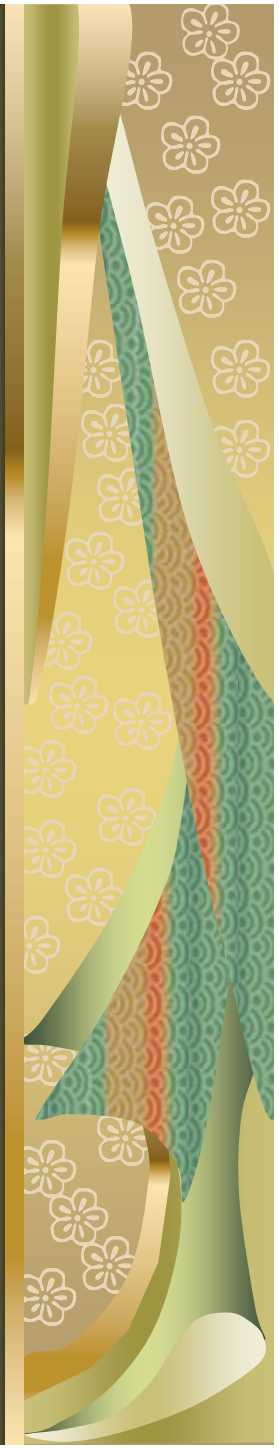
Future B Physics Program at KEK

May 16, 2008

Seminar at Valencia

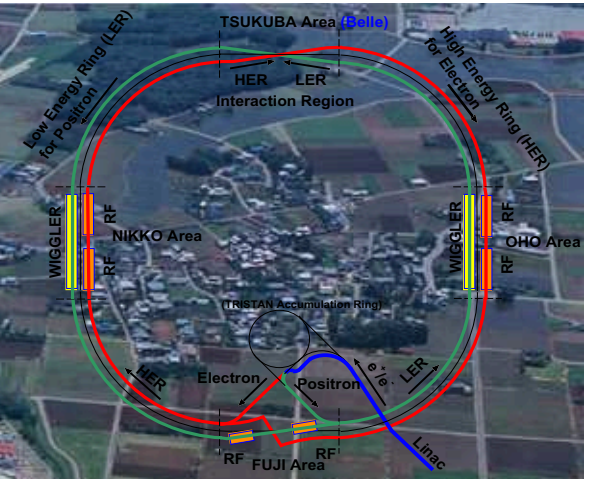
Masa Yamauchi
KEK

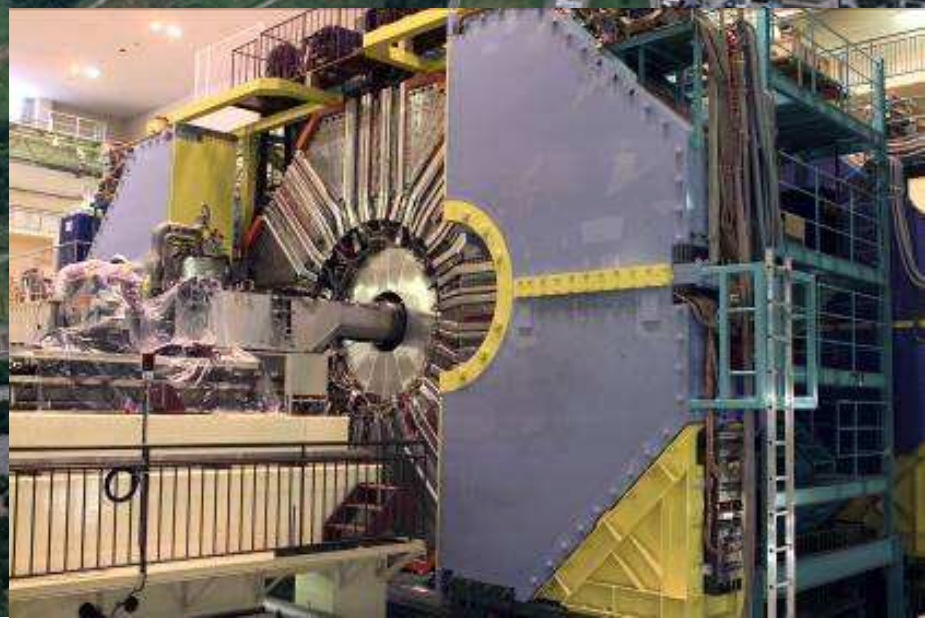


Outline

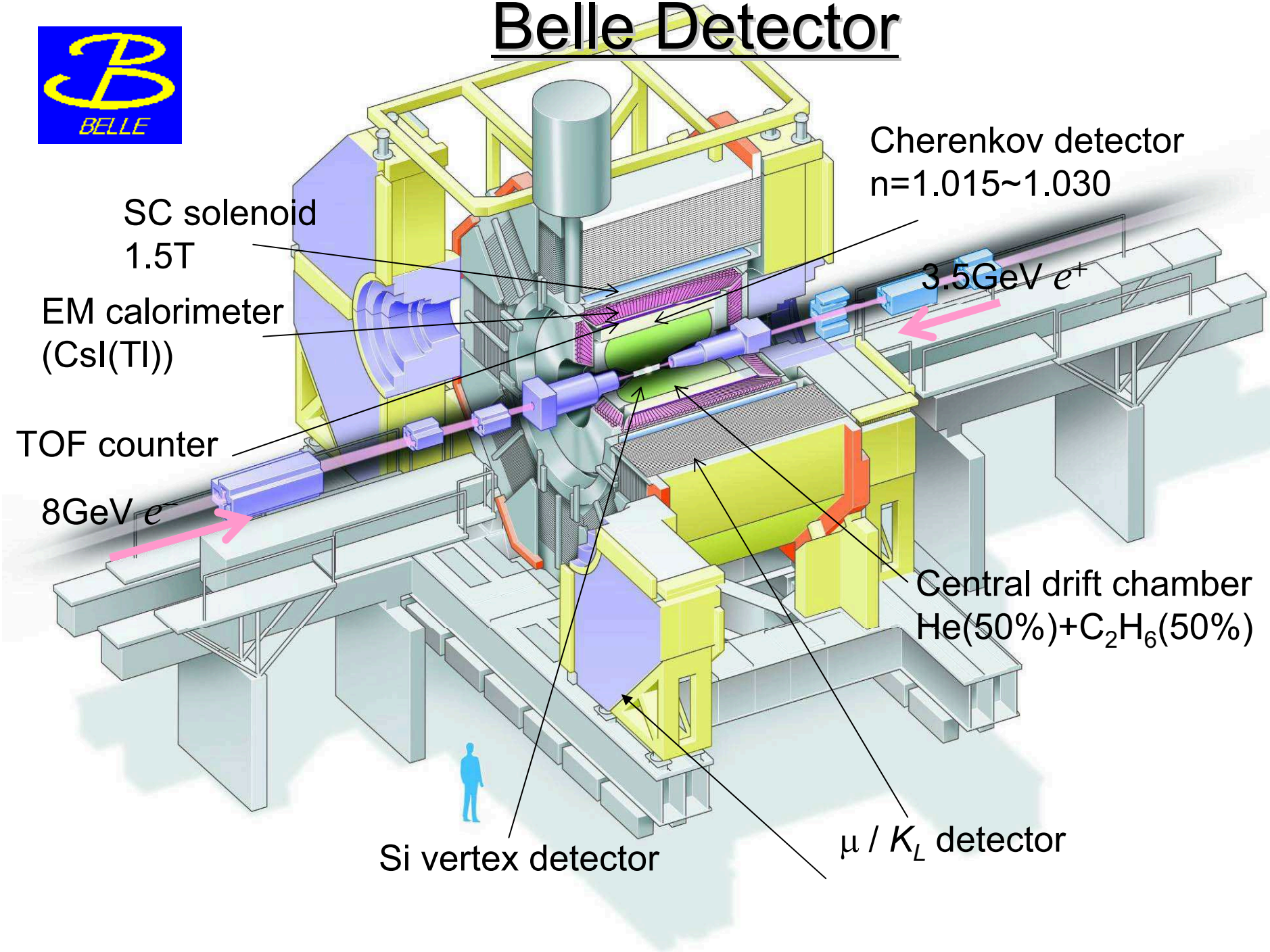
- Introduction: KEKB and Belle
- Achievements of Belle
- Physics case for KEKB/Belle upgrade
- KEKB upgrade plan
- Detector issues
- Long term strategy
- Summary

