ %

B^+ $(72.1 \pm ^{3.9}_{3.8} \pm 5.0)$ %

2 - body	BB:	$(5.5 \pm ^{1.0}_{0.9} \pm 0.4)$ %
	$B^*\bar{B}$:	(13.7 ± 1.3 ± 1.1) %
	$B^*\bar{B}^*$:	$(37.5 \pm ^{2.1}_{1.9} \pm 3.0)$ %
3 - body	$B\bar{B}\pi$	(0.0 ± 1.2 ± 0.3) %
	$B^*\bar{B}\pi$	$(7.3 \pm ^{2.3}_{2.1} \pm 0.8)$ %
	$B^*\bar{B}^*\pi$	$(1.0 \pm ^{1.4}_{1.3} \pm 0.4)$ %
Residual (ISR)		$(9.2 \pm ^{3.0}_{2.8} \pm 1.0)$ %

Signature of fully reconstructed B_s^0 and B decays

MC simulation: $B_s \to D_s^- \pi^+$ and $B^0 \to D^- \pi^+$.



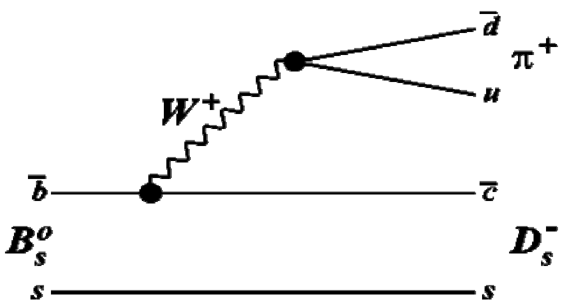
$e^+ e^- \to \Upsilon(5S) \to B_s\bar{B}_s$, $B_s^*\bar{B}_s$, $B_s^*\bar{B}_s^*$, where $B_s^* \to B_s\,\gamma$

B_s or B energy (E^*_B) and momentum (P^*_B) are reconstructed; no rec. γ from $B^*_{(s)}$

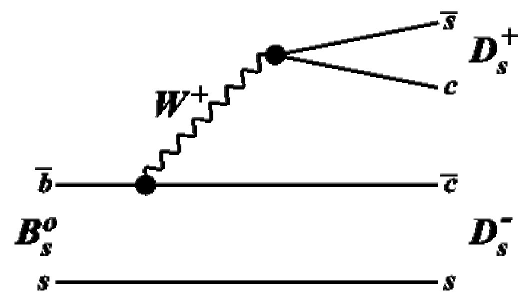
Two variables calculated: $M_{bc} = \sqrt{E^{*2}_{beam} - P^{*2}_B}$, $\Delta E = E^*_B - E^*_{beam}$

Signals in $B_s\bar{B}_s$, $B_s^*\bar{B}_s$ and $B_s^*\bar{B}_s^*$ channels can be well separated.

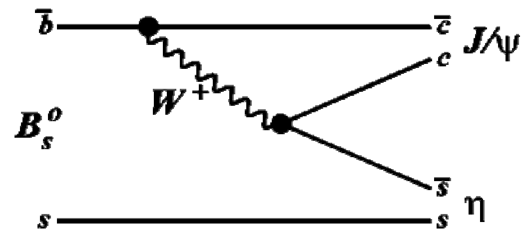
Diagrams of B_s decays studied by Belle with $\mathcal{L}$ = 23.6 fb^{-1}



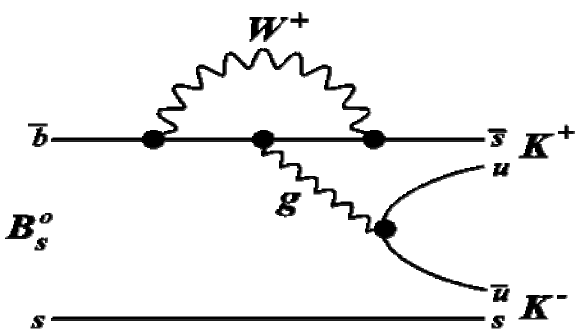
$B_s \rightarrow D_s^- \ \pi^+$



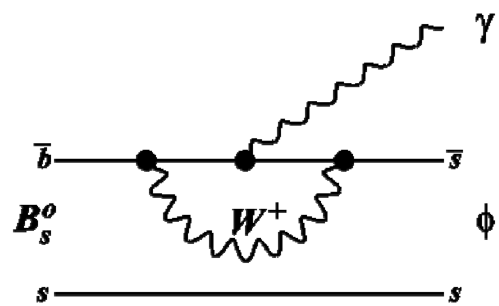
$B_s \rightarrow D_s^- \ D_s^+$



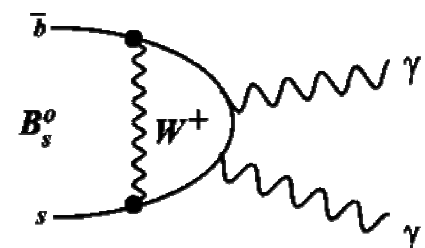
$B_s \rightarrow J/\psi \ \eta$



$B_s \rightarrow K^+ \ K^-$



$B_s \rightarrow \phi \ \gamma$



$B_s \rightarrow \gamma \ \gamma$

B_s^0 decay measurements performed on Belle ($\mathcal{L}$=23.6 fb^{-1})

