Physics Motivation

(Feb.25　13:30-13:50　M.Yamauchi)

Physics at $L>10^{35}$ KEKB

KEKB Review Committee Meeting

Feb. 25, 2002

M.Yamauchi

KEK

Outline

Introduction: where we are now.

Approaches to New Physics in ***B*** decays

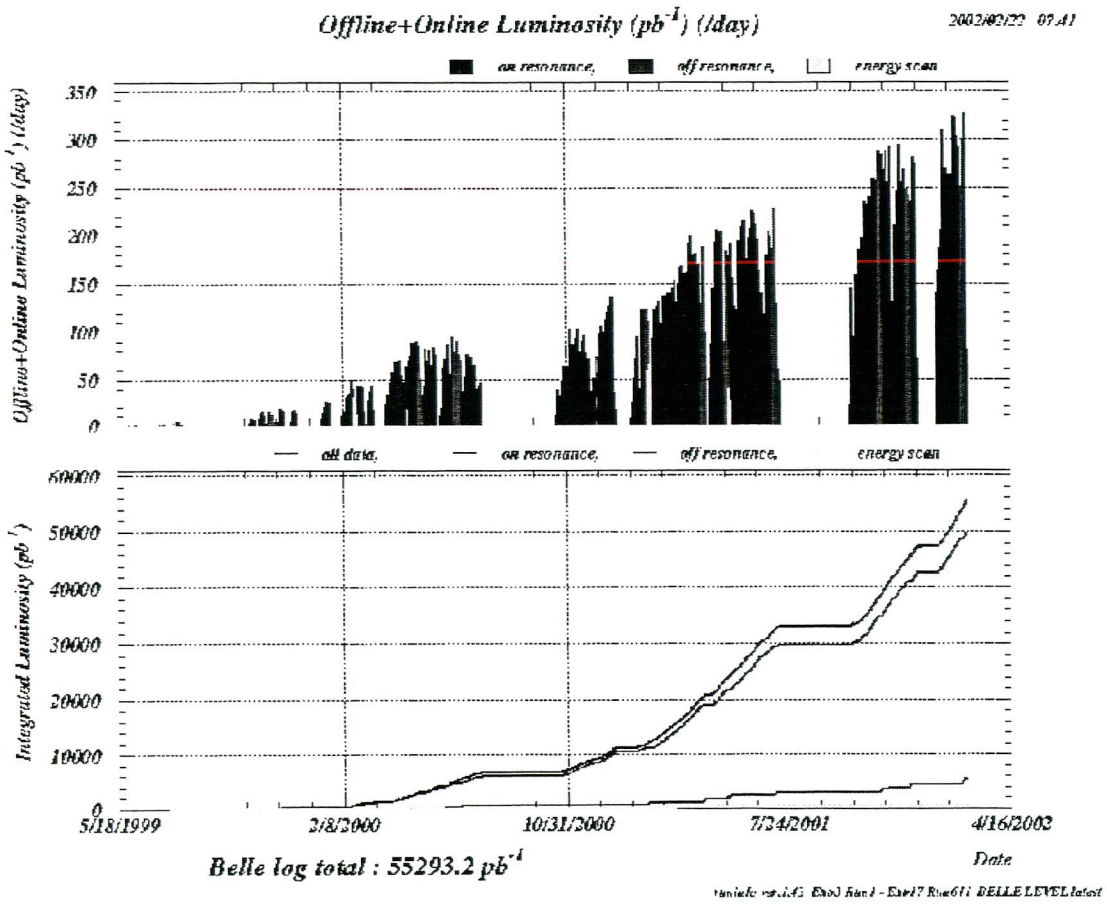
- Unitarity triangle
- Effects on rare B decays
- Effects on τ decays

Detector design

Schedule

Summary

KEKB luminosity



L_{peak}=6.6x10^{33}/cm^2/s
(World record)

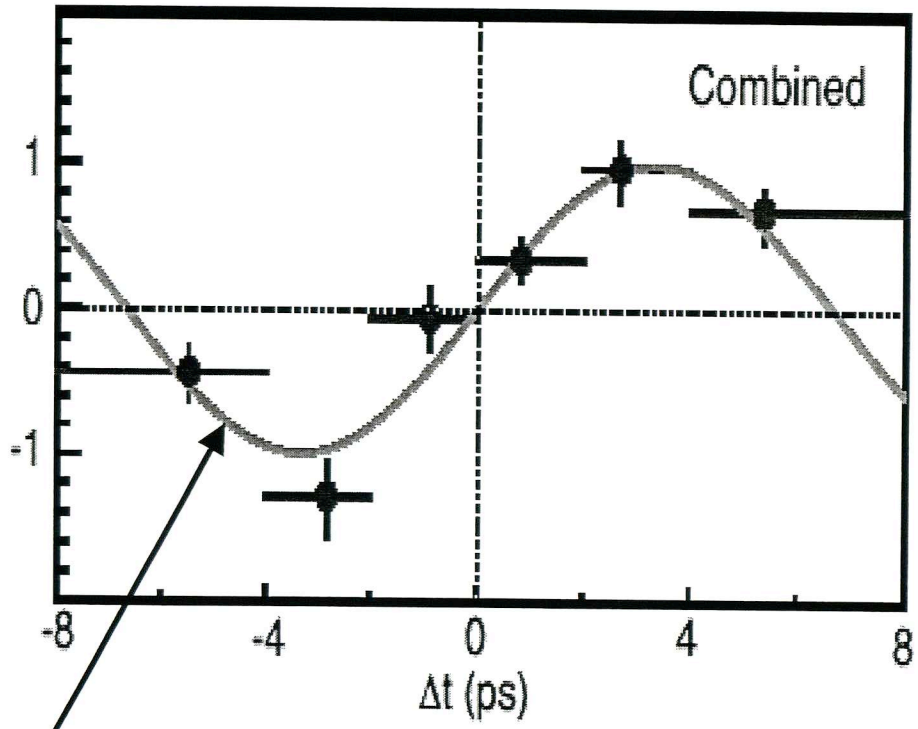
Max L_{day} = 327pb^{-1}

Total integ. L = 55.3fb^{-1}
(~Feb.22, 2002)