KEKB and Belle





Belle Detector

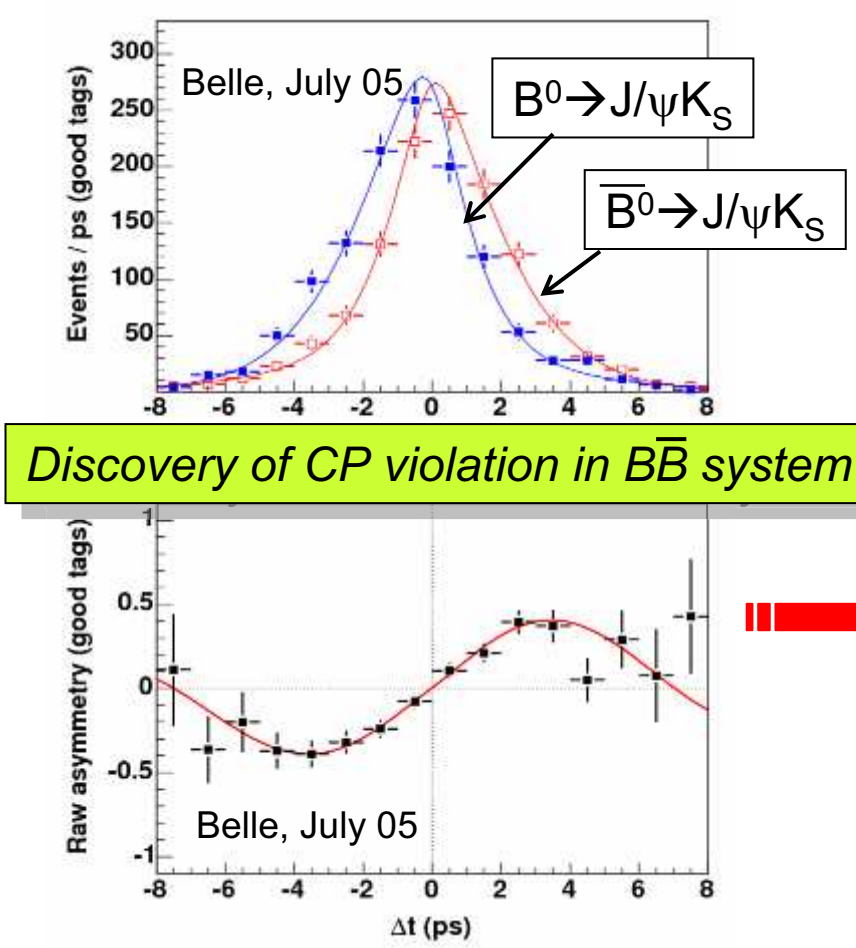


Belle Collaboration

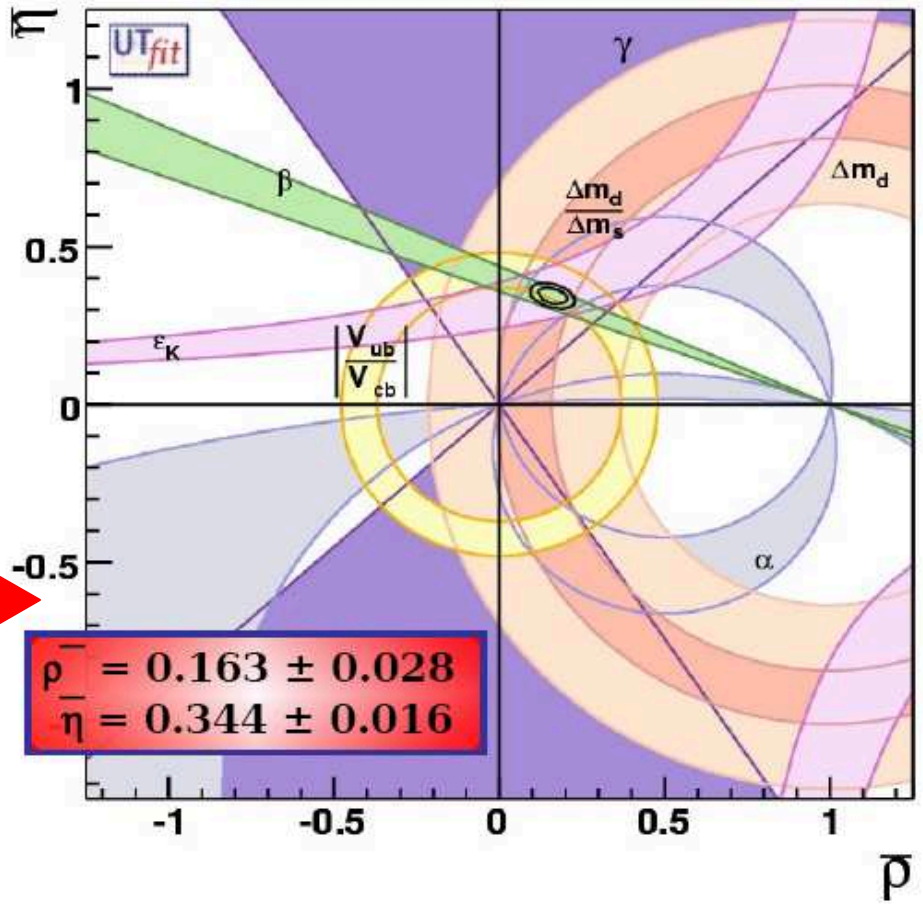
BINP
Chiba U.
Hanyang U.
U. of Cincinnati
Ewha Women's U.
Fu-Jen U.
Giessen U.
Gyeongsang Nat'l U.
U. of Hawaii
Hiroshima Tech.
HEPHY, Vienna
IHEP, Protvino
IHEP, Beijing
INFN, Torino
ITEP
Kanagawa U.
KEK
Korea U.
Krakow Inst. of Nucl. Phys.
Kyoto U.
Kyungpook National U.
U. of Lausanne
Jozef Stefan Inst.
U. of Melbourne
Nagoya U.
Nara Women's U.
National Central U.
National United U.
National Taiwan U.
Nihon Dental College
Niigata U.
Nova Gorica U.
Osaka U.
Osaka City U.
Panjab U.
Peking U.
Princeton U.
Illinois U. - Riken
Saga U.
USTC
Seoul National U.
Shinshu U.
Sungkyunkwan U.
U. of Sydney
Tata Institute
Toho U.
Tohoku U.
Tohuku Gakuin U.
U. of Tokyo
Tokyo Inst. of Tech.
Tokyo Metropolitan U.
Tokyo U. of A and T.
Toyama Nat'l College
U. of Tsukuba
VPI
Yonsei U.