B_s^0 decay mode	Branching fraction , ×10^3	Rel. B^0 mode	Br. fraction , ×10^3
$B_s^0 \to D_s^- \pi^+$	$3.67\ ^{+0.35}_{-0.33}\ ^{+0.43}_{-0.42} \pm 0.49\ (f_s)$	$B^0 \to D^- \pi^+$	2.68 ± 0.13
> $B_s^0 \to D_s^{*-} \pi^+$	$2.4\ ^{+0.5}_{-0.4} \pm 0.3 \pm 0.4\ (f_s)$	$B^0 \to D^{*-} \pi^+$	2.76 ± 0.13
> $B_s^0 \to D_s^- \rho^+$	$8.5\ ^{+1.3}_{-1.2} \pm 1.1 \pm 1.3\ (f_s)$	$B^0 \to D^- \rho^+$	7.6 ± 1.3
> $B_s^0 \to D_s^{*-} \rho^+$	$11.9\ ^{+2.2}_{-2.0} \pm 1.7 \pm 1.8\ (f_s)$	$B^0 \to D^{*-} \rho^+$	6.8 ± 0.9
$B_s^0 \to D_s^{-/+} K^{+/-}$	$0.24\ ^{+0.12}_{-0.10} \pm 0.03 \pm 0.03\ (f_s)$	$B^0 \to D^{-/+} K^{+/-}$	0.20 ± 0.06
> $B_s^0 \to \phi \gamma$	$(5.7\ ^{+1.8}_{-1.5}\ ^{+1.2}_{-1.1}) \times 10^{-2}$	$B^0 \to K^*(892)^0 \gamma$	$(4.01 \pm 0.20) \times 10^{-2}$
$B_s^0 \to K^+ K^-$	$(3.8\ ^{+1.0}_{-0.9} \pm 0.5 \pm 0.5\ (f_s)) \times 10^{-2}$	$B^0 \to K^+ \pi^-$	$(1.94 \pm 0.06) \times 10^{-2}$
$B_s^0 \to D_s^+ D_s^-$	$(1.03\ ^{+0.39}_{-0.32}\ ^{+0.26}_{-0.25}) \times 10$	$B^0 \to D_s^+ D^-$	$(0.72 \pm 0.08) \times 10$
> $B_s^0 \to D_s^{*+} D_s^-$	$(2.75\ ^{+0.83}_{-0.71} \pm 0.69) \times 10$	$B^0 \to D_s^{*+} D^-$	$(0.80 \pm 0.11) \times 10$
> $B_s^0 \to D_s^{*+} D_s^{*-}$	$(3.08\ ^{+1.22}_{-1.04}\ ^{+0.85}_{-0.86}) \times 10$	$B^0 \to D_s^{*+} D^{*-}$	$(1.77 \pm 0.14) \times 10$
> $B_s^0 \to J/\psi\, \eta$	$(3.32 \pm 0.87\ ^{+0.32}_{-0.28} \pm 0.42(f_s)) / 10$	$B^0 \to J/\psi\, K^0$	$(8.71 \pm 0.32) / 10$ [/3]
> $B_s^0 \to J/\psi\, \eta'$	$(3.1 \pm 1.2\ ^{+0.5}_{-0.6} \pm 0.38(f_s)) / 10$	$B^0 \to J/\psi\, K^0$	$(8.71 \pm 0.32) / 10$ [/3]
> $B_s^0 \to X^- \ell^+ \nu$	$(10.2 \pm 0.8 \pm 0.9) \times 10$	$B^0 \to X^- \ell^+ \nu$	$(10.33 \pm 0.28) \times 10$

> - first measurements, > - unpublished first measurements

Reasonable agreement between branching fractions for related B_s^0 и B^0 decays

Potential measurements with 1 ab^{-1} at $\Upsilon(5S)$

Where can SuperB factories be competitive with LHCb by 2016 ?

What are advantages of B factories comparing with hadron colliders?

Advantages and disadvantages of B factories.

- **Advantages of Super B factories running at $\Upsilon(5S)$, comparing with hadron-hadron colliders (in particular with LHCb):**

1) Low background, clean B_s samples (first LHCb results are rather clean).
2) A few percent systematics in determination of full B_s number in dataset.
3) Measurements of decay modes with many γ, π^0 and η in final state.
4) No problems with trigger for no-vertex and multi-particle final states.
5) Inclusive measurements (inclusive photon spectrum, semileptonic *BF*).
6) Partial reconstruction ("missing-mass" method).
7) Full reconstruction B_s sample can be used to study opposite side B_s.

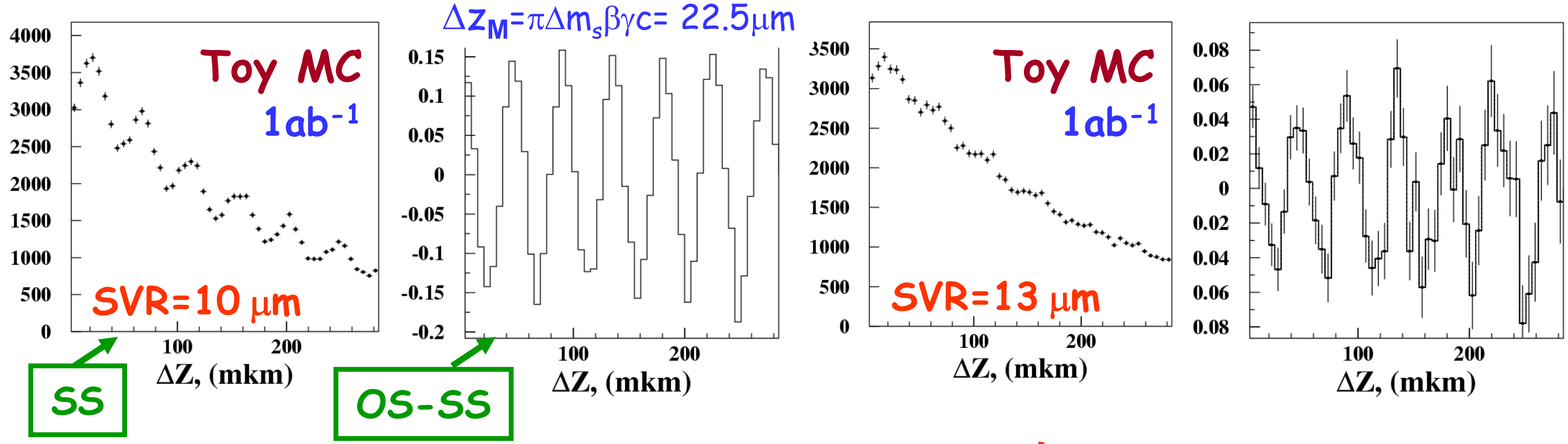
- **Disadvantages:**

1) We have to choose between running at $\Upsilon(4S)$ and $\Upsilon(5S)$.
2) Number of B_s mesons is smaller than in LHCb.
3) In LHCb lepton trigger efficiency is also high (close to 100 %).
3) Vertex resolution is not good enough to measure B_s mixing (?).