CP violation in summer 2001

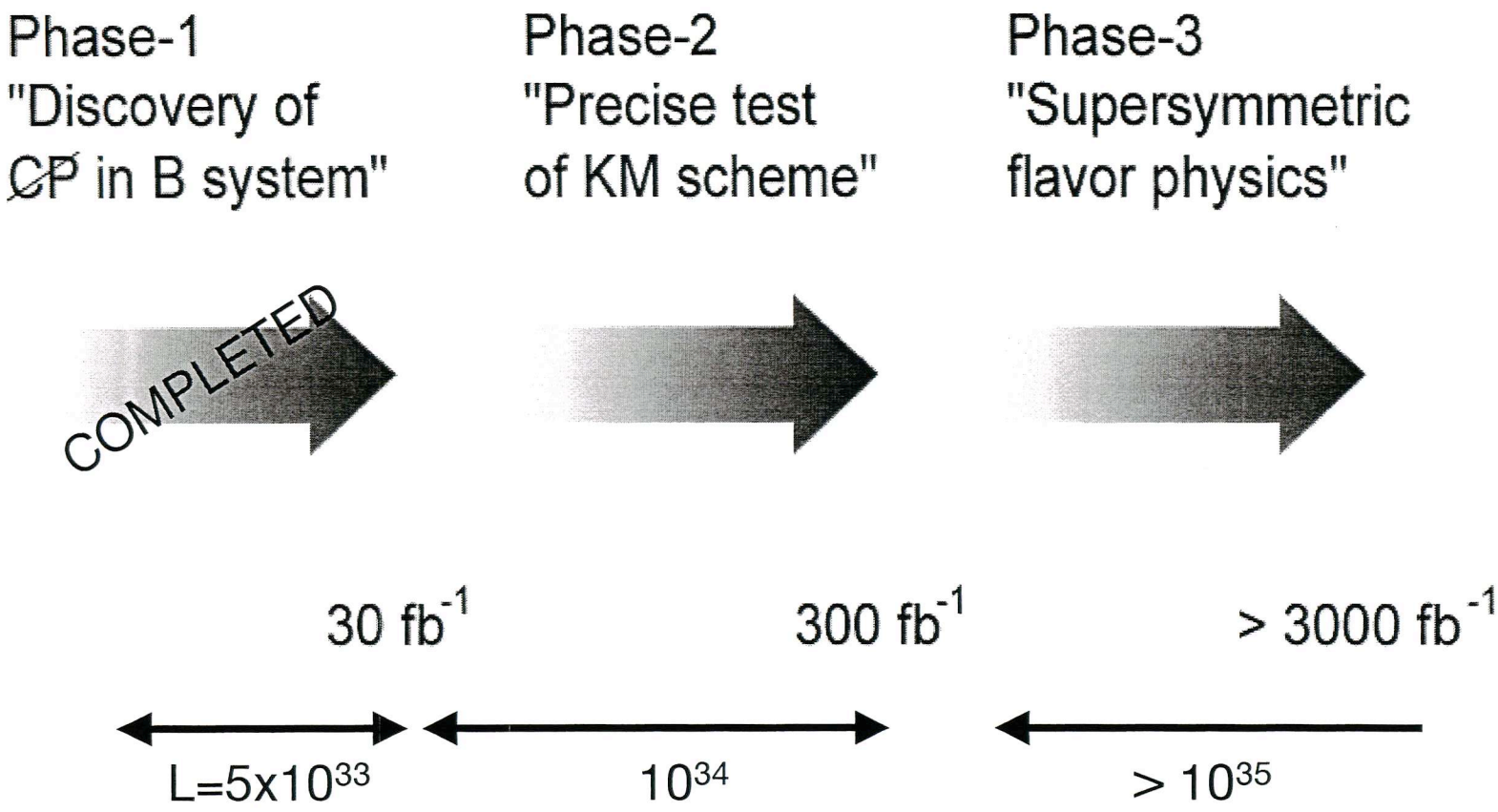
$$A_{CP}(t) = \frac{\Gamma(\overline{B}^0 \to J/\psi K_S;t) - \Gamma(B^0 \to J/\psi K_S;t)}{\Gamma(\overline{B}^0 \to J/\psi K_S;t) + \Gamma(B^0 \to J/\psi K_S;t)} = \sin 2\phi_1 \sin \Delta m t$$

CP asymmetry and meas. of ϕ_1.

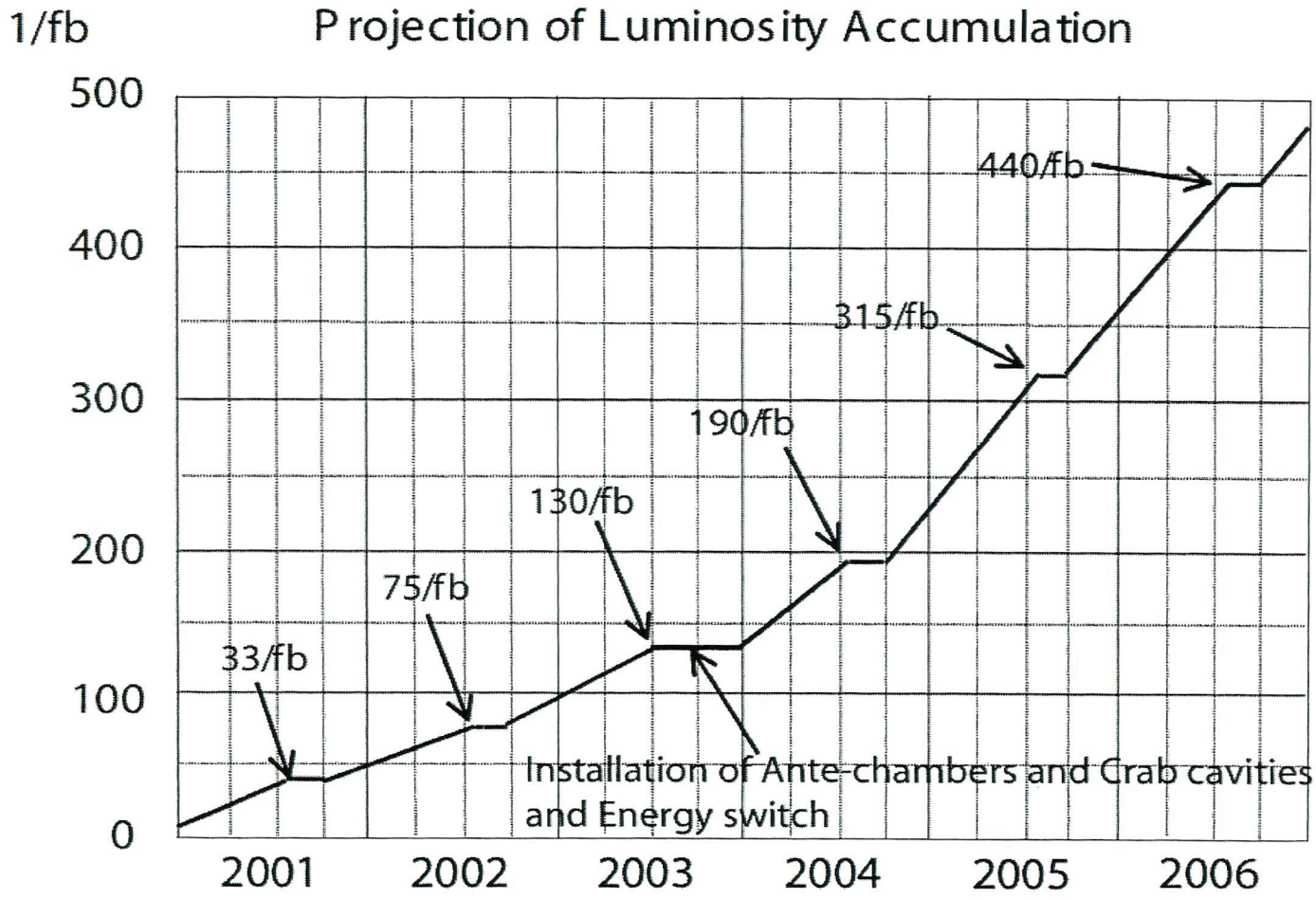


Result from global fit ($\sin 2\phi_1 = 0.99$)