Achievement of the *B* Factories

Quantitative confirmation of the KM model

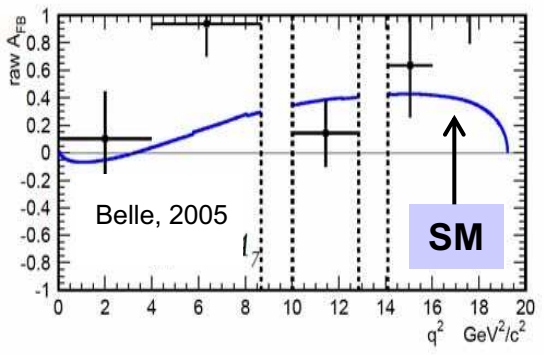


Discovery of CP violation in $B\overline{B}$ system

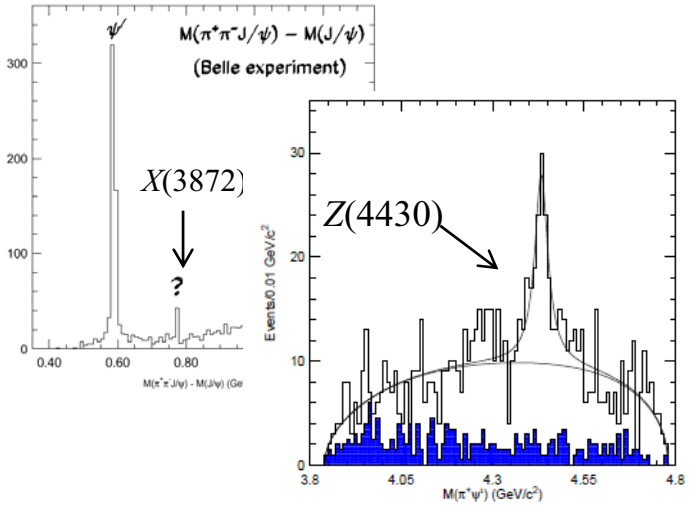


Other highlights

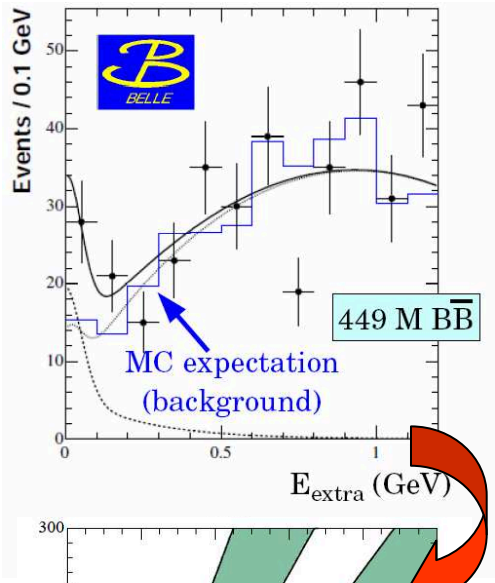
A_{FB} in $B \to K^* l^+ l^-$

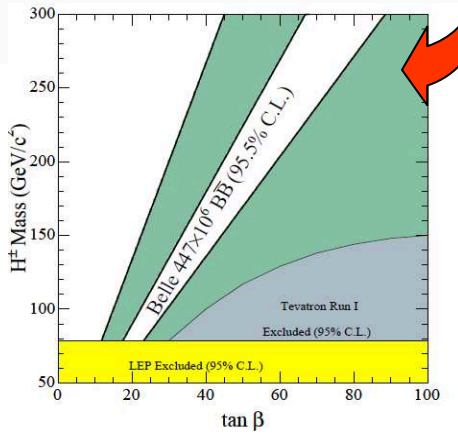


Many new resonances

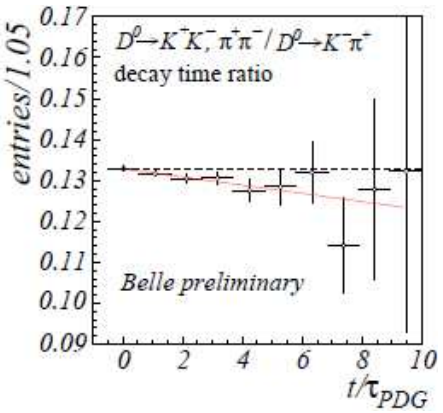


Evidence for $B \to \tau\nu$



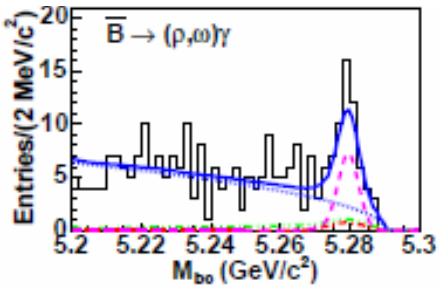


D^0-$\overline{D^0}$ mixing

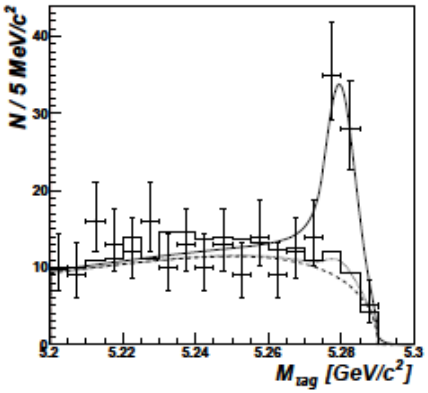


$y_{CP} = 1.31 \pm 0.32 \pm 0.25$ %

$b \to d\gamma$ transition



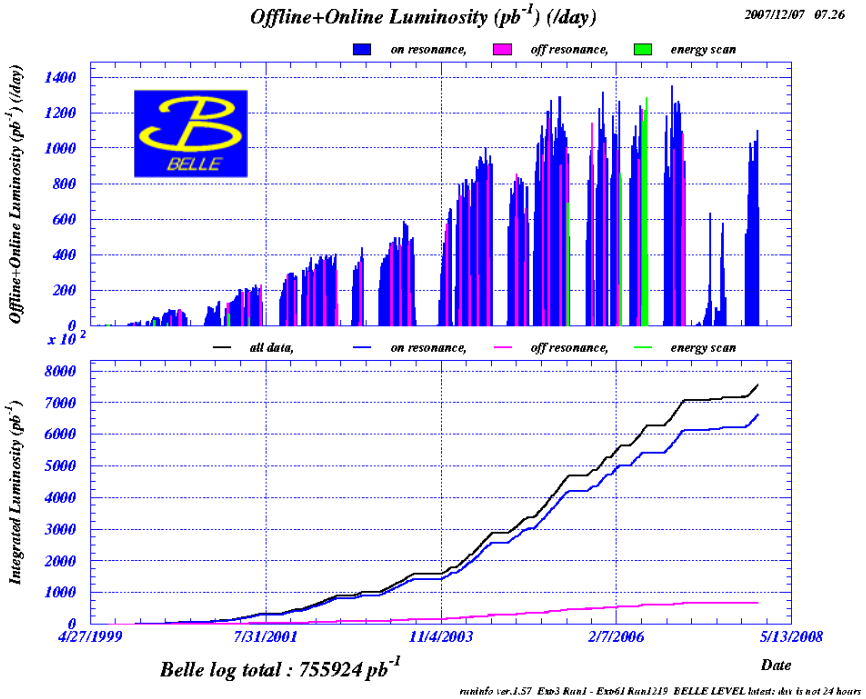
$B \to D^* \tau\nu$

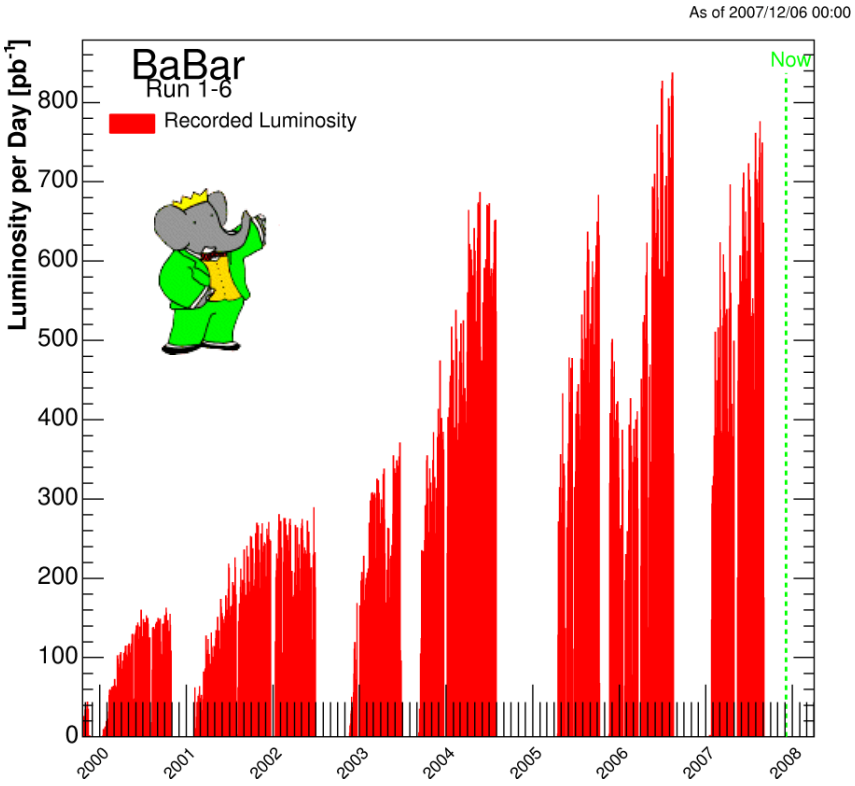


and more…

Another important achievement

Asymmetric e^+e^- collider with $L > 10^{34}$





- Success of KEKB and PEP-II enabled us to design a new e^+e^- *B* factory with much higher $L_{\rm peak}$.

What is next with flavour physics?

- If new physics at O(1)TeV…
  - It is natural to assume that the effects are seen in $B/D/\tau$ decays.
  - Flavour structure of new physics?
  - CP violation in new physics?
  - These studies will be useful to identify mechanism of SUSY breaking, if NP=SUSY.

- Otherwise…
  - Search for deviations from SM in flavor physics will be one of the best ways to find new physics.

KEKB Upgrade Plan

- ***Asymmetric energy e^+e^- collider at E_{CM}=m(Υ(4S)) to be realized by upgrading the existing KEKB collider.***
- ***Initial target: 10× higher luminosity*** ***≅ 2×10^{35}/cm^2/sec*** **after 3 year shutdown**
  → 2×10^9 $B\bar{B}$ and $\tau^+\tau^-$ per yr.
- ***Final goal: L=8×10^{35}/cm^2/sec and $\int L\,dt$ = 50 ab^{-1}***



Crab cavity

8GeV e^-

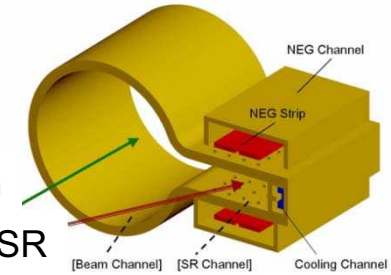
New IR with crab crossing and smaller β_y^*