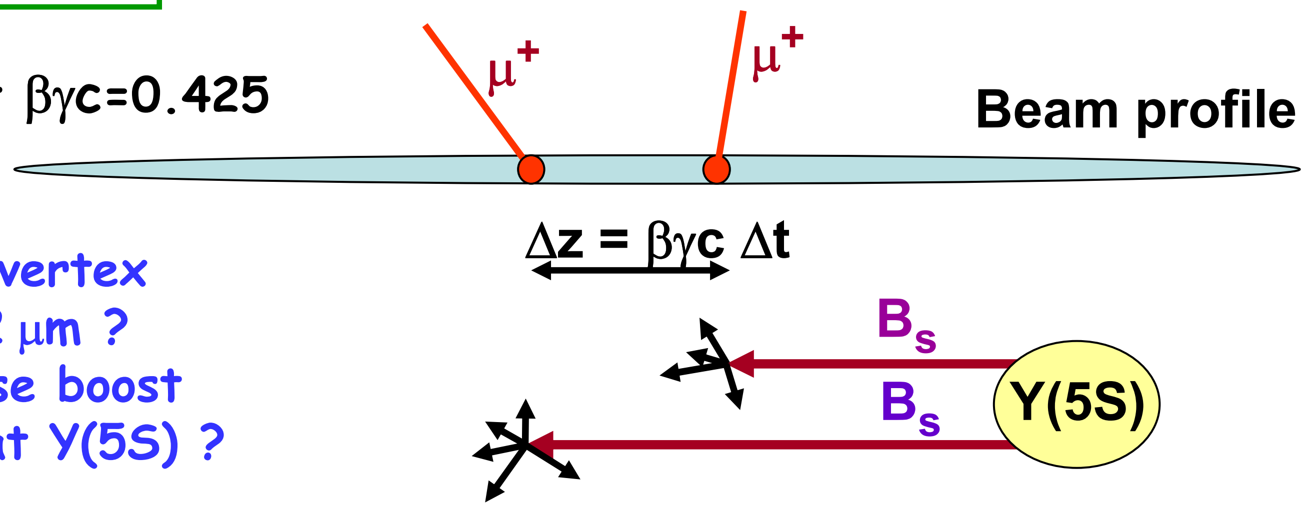
If we could measure time-dependent CP, physics program will be much wider.

Feasibility of B_s mixing measurement with two same-sign leptons

$\Delta z_M = \pi \Delta m_s \beta\gamma c =$ 22.5μm



Assuming boost βγc=0.425



Can we reach vertex resolution ~12 μm ?
Can we increase boost when running at Y(5S) ?

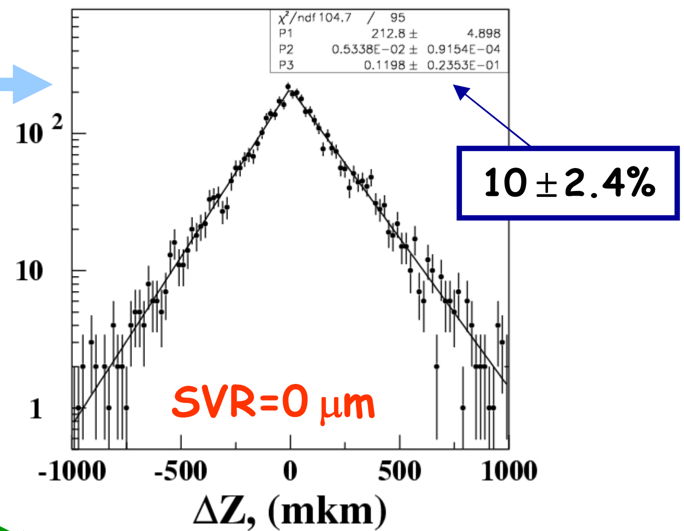
B_s mixing can be measured with Single Vertex Resol ~12μm and boost ~0.425

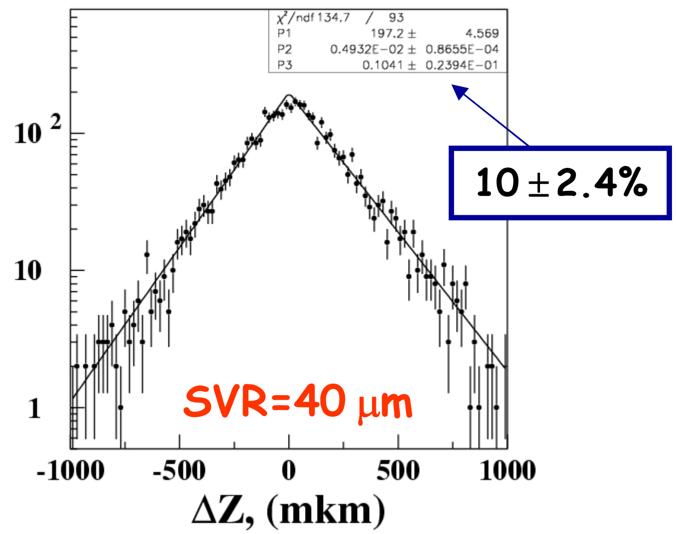
If B_s mixing oscillations cannot be resolved,

lifetime difference between *CP*= + and *CP*= –
B_s decays can be used
to search for BSM effects.

Direct $\Delta\Gamma_s$ measurement using CP-fixed B_s modes with $1ab^{-1}$

Toy MC, 4000 events





Vertex resol. is not critical

No BSM

$e^+e^- \to \Upsilon(5S) \to B_s^*(CP{=}+)\ \bar{B}_s^*(CP{=}-) = B_s(CP{=}-)\,\gamma\ \bar{B}_s(CP{=}+)\,\gamma$: *CP* anti-correlated

$$A_1 \exp(-\Gamma_1 t_1) + A_2 \exp(-\Gamma_2 (t_1+\Delta t)) \to \begin{cases} A \exp(\Gamma_1 \Delta t), & \text{if } \Delta t<0 \\ A \exp(-\Gamma_2 \Delta t), & \text{if } \Delta t>0 \end{cases}$$

~4000 (eff) CP-fixed events with $1000fb^{-1}$ => 2.4% accuracy in $\Delta\Gamma_s$.

CP-fixed: $D_s^{(*)}D_s^{(*)}$ (1000 ev), $J/\psi\,\eta^{(\prime)}$ (1500), K^+K^-(800), $D^0_{CP}K^0$ (250), $J/\psi\,\phi$ (2200).

4σ measurement of $\Delta\Gamma_s/\Gamma_s$ with $1ab^{-1}$ at $\Upsilon(5S)$

$\Delta\Gamma_s/\Gamma_s$ measurement from *Bf* ($B_s \to D_s^{+(*)} D_s^{-(*)}$)

We can test SM comparing directly measured $\Delta\Gamma_s$ with $\Delta\Gamma_s^{CP}$.

$\Delta\Gamma_s = \Delta\Gamma_s^{CP} \cos\phi_s$

ϕ_s is small in SM (phase in V_{ts} is small)

BSM effects can decrease lifetime difference $\Delta\Gamma_s$.

$$\Delta\Gamma_s^{CP} = \Sigma\,\Gamma(CP=+) - \Sigma\,\Gamma(CP=-)$$

$B_s \to D_s^{(*)+} D_s^{(*)-}$ decays are *CP*-even final states with largest *BF's* of ~(1-3)% each, saturating $\Delta\Gamma_s^{CP}$.

$$\frac{\Delta\Gamma_s^{CP}}{\Gamma_s} \approx \frac{Bf\,(B_s \to D_s^{(*)+} D_s^{(*)-})}{1 - Bf\,(B_s \to D_s^{(*)+} D_s^{(*)-})/2}$$

This formula is based on assumptions : 1) Contribution of $B_s \to D_s^{+(*)} D_s^{-(*)}\, n\pi$ is small 2) Decays $B_s \to D_s^{+} D_s^{-*}$ and $B_s \to D_s^{+*} D_s^{-*}$ are dominantly *CP*-even states.