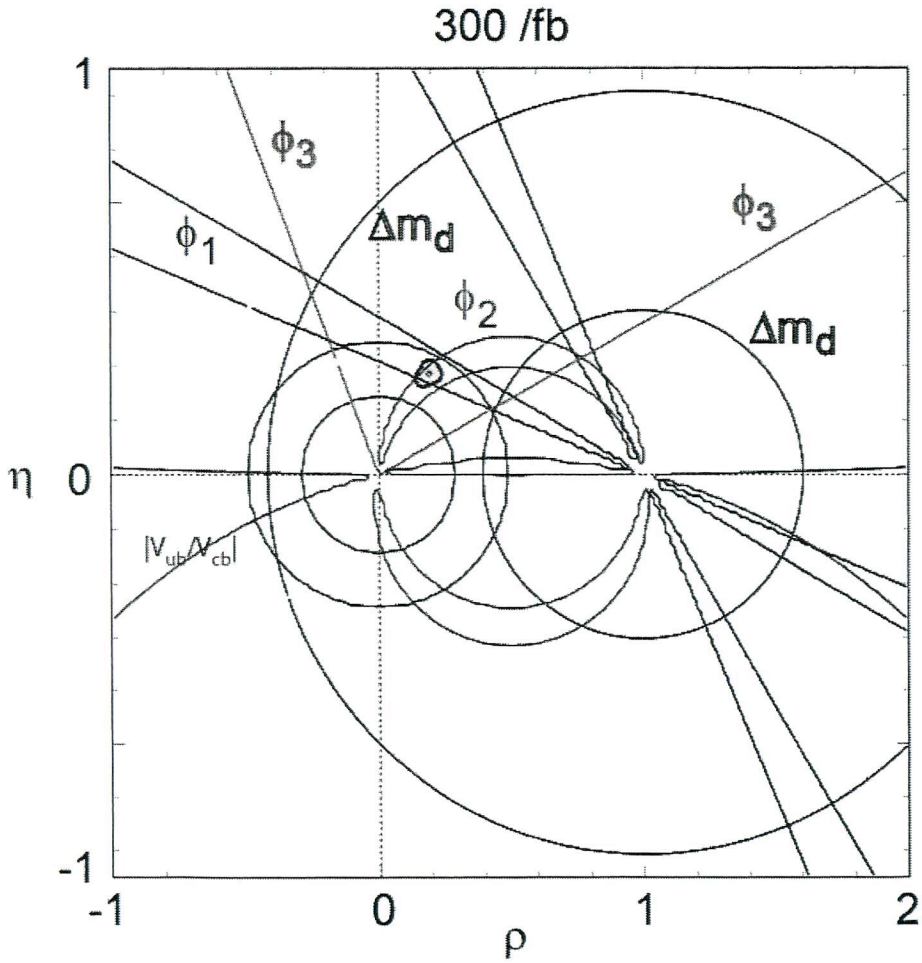
Three phases of KEKB



KEKB in near future



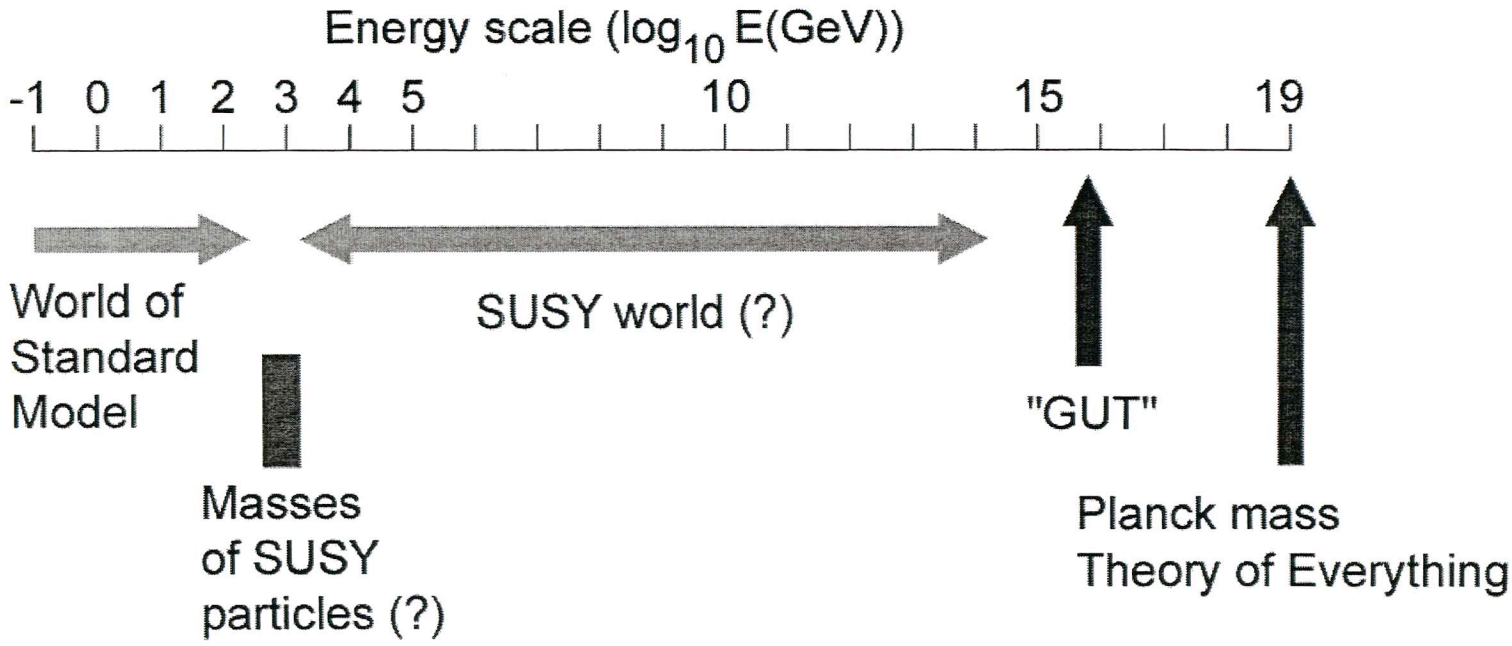
The triangle in 2006



(ρ,η) will be determined well by ϕ_1 and ϕ_2 meas. with 300 fb^{-1}.

Consistency check with ϕ_3, V_{td} and V_{ub} will be still insufficient.