3.5GeV e^+

New beam-pipes with ante-chamber

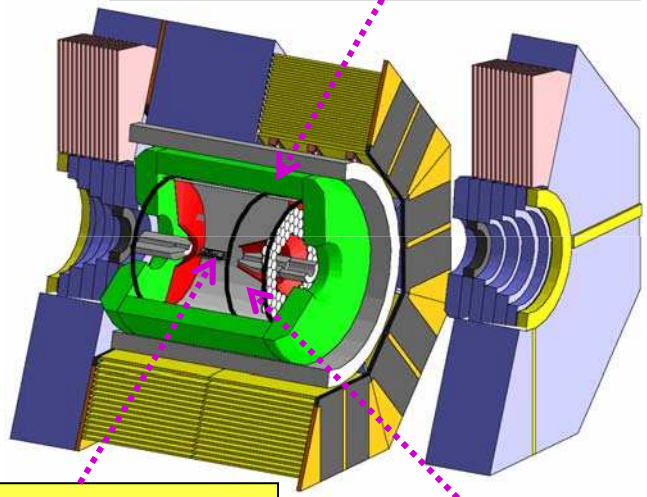
More RF for higher beam current

Damping ring for e$^+$



Belle with improved rate immunity

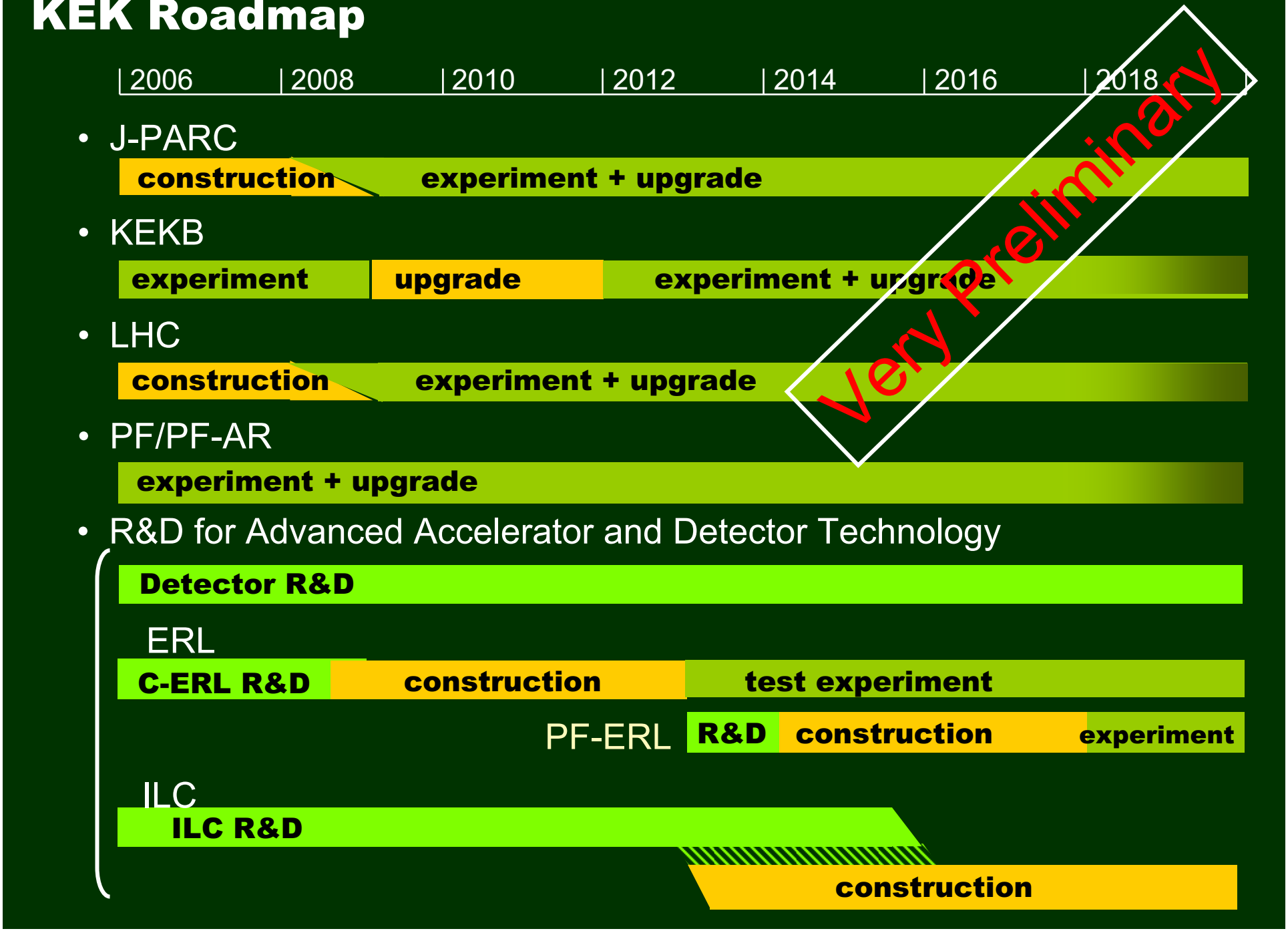
Faster calorimeter with wave form sampling and pure CsI

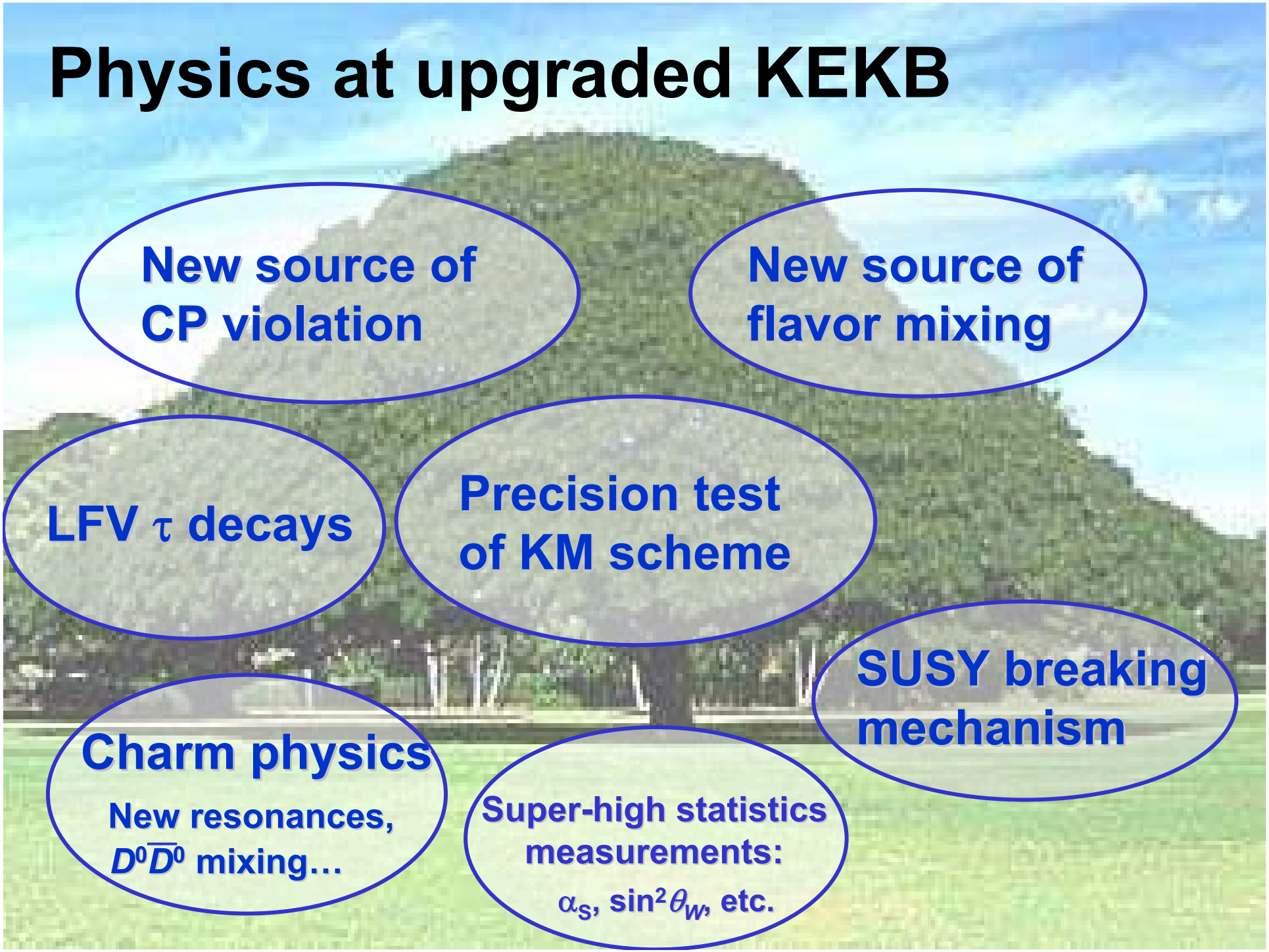


Si vertex detector with very short strips

Background tolerant small cell drift chamber

KEK Roadmap

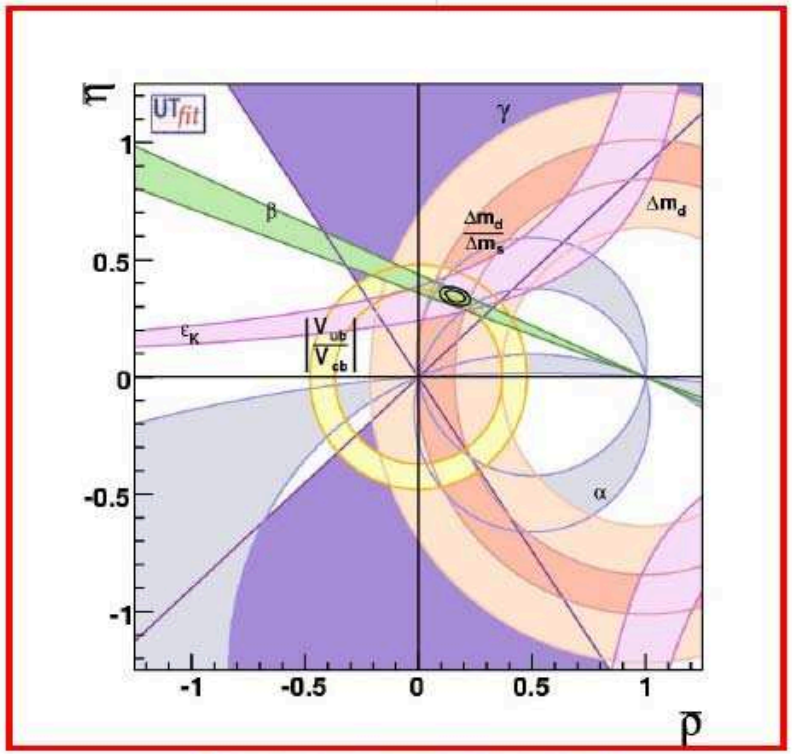

2006
2008
2010
2012
2014
2016
2018
Very Preliminary
J-PARC
construction
experiment + upgrade
KEKB
experiment
upgrade
experiment + upgrade
LHC
construction
experiment + upgrade
PF/PF-AR
experiment + upgrade
R&D for Advanced Accelerator and Detector Technology
Detector R&D
ERL
C-ERL R&D
construction
test experiment
PF-ERL
R&D
construction
experiment
ILC
ILC R&D
construction


Physics at upgraded KEKB
New source of CP violation
New source of flavor mixing
LFV τ decays
Precision test of KM scheme
SUSY breaking mechanism
Charm physics
New resonances, $D^0\overline{D}^0$ mixing…
Super-high statistics measurements:
α_S, $\sin^2\theta_W$, etc.