Corrections are expected to be small **(~5-7%)**, $\Delta\Gamma_s^{CP}$ can be well measured.

Two body B_s decays

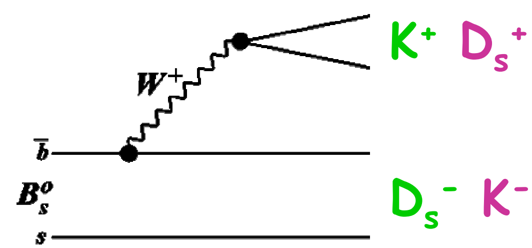
Many two-body (b->u and penguin) decays can be measured with $1\ ab^{-1}$. Decays with η and η' mesons are specially interesting. It is possible in some modes to measure time-integrated asymmetry and/or polarization. Best candidates with large branching fractions are:

$B_s \to K^- \pi^+$,
$B_s \to K^0\ K^0$,
$B_s \to K^- \rho^+$,
$B_s \to \eta^{(\prime)}\ \eta^{(\prime)}$,
$B_s \to \phi\ \phi$.

Phys.Rev. D76, 074018 (2007) Ali et al.

Decay mode $B_s \to D_s^{-/+} K^{+/-}$ can be used to measure precisely angle γ with $1\ ab^{-1}$. Two contributing tree diagrams (Cabibbo-suppressed and b->u) are of the same order:

Time-dependent measurement :
Z. Phys. C54, 653 (1992) Aleksan, Dunietz, Kayzer
Time-integrated (other side CP-tagged B_s, ~ $5\ ab^{-1}$):
Phys.Rev.Lett 85, 252 (2000) Falk, Petrov



Inclusive B_s decays

1. Inclusive $B_s \to X^- \ell^+ \nu$ decay branching fraction. It was measured (not published in journals) by Belle with 23.6 fb^{-1}.

2. Inclusive $B_s \to X_{ss} \gamma$ decay branching fraction ($B_s \to \phi \gamma$). It requires to develop relevant semi-inclusive method.

Partial reconstruction or full reconstruction of other side B_s:

1. Exclusive $B_s \to D_s^{(*)-} \ell^+ \nu$ decay branching fractions. Precise measurements can be done with Belle statistics of ~121 fb^{-1}.

2. Exclusive $B_s \to D_{sJ}^- \ell^+ \nu$ decay branching fractions (~1 ab^{-1}).

3. Exclusive $B_s \to K^- \ell^+ \nu$ decay branching fraction (probably ~1 ab^{-1}).

4. Exclusive $B_s \to D_s^- \tau^+ \nu$ decay branching fraction. It requires MC studies (probably ~1 ab^{-1} will be enough).

Leptonic B_s decays

1 ab^{-1} = 10^8 B_s mesons

1. Measurement of $B_s \to \mu^+ \mu^-$ decay branching fraction.
   SM: $\mathcal{B} \sim (3.4 \pm 0.5) \times 10^{-9}$ => too small PDG: < 4.7×10^{-8} @90%CL

2. Measurement of $B_s \to \mu^+ \mu^- \gamma$ decay branching fraction.
   SM: $\mathcal{B} \sim 3 \times 10^{-9}$ => too small (not helicity suppressed) BSM ↑ up to x 5

3. Measurement of $B_s \to \tau^+ \tau^-$ decay branching fraction.
   SM: $\mathcal{B}(B_s \to \tau^+ \tau^-) \sim 7 \times 10^{-7}$, BSM can ↑ up to x 10 OK, requires MC study
   SM: $\mathcal{B}(B_s \to \tau^+ \tau^- \gamma) = 1.5 \times 10^{-8}$ (hep-ph/0504193), BSM can ↑ up to x 10

4. Measurement of $B_s \to \phi \mu^+ \mu^-$ decay parameters. LHCb will do it.
   Maybe $B_s \to \eta^{(\prime)} \mu^+ \mu^-$ decay is not that easy for LHCb.

5. Measurement of $B_s \to \phi \nu \nu$ decay branching fraction.
   SM: $\mathcal{B} \sim 10^{-5}$, Full reconstruction B_s, BSM sensitive, OK, requires MC study

Lepton charge asymmetry measurement

$1\ ab^{-1} = 10^8\ B_s$ mesons

A_{sl}^{s} = (Bf($\bar{B}_s \to \ell^+ X$) - Bf($B_s \to \ell^- X$)) / (Bf($\bar{B}_s \to \ell^+ X$) + Bf($B_s \to \ell^- X$))

D0: $A_{sl}^{b} = (-0.957 \pm 0.251 \pm 0.146)\,\%$; SM: $\sim -2\times10^{-4}$; BSM: up to 10^{-3}

Advantage of B factories : separation of B_s and B sources for leptons

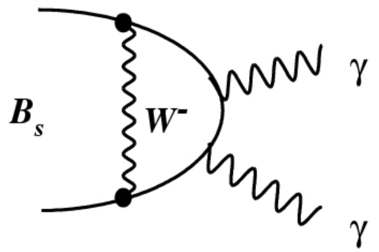
Technique : selection of $\mu\mu$ and $\phi\mu\mu$ samples

Electrons can be used as well

Expected accuracy at Super B factory with 1 ab^{-1}: $\sigma(A_{sl}^{s}) \sim 0.3\,\%$

$A_{sl}^{s} = (\Delta\Gamma_s / \Delta M_s) \times \tan\phi_s$

Measurement of $B_s \to \gamma\gamma$ decay



SM: $\mathcal{B} \sim (0.5\text{-}1.0) \times 10^{-6}$

Belle (23.6 fb^{-1}) :
$\mathcal{B}(B_s \to \gamma\gamma) < 8.7\times10^{-6}$ (90% CL)

With 1 ab^{-1} (3-5)σ measurement of SM branching fraction is expected.

With specific set of parameters BSM model branching fraction is increased up to:

2×10^{-6}	T.M. Aliev, et al, "Leading logarithmic corrections to the $B_s \to \gamma\gamma$ decays in the two Higgs doublet model", Nucl. Phys. B515 321 (1998).
3×10^{-6}	W.J. Huo, et al, "$B_s \to \gamma\gamma$ decays with the fourth generation",hep-ph/0302177
5×10^{-6}	A. Gemintern, et al, "$B_s \to X(s)\gamma\gamma$ and $B_s \to \gamma\gamma$ in supersymmetry with broken R-parity", Phys. Rev. D70 035008 (2004).
0.04×10^{-6}	J.I. Aranda, et al, "Bounding the $B_s \to \gamma\gamma$ decay from Higgs mediated FCNC transitions", arXiv:1005.5452 (hep-ph).