SUSY as the next target

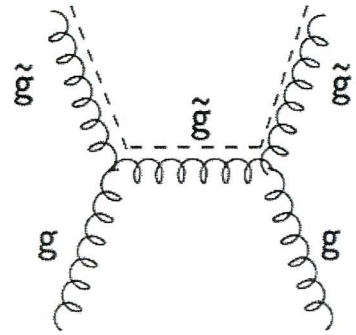


Reasons for SUSY:

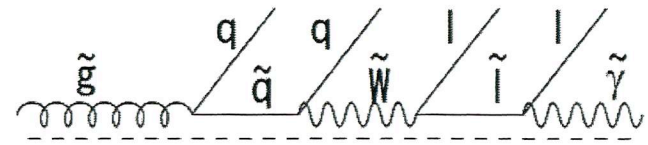
- Too many arbitrary parameters in the Standard Model.
- "Hierarchy problem" requires new physics at ~TeV scale.
- Three cupling constants become equal at 10^{16}GeV : GUT?
- Beutiful theory!!

SUSY at H.E. colliders

at LHC



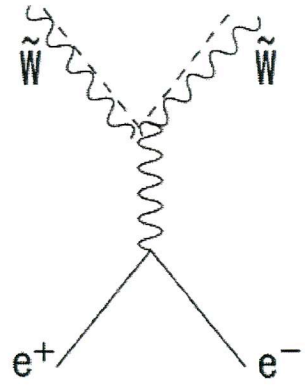
gluons in protons



$\tilde{g}$ decays through a complicated process.

$\tilde{\gamma}$ is a stable and invisible particle.

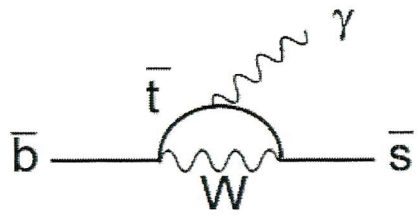
at LC



LHC:
The energy is (probably) high enough.
Search region is determined by L.
Maybe difficult to measure the masses precisely.

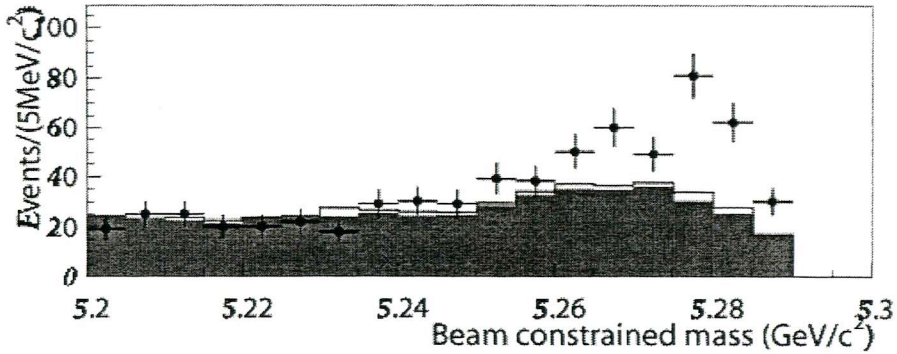
LC:
Search region is limited by the energy.
Masses will be measured precisely.

SUSY in EW penguin (1)



+ H^+ , SUSY particles??

- Dataset
  5.3 million $B\bar{B}$
- Signal yield
  106.5 ± 16.8 events



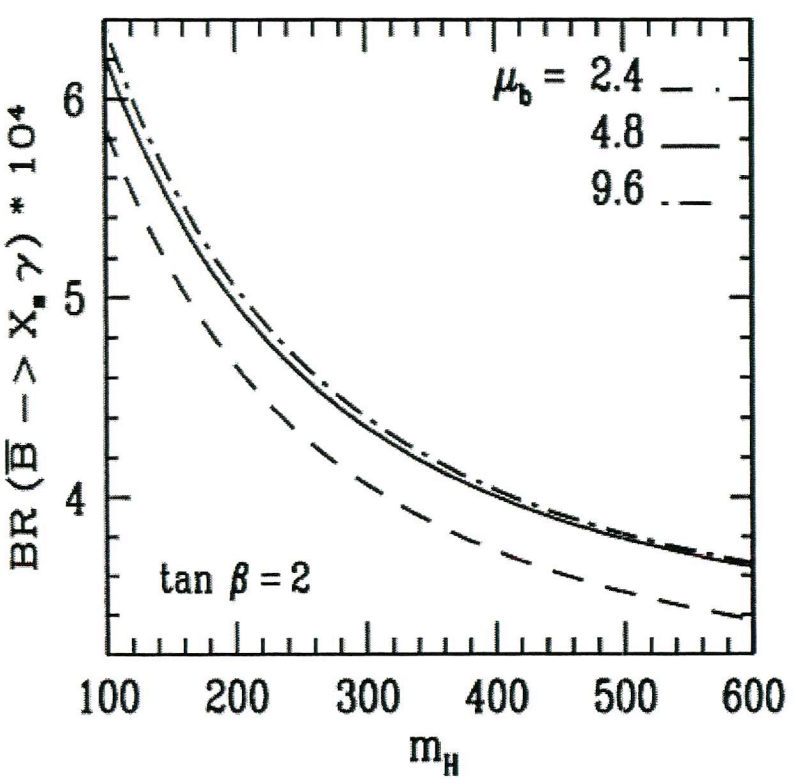
$$Br(B \to X_s\gamma) = (3.36 \pm 0.53(stat) \pm 0.42(sys)^{+0.50}_{-0.54}(th)) \times 10^{-4}$$

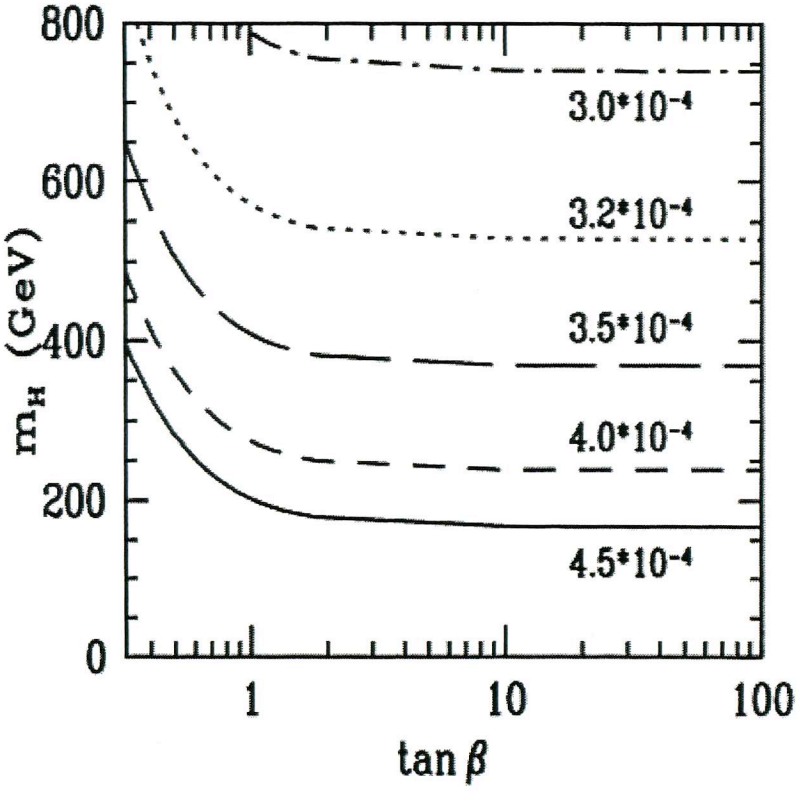
[PL B511, 151 (2001)]

⟺ SM: Br = ~3x10^{-4} with 10% uncertainty
Acp = 0.5%
(to be measured with 1% error with 1000fb^{-1}.)