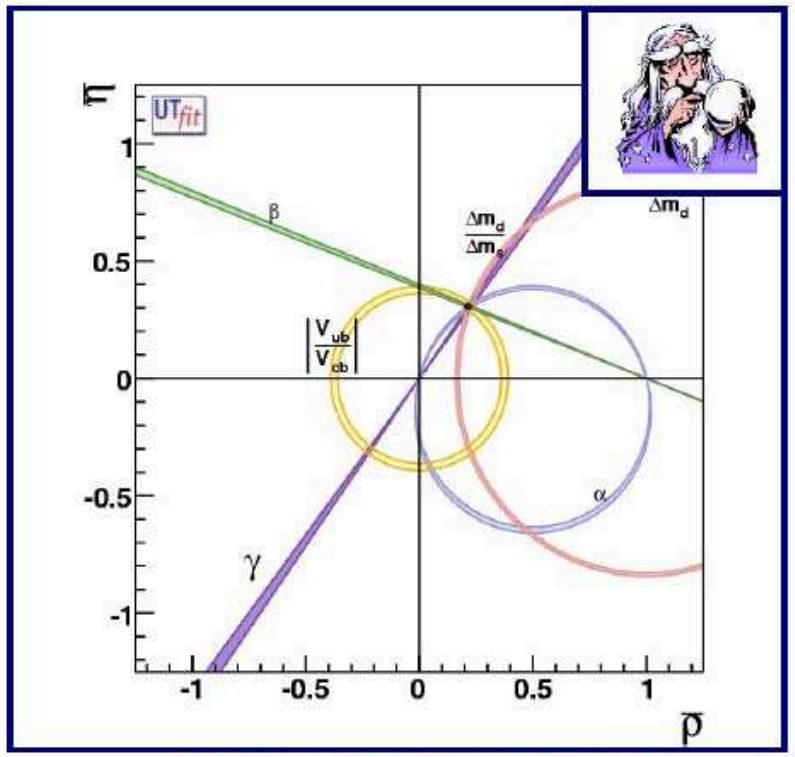
Precision test of KM scheme

UTfit in the SM: 2006 vs.2015

M.Pierini
CKM2006

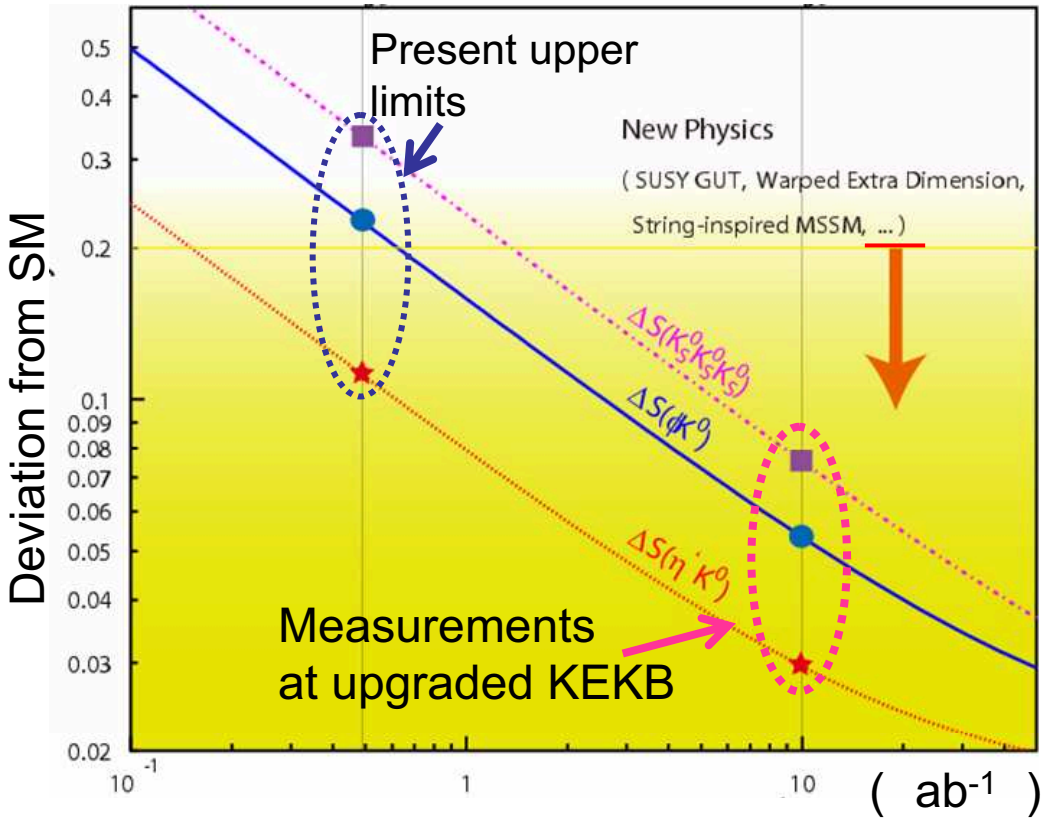


$\bar{\rho} = 0.163 \pm 0.028$
$\bar{\eta} = 0.344 \pm 0.016$



$\bar{\rho} = 0.2226 \pm 0.0028$
$\bar{\eta} = 0.3052 \pm 0.0024$

CP asymmetries of penguin dominated B decays



Deviation from SM

↓

New source of CP violation

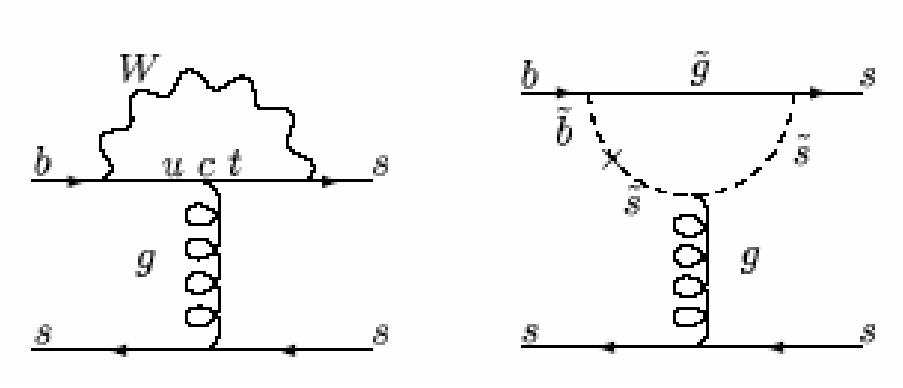
↓

Relevant to baryogenesis?

Search for new CP phases

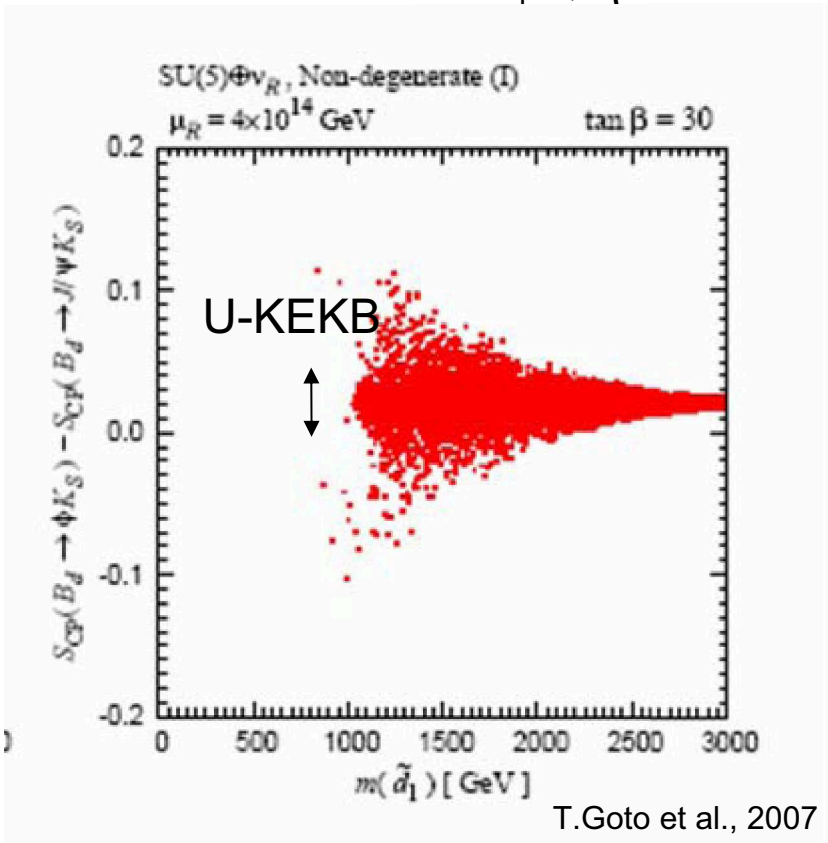
In general, new physics contains new sources of flavor mixing and CP violation.