Searches for new bottomonium states at $\Upsilon(5S)$

New (almost unexpected) field in $\Upsilon(5S)$ physics:

Searches for new bottomonium states

In contrast to $\Upsilon(4S)$ data, $\Upsilon(5S)$ can decay in bottomonium states with high rates up to 1% level (next two slides)

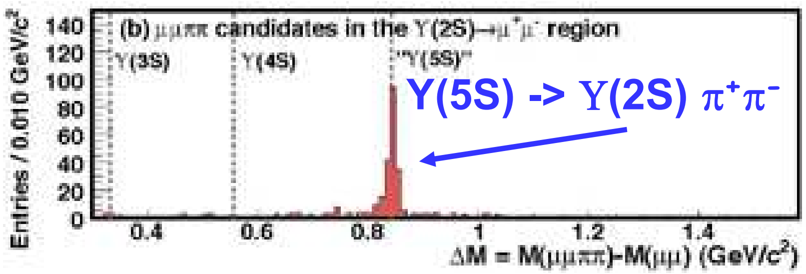
Why $\Upsilon(5S)$ does not decay only to B and B_s mesons ?
Exotic mechanisms ?

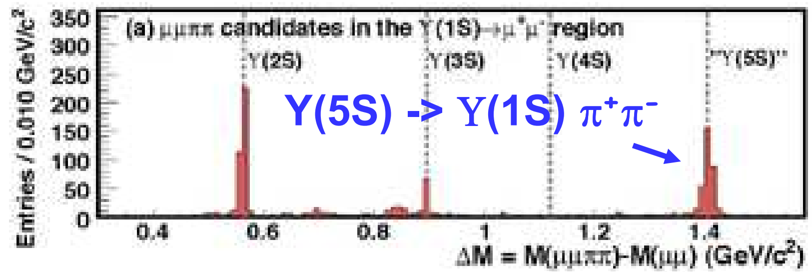
We don't know answers to these questions.

It is important to develop physics program in this field

Observation of $\Upsilon(5S) \to \Upsilon(nS)\pi^+\pi^-$

K.-F. Chen et al. (Belle coll), PRL 100, 112001 (2008)





Process	σ(pb)	$\mathcal{B}$(%)	Γ(MeV)
$\Upsilon(1S)\pi^+\pi^-$	$1.61 \pm 0.10 \pm 0.12$	$0.53 \pm 0.03 \pm 0.05$	$0.59 \pm 0.04 \pm 0.09$
$\Upsilon(2S)\pi^+\pi^-$	$2.35 \pm 0.19 \pm 0.32$	$0.78 \pm 0.06 \pm 0.11$	$0.85 \pm 0.07 \pm 0.16$
$\Upsilon(3S)\pi^+\pi^-$	$1.44^{+0.55}_{-0.45} \pm 0.19$	$0.48^{+0.18}_{-0.15} \pm 0.07$	$0.52^{+0.20}_{-0.17} \pm 0.10$
$\Upsilon(1S)K^+K^-$	$0.185^{+0.048}_{-0.041} \pm 0.028$	$0.061^{+0.016}_{-0.014} \pm 0.010$	$0.067^{+0.017}_{-0.015} \pm 0.013$

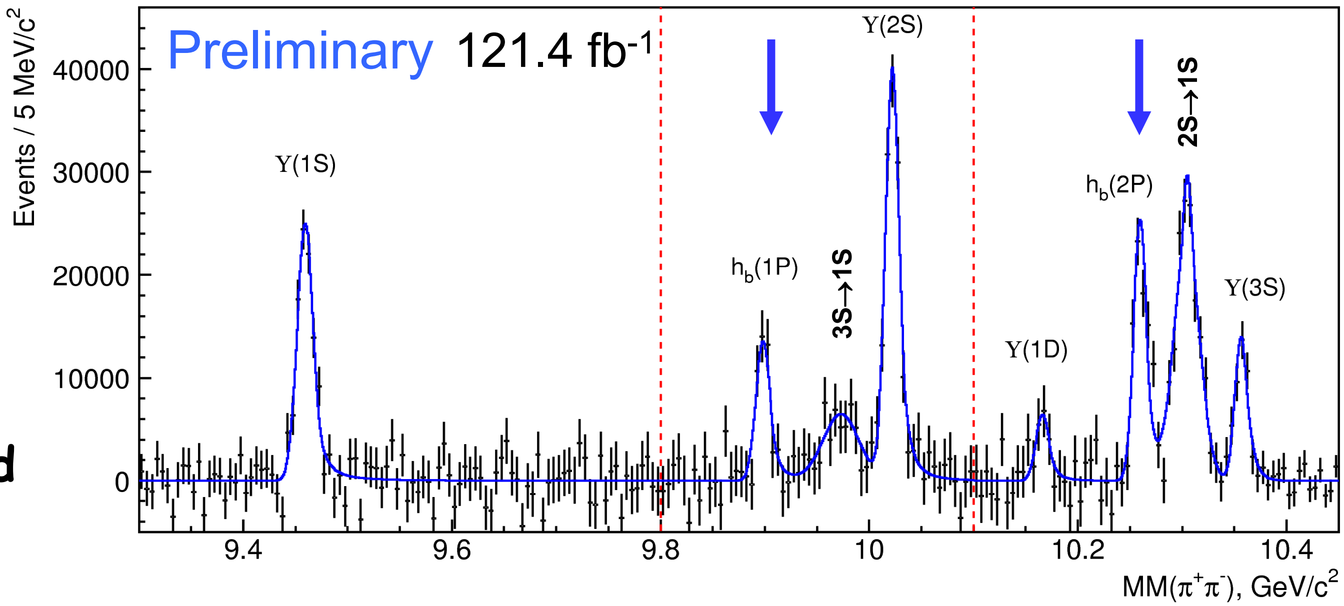
Process	Γ_{total}	$\Gamma_{e^+e^-}$	$\Gamma_{\Upsilon(1S)\pi^+\pi^-}$
$\Upsilon(2S) \to \Upsilon(1S)\pi^+\pi^-$	0.032 MeV	0.612 keV	0.0060 MeV
$\Upsilon(3S) \to \Upsilon(1S)\pi^+\pi^-$	0.020 MeV	0.443 keV	0.0009 MeV
$\Upsilon(4S) \to \Upsilon(1S)\pi^+\pi^-$	20.5 MeV	0.272 keV	0.0019 MeV
$\Upsilon(10860) \to \Upsilon(1S)\pi^+\pi^-$	110 MeV	0.31 keV	0.59 MeV

larger by > 10^2

Production of $h_b(1P)$ and $h_b(2P)$ at $\Upsilon(5S)$ (R.Mizuk talk, Moriond 2011)