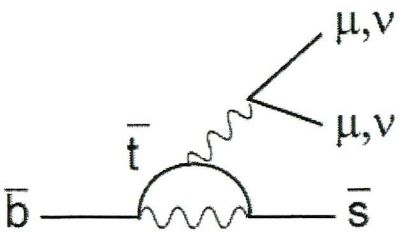
$B \to X_s\gamma$ and $H^{+/-}$

Borzumati and Greub



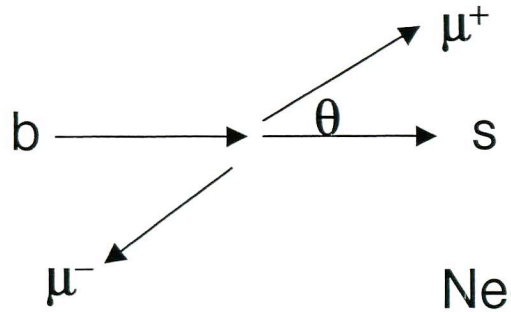


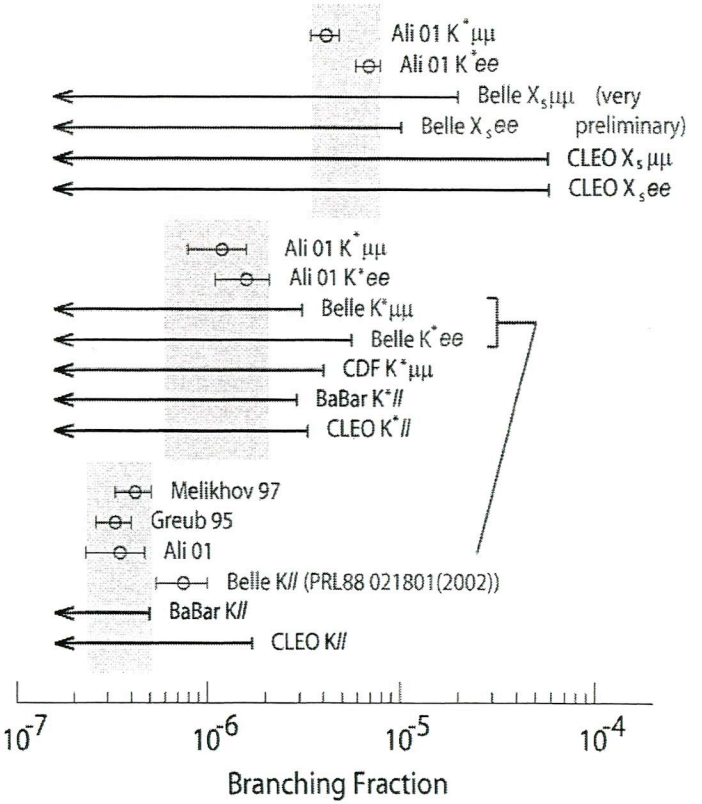
SUSY in EW penguin (2)



+ H^+ , SUSY particles??