- In SUSY models, for example, SUSY particles contribute to the $b \to s$ transition, and their CP phases change CPV observed in $B \to \phi K$, $\eta' K$ etc.



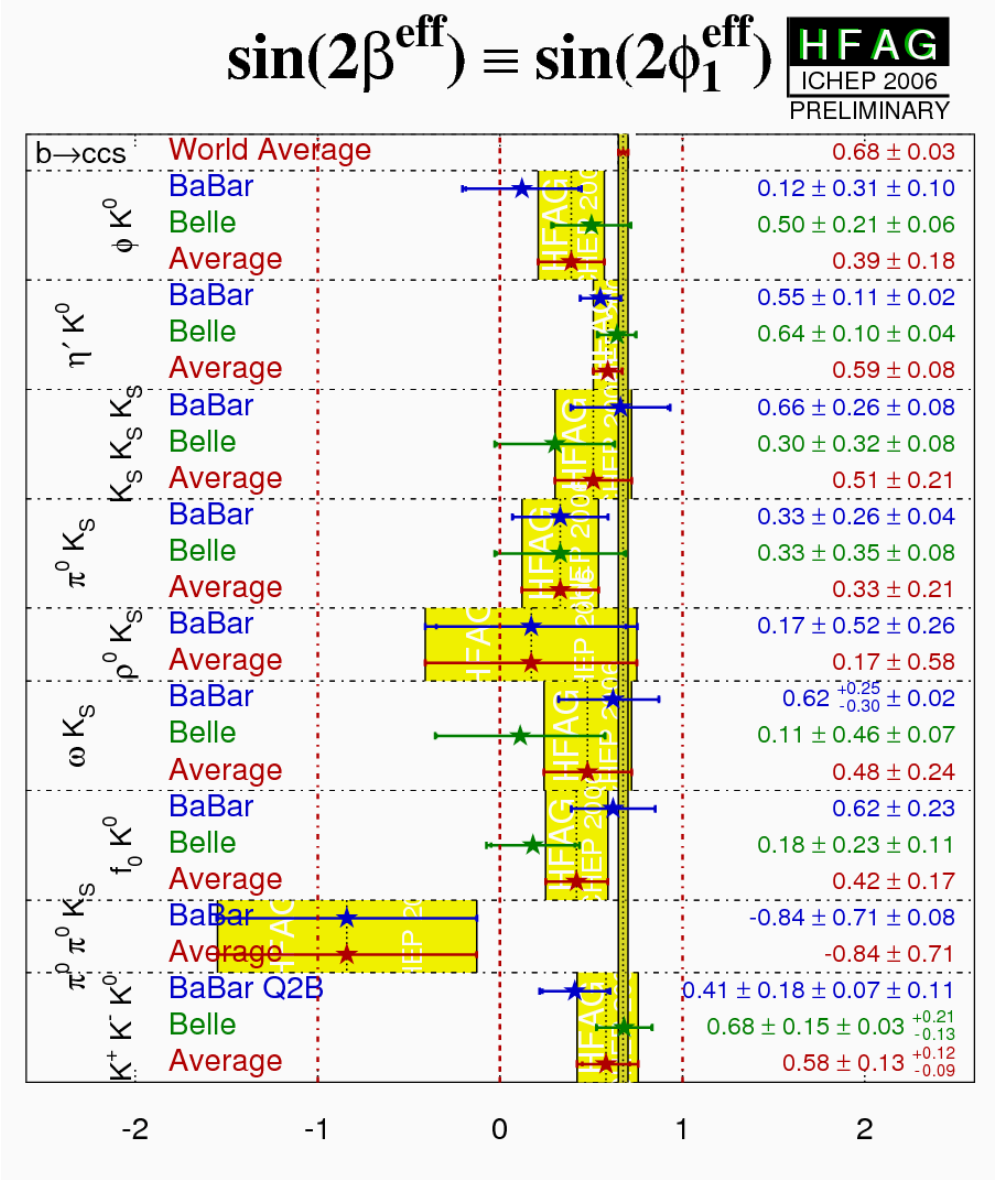
SM SUSY contribution

In general, if SUSY is present, the *s*-quark mixing matrix contains complex phases just as in the Kobayashi-Maskawa matrix.



T.Goto et al., 2007

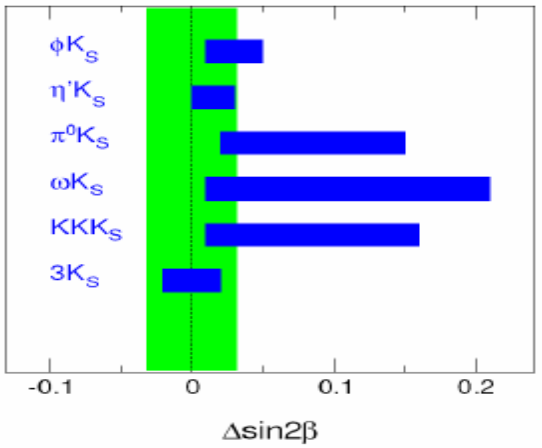
A possible hint for NP: $b \to s\bar{q}q$



Smaller than $b \to c\bar{c}s$ in all of 9 modes

some of recent QCDF estimates

$\sin2\beta^{f}_{eff} - \sin2\beta$



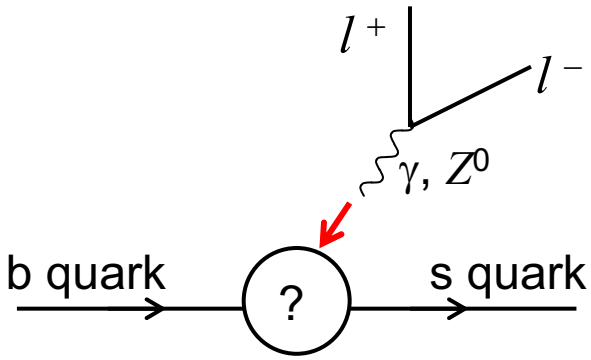
Theory : tends to positive shifts

Naïve average of all b → s modes

$\sin2\beta^{eff} = 0.52 \pm 0.05$

2.6 σ deviation from SM

Search for new flavor mixing



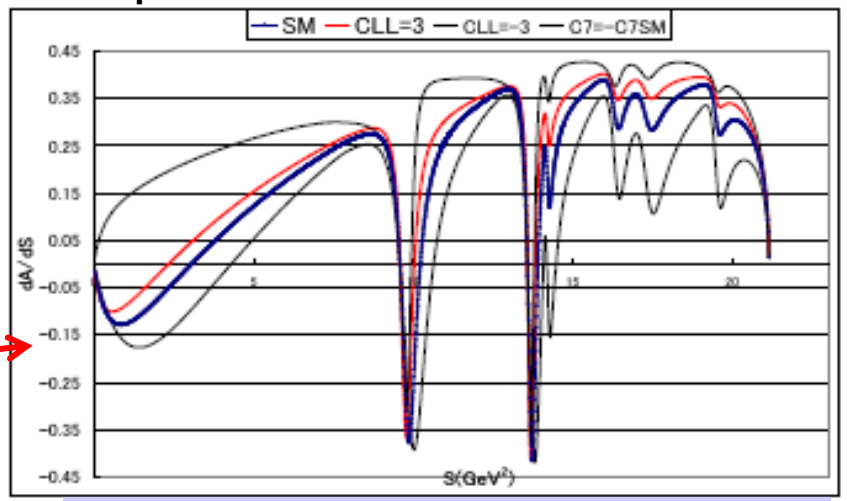
: Probe the flavor changing process with the “EW probe”.

This measurement is especially sensitive to new physics such as SUSY, heavy Higgs and extra dim.