$MM(\pi^+\pi^-)$ spectrum

Smooth background was subtracted



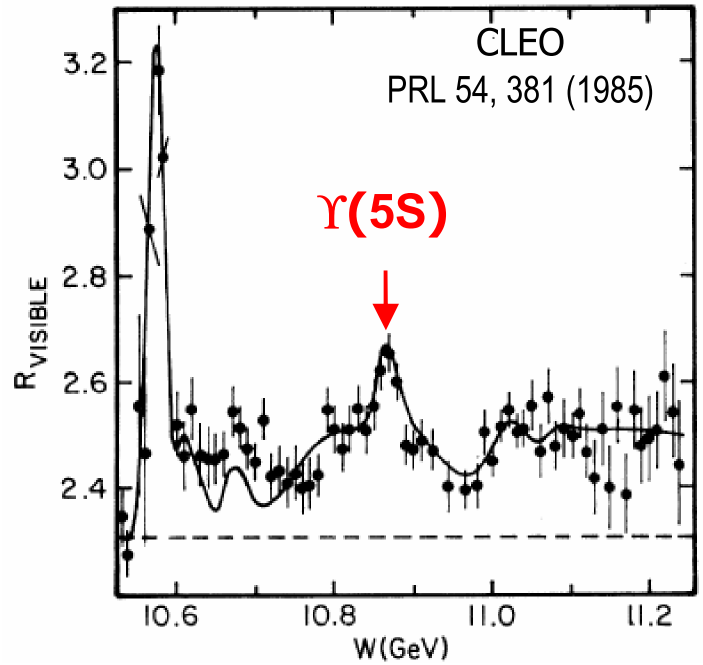
Masses consistent with CoG of χ_{bJ} states, as expected.
Anomalous production rates of ~0.5% level.

	Yield, 10^3	Mass, MeV$/c^2$	Signif.
$\Upsilon(1S)$	$105.2 \pm 5.8 \pm 3.0$	$9459.42 \pm 0.53 \pm 1.02$	$18.2\,\sigma$
$h_b(1P)$	$50.4 \pm 7.8^{+4.5}_{-9.1}$	$9898.25 \pm 1.06^{+1.03}_{-1.07}$	$\boxed{6.2\,\sigma}$
$3S \to 1S$	55 ± 19	9973.01	$2.9\,\sigma$
$\Upsilon(2S)$	$143.4 \pm 8.7 \pm 6.8$	$10022.25 \pm 0.41 \pm 1.01$	$16.6\,\sigma$
$\Upsilon(1D)$	22.1 ± 7.8	10166.2 ± 2.4	$2.4\,\sigma$
$h_b(2P)$	$84.4 \pm 6.8^{+23.}_{-10.}$	$10259.76 \pm 0.64^{+1.43}_{-1.03}$	$\boxed{12.4\,\sigma}$
$2S \to 1S$	$151.6 \pm 9.7^{+9.0}_{-20.}$	$10304.57 \pm 0.61 \pm 1.03$	$15.7\,\sigma$
$\Upsilon(3S)$	$44.9 \pm 5.1 \pm 5.1$	$10356.56 \pm 0.87 \pm 1.06$	$8.5\,\sigma$

What else can be done at Super B Factory?

PDG (Z->bb, pp at $S^{1/2}$=1.8TeV)

b hadron	fraction(%)
B^+, B^0	39.8 ± 1.0
B_s	10.4 ± 1.4
b baryons	9.9 ± 1.7 (90% Λ_b)



Rates at e+e- continuum should be similar, baryon production is large.

$M(\Lambda_b) = (5624 \pm 9)\ \mathrm{MeV}/c^2$

$M(\Lambda_b)\mathrm{x}2 = (11248 \pm 18)\ \mathrm{MeV}/c^2$ => 6.3 % up from ϒ(4S) CME.

Can Super B factory CM energy range be increased ?

$M(B_c) = (6286 \pm 5)\ \mathrm{MeV}/c^2$

$e^+e^- \rightarrow \Upsilon(6S,7S) \rightarrow B_s\overline{B}_s,\ \Lambda_b\overline{\Lambda}_b,\ B_c\overline{B}_c,\ \Xi_b\overline{\Xi}_b \ldots$?