- Precise Br
- $M_{\mu\mu}$, $M_{\nu\nu}$ distributions
- F/B charge asymmetry

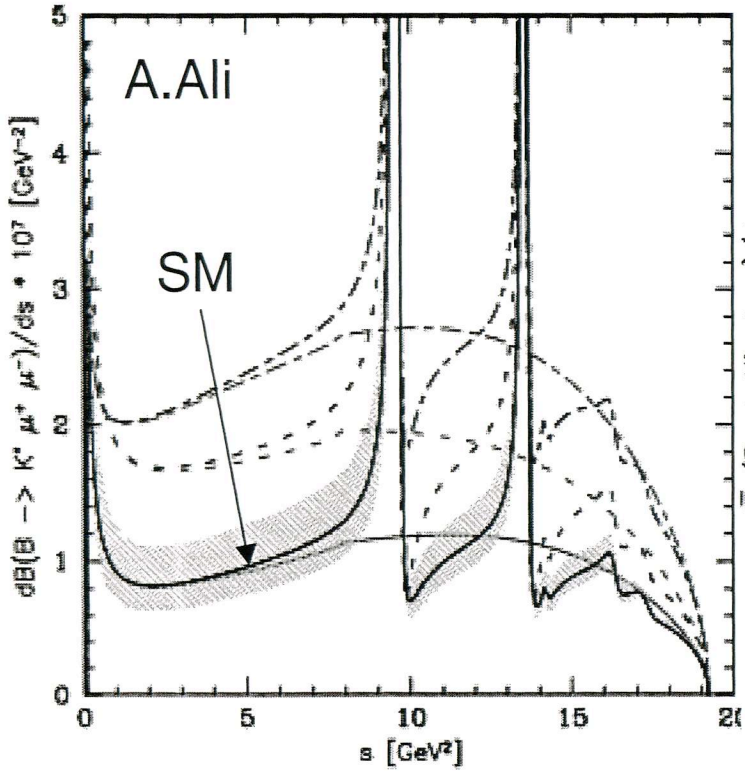




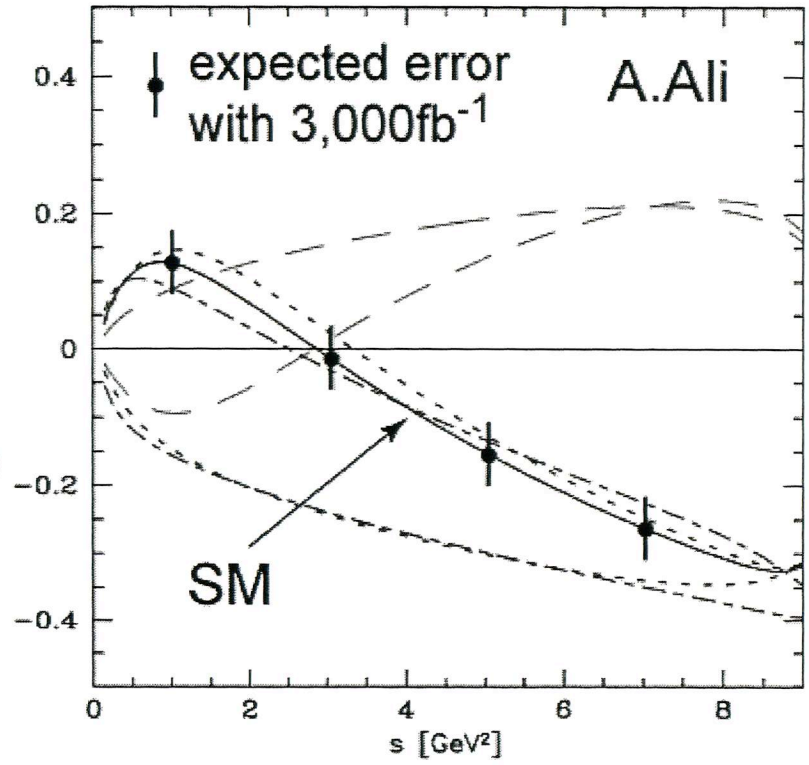
Need a few x 1000 fb^{-1}

$B \to K^* \mu\mu$

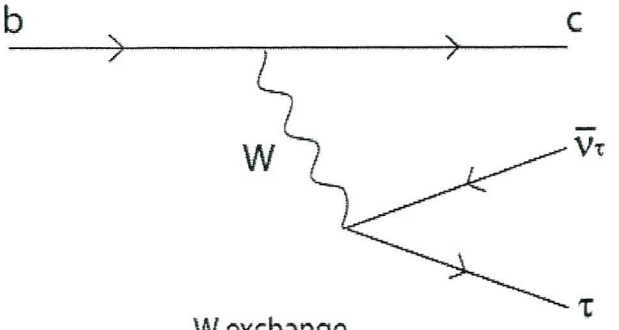
m(μμ)^2 distribution



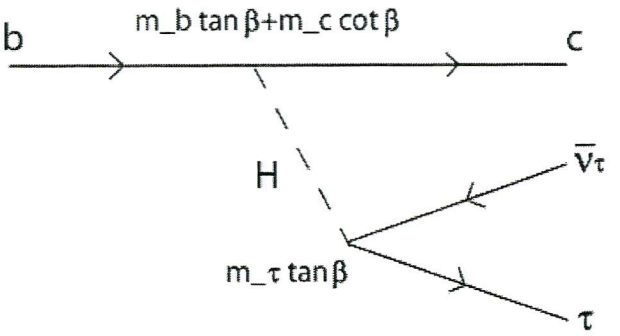
F/B asymmetry



$H^{+/-}$ in tree decay

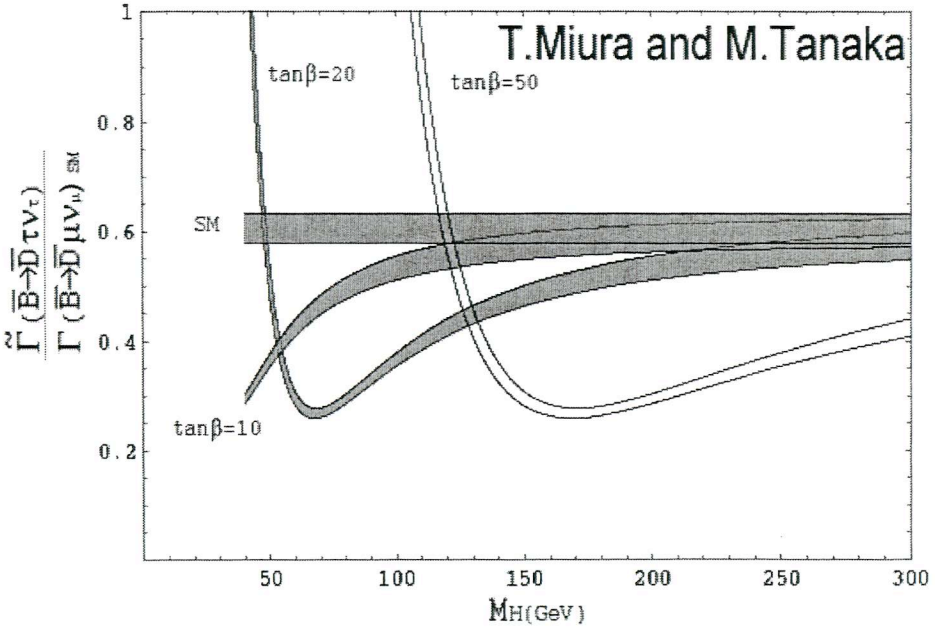


W exchange



charged Higgs exchange

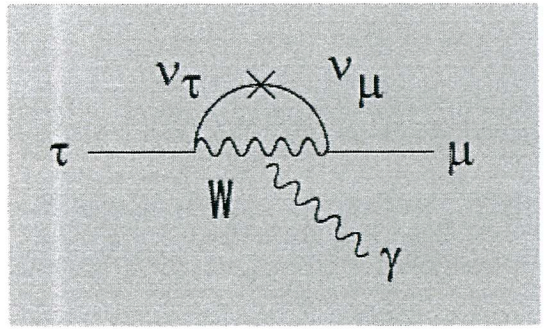
- Large Br of O(1)%
- Uncertainty in form factor cancels.
- τ polarization: exp. challenge



New physics in τ decay

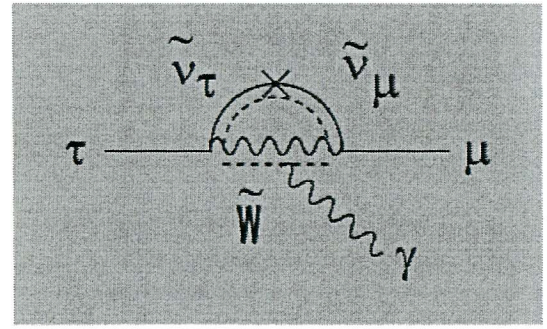
There is no transition among *e*, μ and τ in the standard model.