Possible observables:

- Ratio of branching fractions
- Branching fraction
- CP asymmetry
- q^2 distribution
- Isospin asymmetry
- Triple product correlation
- Forward backward asymmetry
- Forward backward CP asymmetry

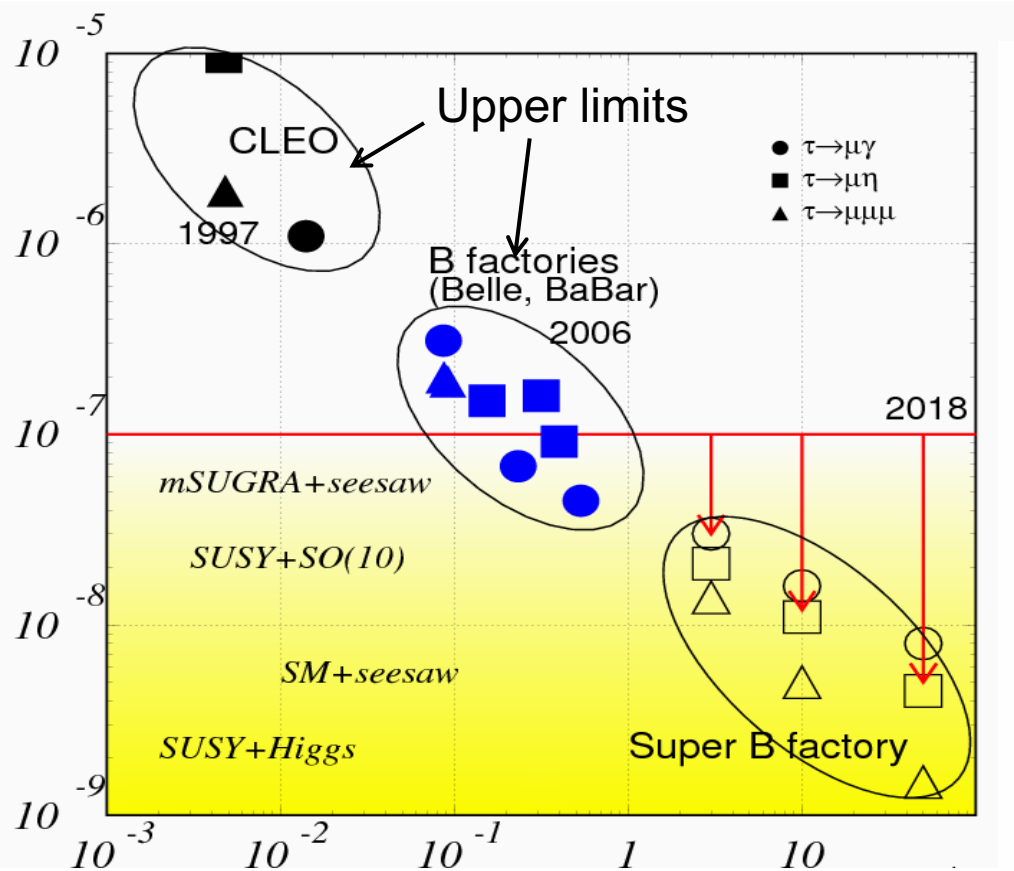
Theoretical predictions for l^+l^- forward-backward charge asymmetry for SM and SUSY model with various parameter sets.

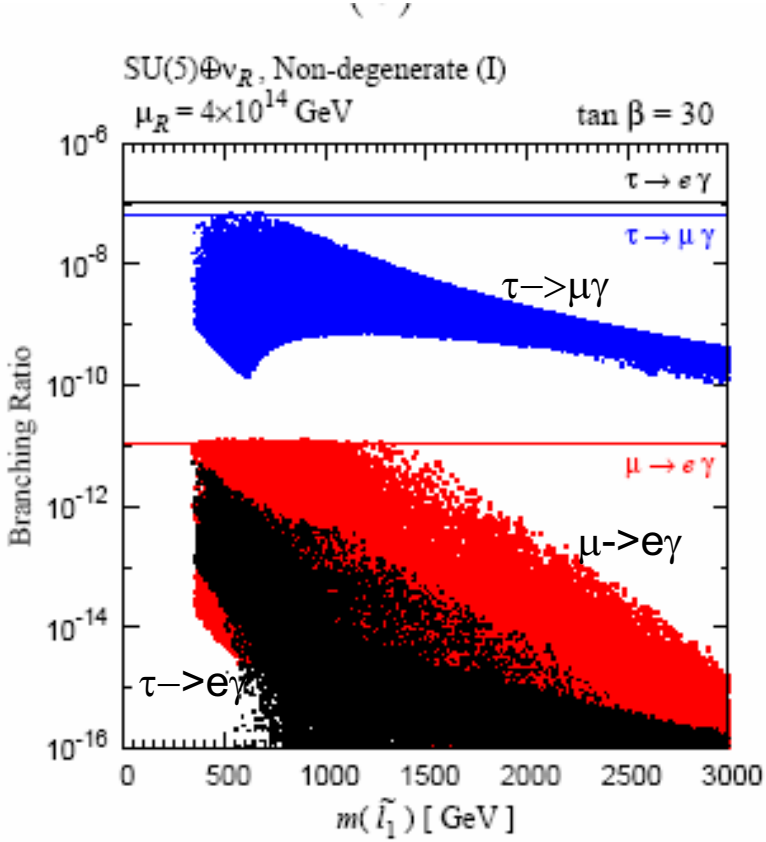


The F/B asymmetry is a consequence of γ-Z^0 interference.

Precise measurements of τ decays

LFV violating τ decay?

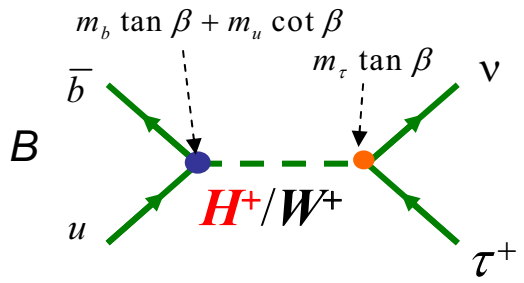




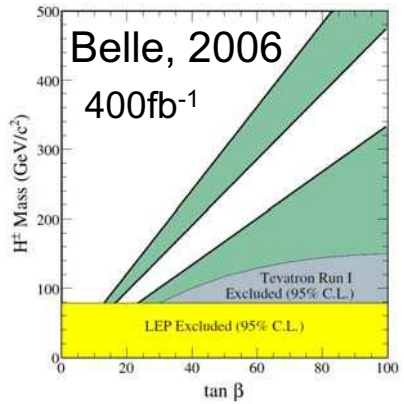
T.Goto et al., 2007

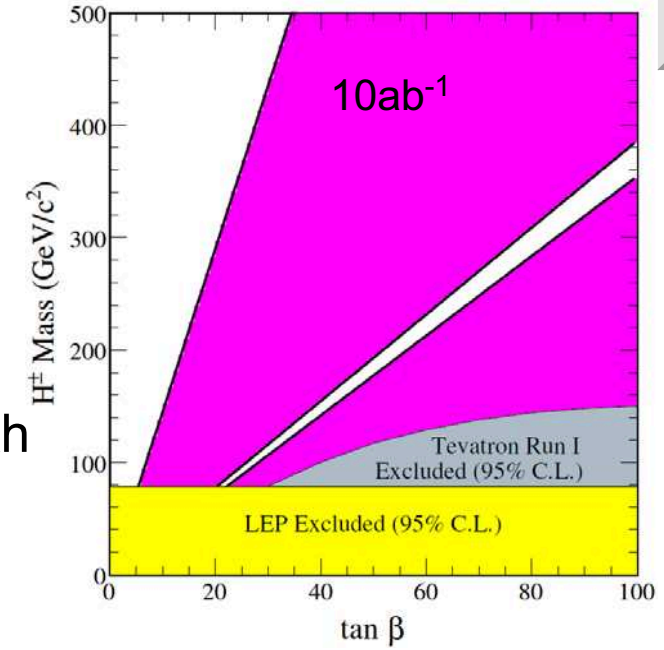
B decays with more than one ν

Interactions of H±

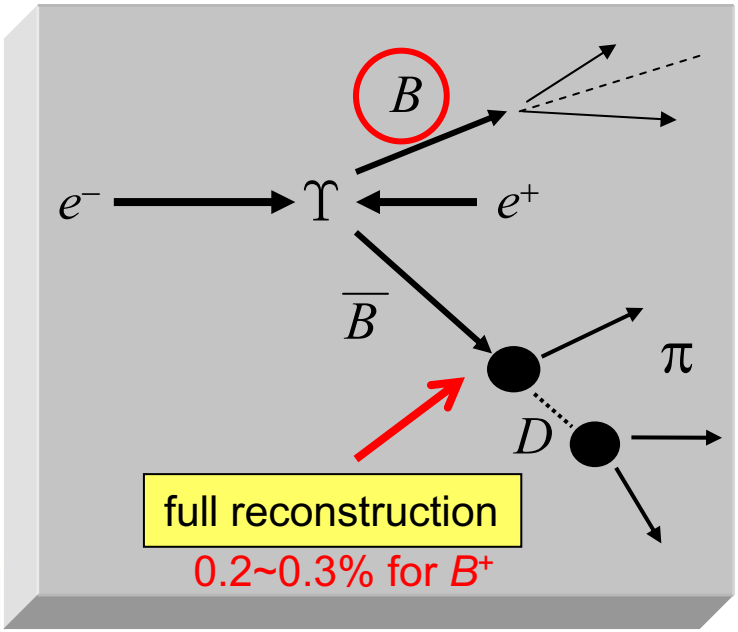


$B\to\tau\nu$ decays





Search region with
$B\to\tau\nu$ decays



Provides a unique method to measure b-$H^\pm$-u and b-$H^\pm$-c coupling strength.