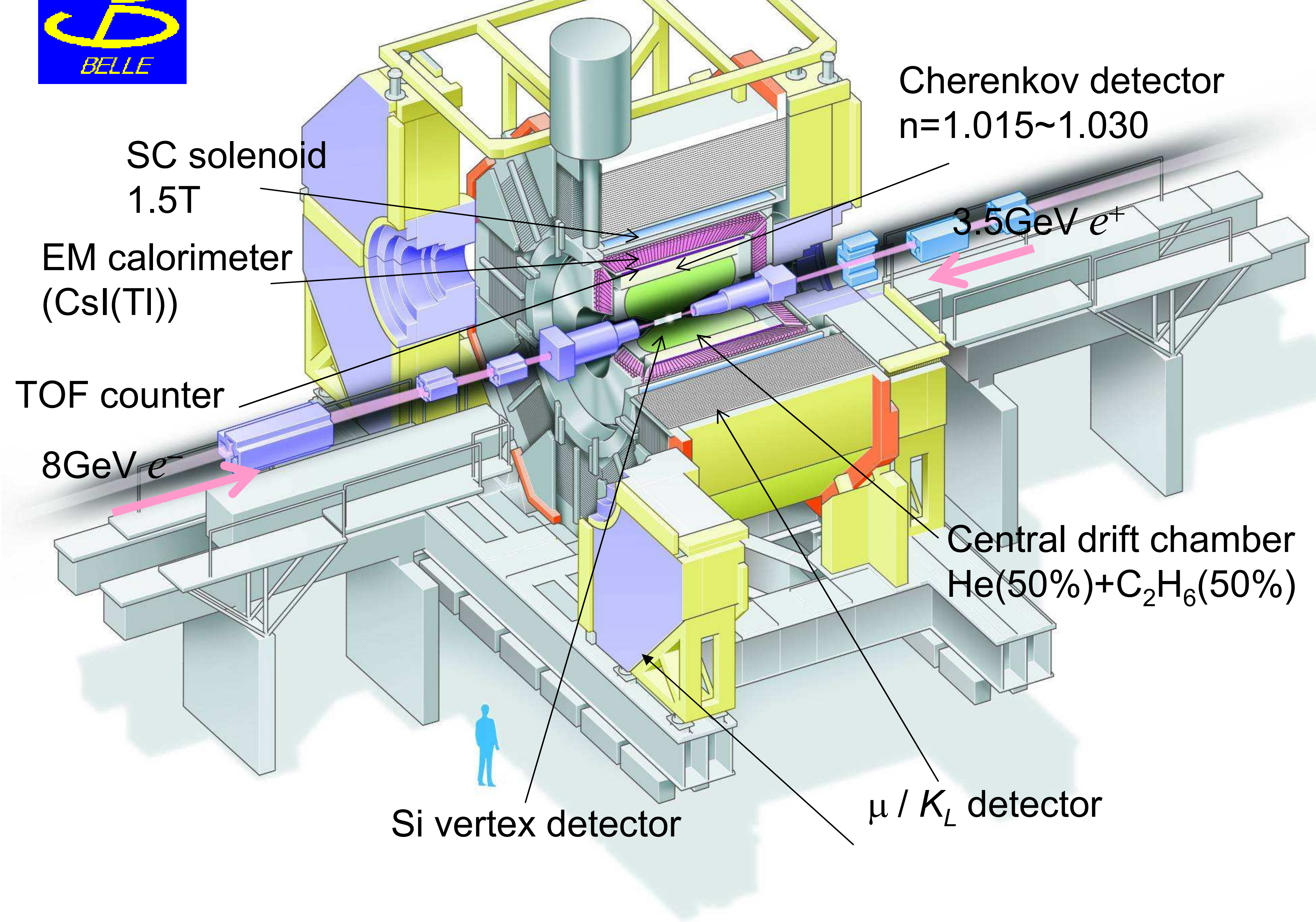
Conclusions

- Extensive physics program can be proposed at Super B factories with statistics of 1 ab^{-1} at Υ(5S). Important SM tests can be done.

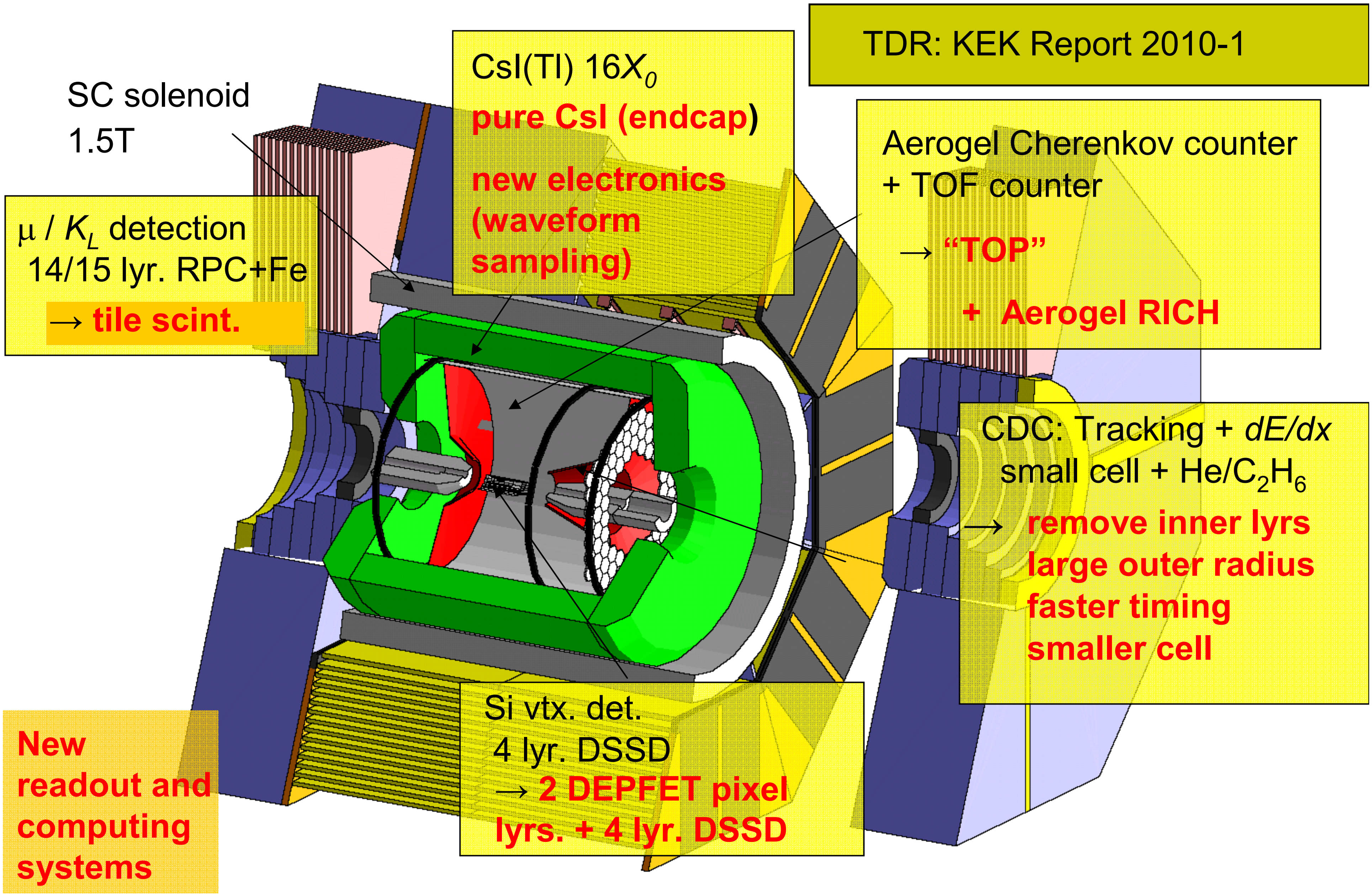
- Because we don't know which BSM model is correct, we should develop comprehensive program with all possible BSM searches.

- It is important to have good vertex resolution and option with large e+e- CM boost to measure time dependent *CP* violation.