SM + ν mass



Extremely small

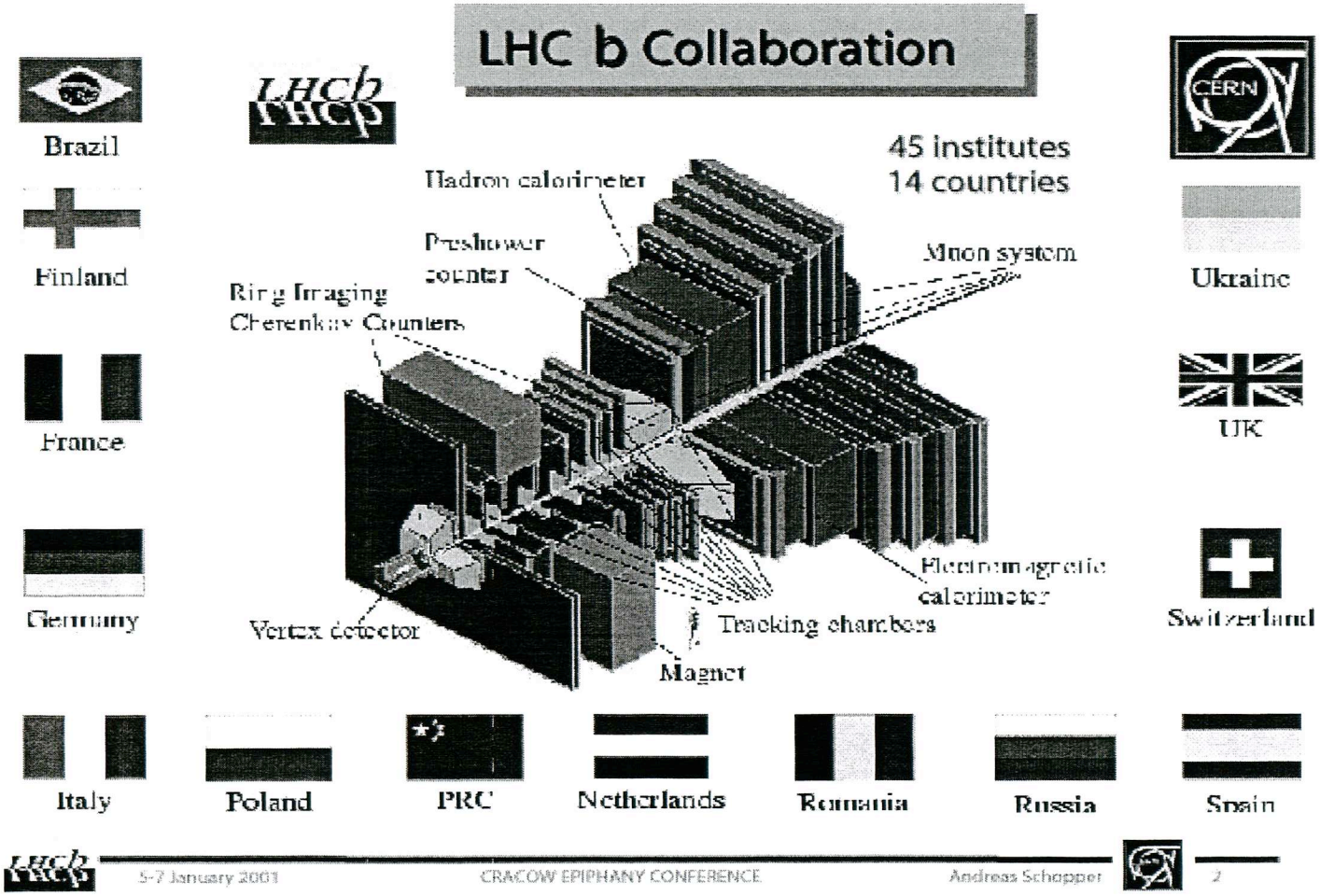
SUSY



$BR \sim 10^{-6} - 10^{-12}$

- This measurement is not difficult in e^+e^- experiment, if *L* is high enough.
- Similar to μ → *e*γ measurements.

Competition with hadronic B factories



Possible scenario (1)

To compete with the hadronic *B* factories (LHCb and BTeV):

- look at *B* decays including γ / π^0 or (multiple) ν's,
- look at ϕ inclusive decays, and
- measure inclusive decays.

For these purposes:

- hermeticity of the detector,
- topological vertex reconstruction, and
- low background EM cal are important.

Possible scenario (2)

- Before discovery of SUSY at LHC or LC:

  - Search for the hints in B decays and give tighter constraints to the models.

- After discovery of SUSY:

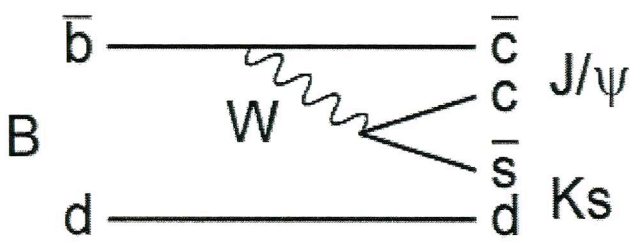
  - Measure SUSY couplings including complex phases.

  "Supersymmetric flavor physics"

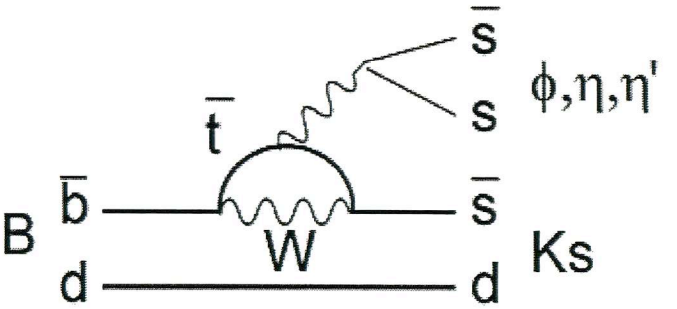
Looking for CP violation in SUSY

Test the difference between the tree and penguin phases.

$$\phi_1(B\to J/\psi Ks) \overset{?}{=} \phi_1(B\to \phi Ks) \quad : \text{YES in KM}$$

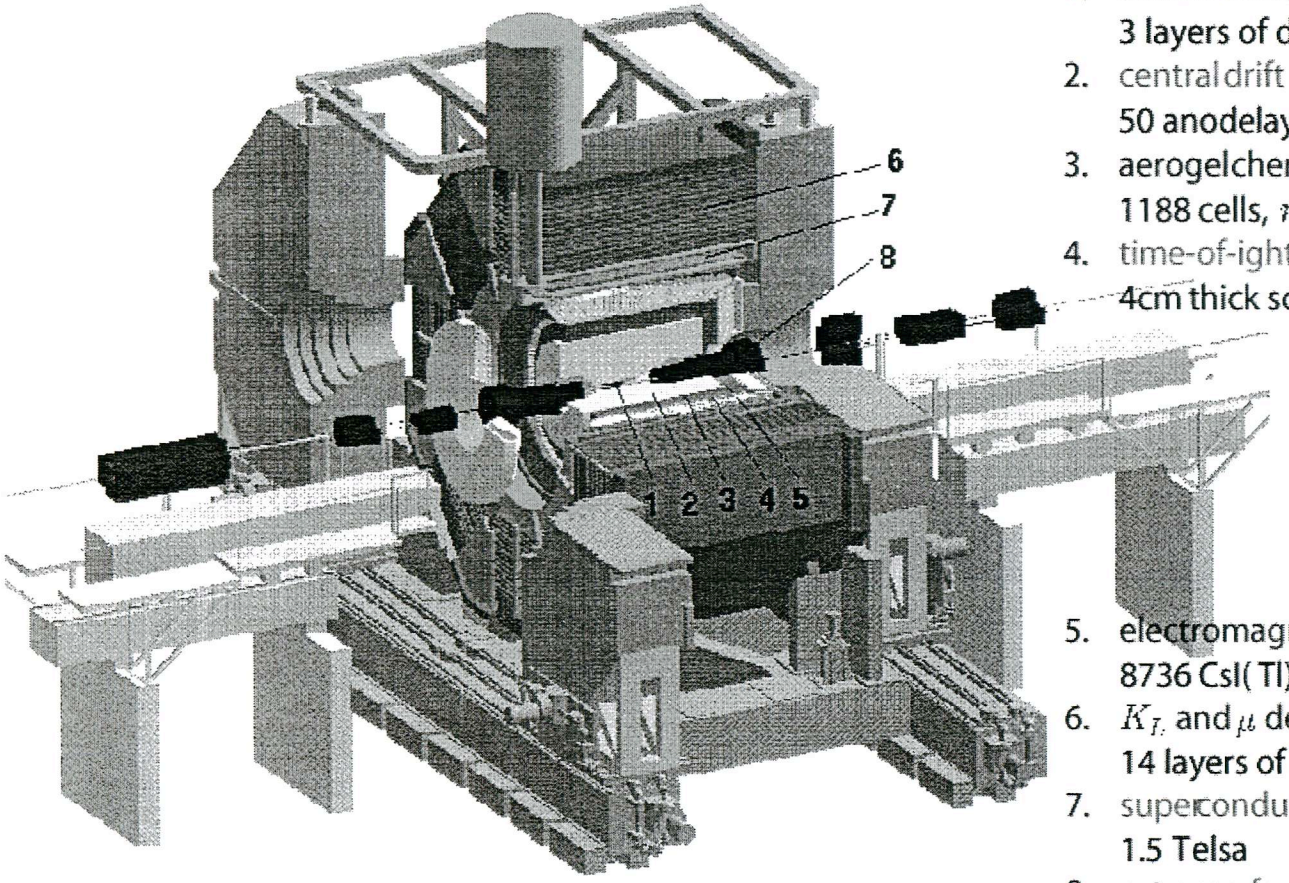


$\delta \sin 2\phi_1 \cong 0.05$
with 300 fb^{-1}



$\delta \sin 2\phi_1 \cong 0.15$
with 300 fb^{-1}

Detector – present Belle



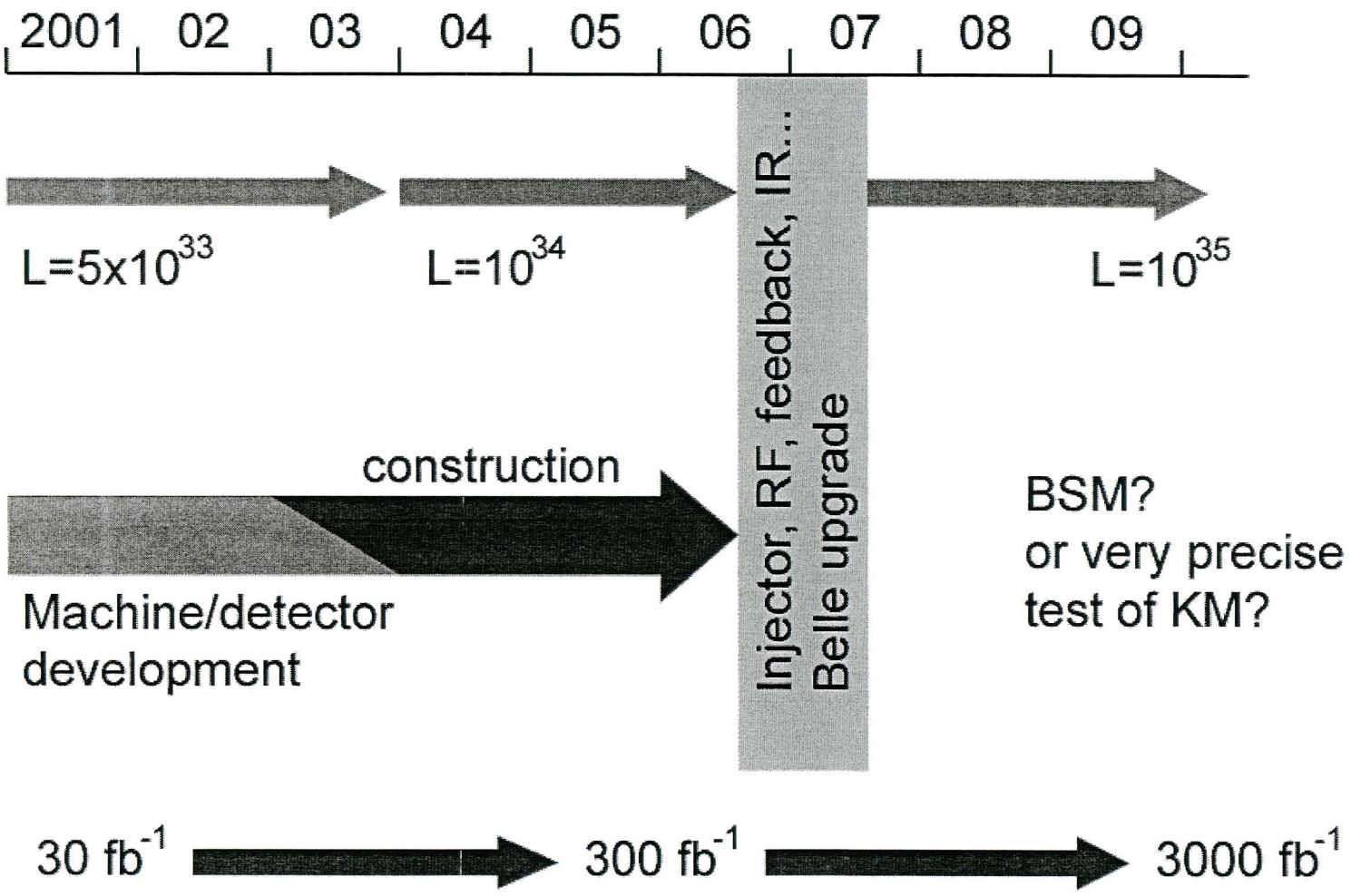
1. silicon vertex detector(SVD)
   3 layers of doublesided sensors
2. central drift chamber(CDC)
   50 anodelayers
3. aerogelcherenkov counters(ACC)
   1188 cells, $n = 1.01$ to 1.03
4. time-of-ight counters(TOF)
   4cm thick scintillator, 128 in ϕ
5. electromagneticcalorimeter(ECL)
   8736 CsI(Tl) crystals
6. K_L and μ detector(KLM)
   14 layers of glass RPC in iron yoke
7. superconductingsolenoid
   1.5 Telsa
8. extreme-forward calorimeter(EFC)
   320 BGO on topof nal focus quad

Detector upgrade

Higher luminosity collider will lead to:

- Higher background
  - radiation damage and occupancy in the vtx. detector
  - fake hits in the EM calorimeter
  - radiation problem in the tracker and $K_L\mu$ detector
- Higher event rate
  - higher rate trigger, DAQ and computing
- Require special features to the detector.
  - low p μ identification ← s$\mu\mu$ reconstruction eff.
  - hermeticity ← ν "reconstruction"

Schedule – an example



Summary

A possible extension of KEKB/Belle is considered to search for New Physics in *B* decays.

- Precise test of KM unitarity triangle
- Test of SUSY effects in penguin loop
- Search for $H^{+/-}$ in *B* decays

These are competitive with the hadronic B factories.

- Machine design is going on. The target date will be ~2006.
- Work on detector design and physics reach study are also going on.