Belle Detector



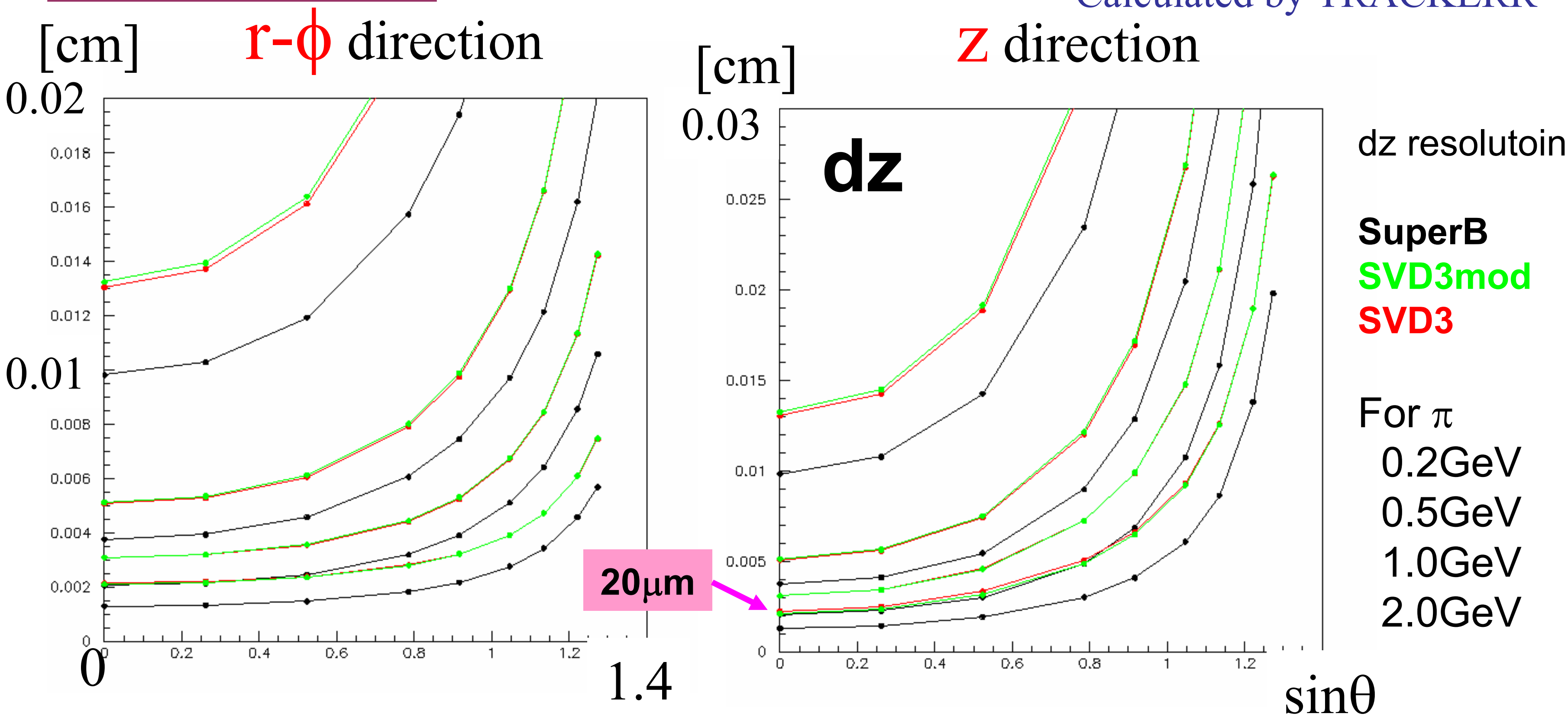
Belle Upgrade for the Super B Factory



T.Kawasaki,
Atami BNM2008
Jan 2008

Impact Parameter resolution

Calculated by TRACKERR



Beampipe radius is important
Competitive performance as the current SVD

Occupancy effects.
Degradation of intrinsic resolution is included.
Efficiency loss is NOT included

Observation of $\Upsilon(5S) \to \Upsilon(1S)\pi^+\pi^-$, $\Upsilon(2S)\pi^+\pi^-$

K.-F. Chen et al. (Belle coll),
PRL 100, 112001 (2008)

L= 21.7 fb^{-1}

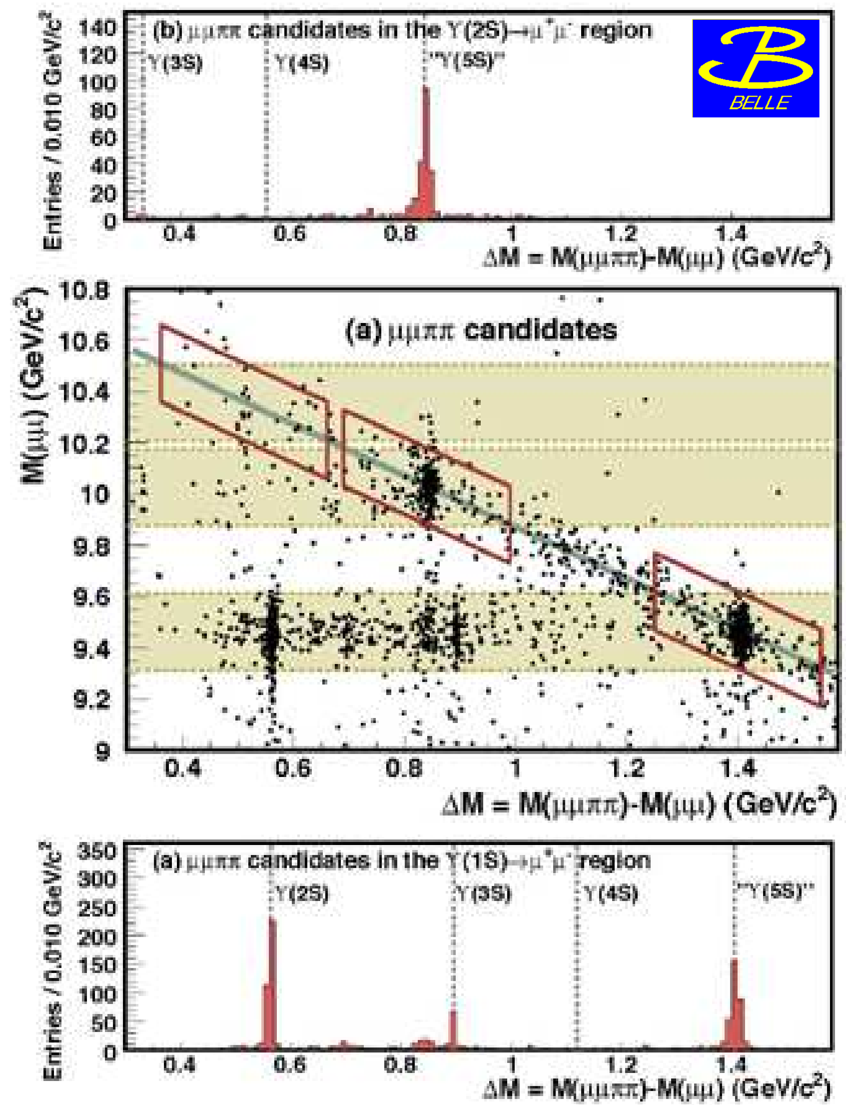
-> look for: $\mu^+\mu^- h^+ h^-$

e^+e^- -> Υ(1S) $\pi^+\pi^-$X

e^+e^- -> Υ(2S) $\pi^+\pi^-$X

Signals are about 1%. Is it similar to recently observed Y(4230) -> J/Ψ $\pi^+\pi^-$ state (hybrid interpret.)?

CME calibration accur. < 1 MeV



Υ(2S)

Υ(3S)

Υ(2S)

Υ(1S)

Υ(1S)