Identification of SUSY breaking scenario

Pattern of deviations from the Standard Model

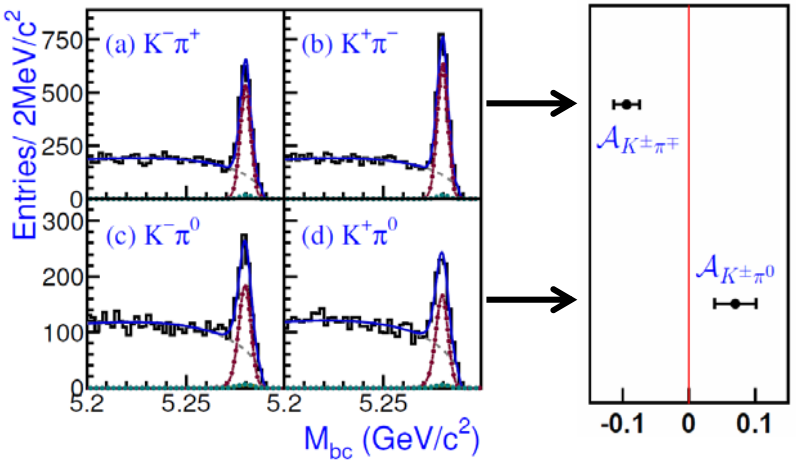
Y.Okada

SUSY models \ Observ-ables	Unitarity triangle	$B \to \phi K_S$	$b \to s\gamma$ Indirect CPV	$b \to s\gamma$ Direct CPV	$\tau \to \mu\gamma$
mSUGRA	–	–	–	–	–
SU(5) SUSY GUT + ν_R (degenerate)	–	–	+	–	–
SU(5) SUSY GUT + ν_R (non-degenerate)	+	+	+ +	–	+ +
U(2) Flavor symmetry	+	+	+ +	+	

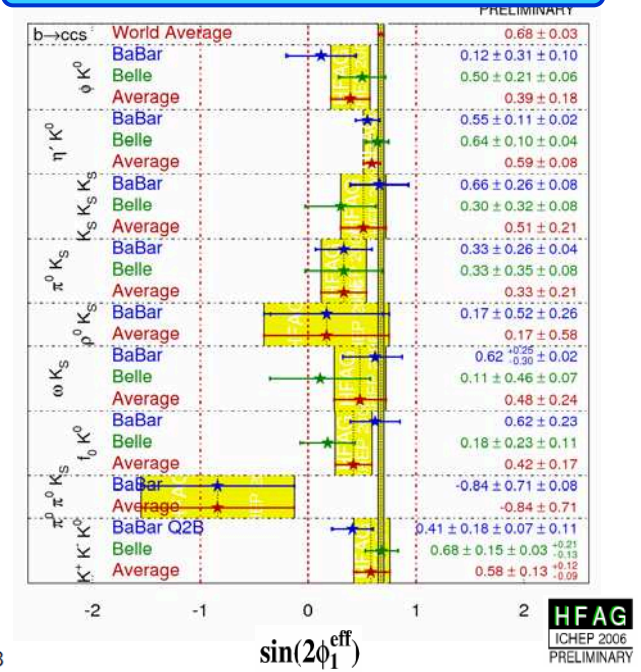
+ +: large + : sizable – : small

Possible Hints for New Physics in Flavor Decays

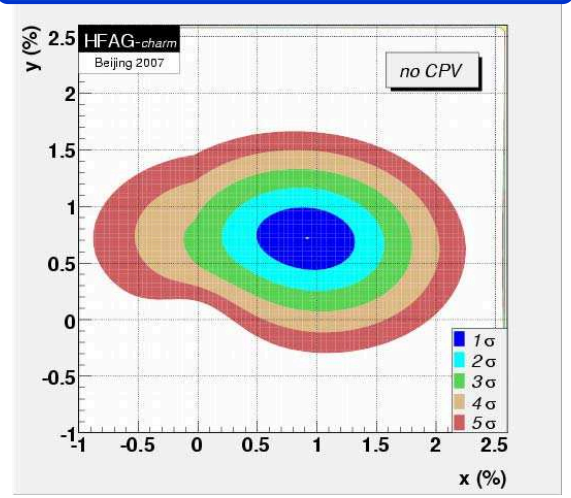
Opposite CP asymmetry between B^0 and $B^\pm$



Anomalous CPV in $b \to s$ transition?

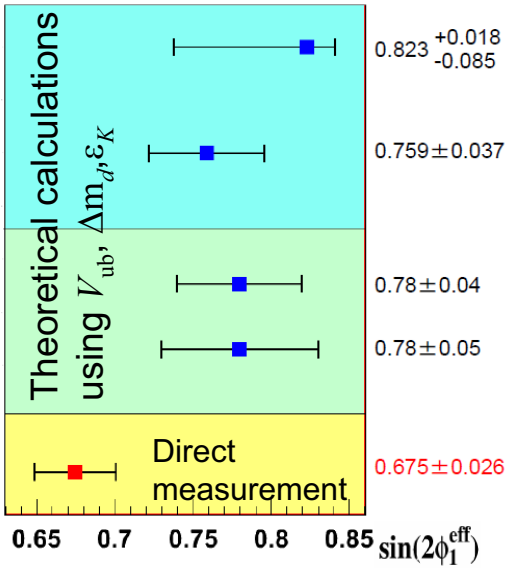


Unexpectedly large $D^0\overline{D}^0$ mixing

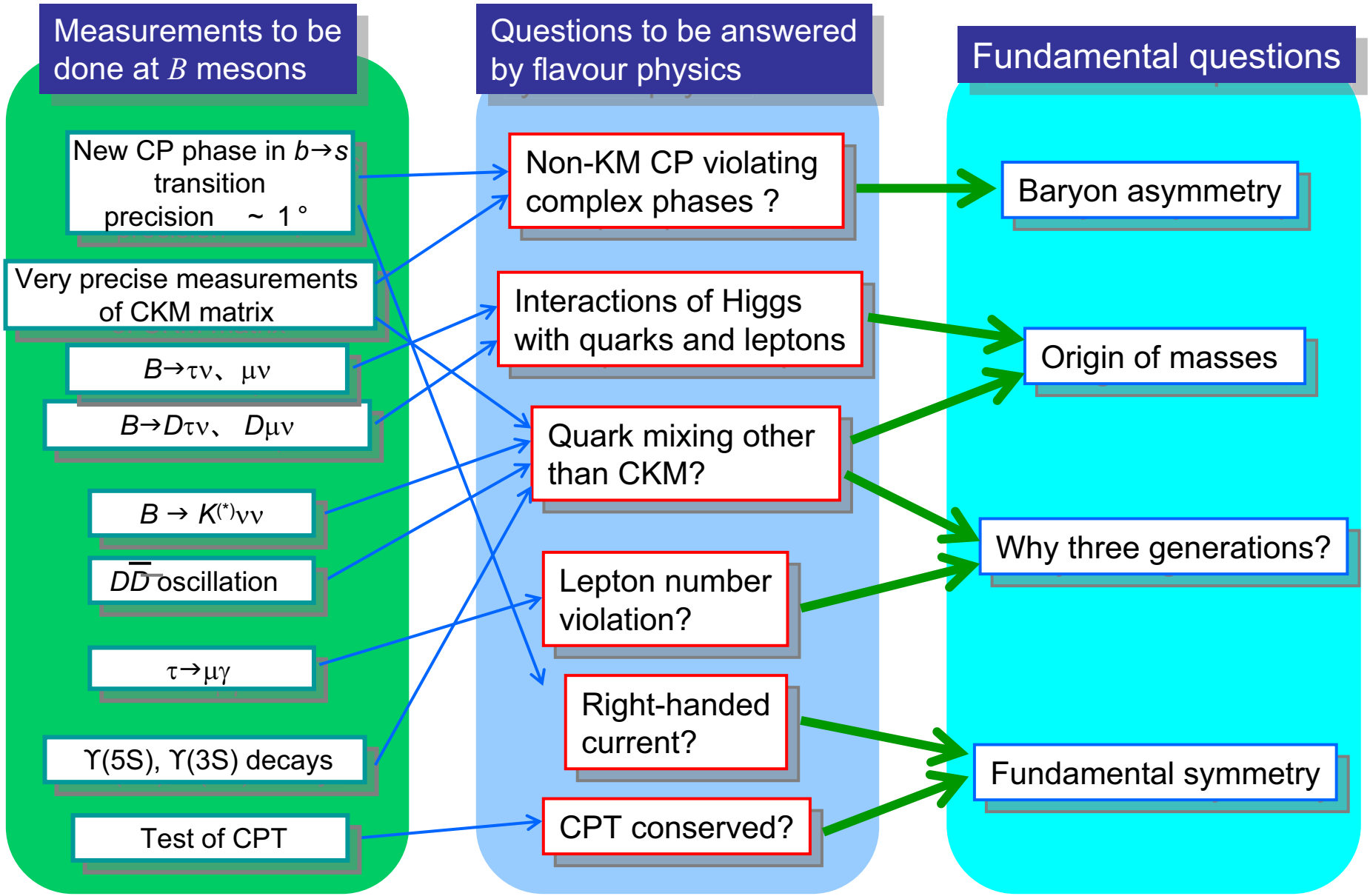


x=(0.97±0.29)%, y=(0.78±0.19)%

Small inconsistency in the unitarity triangle?



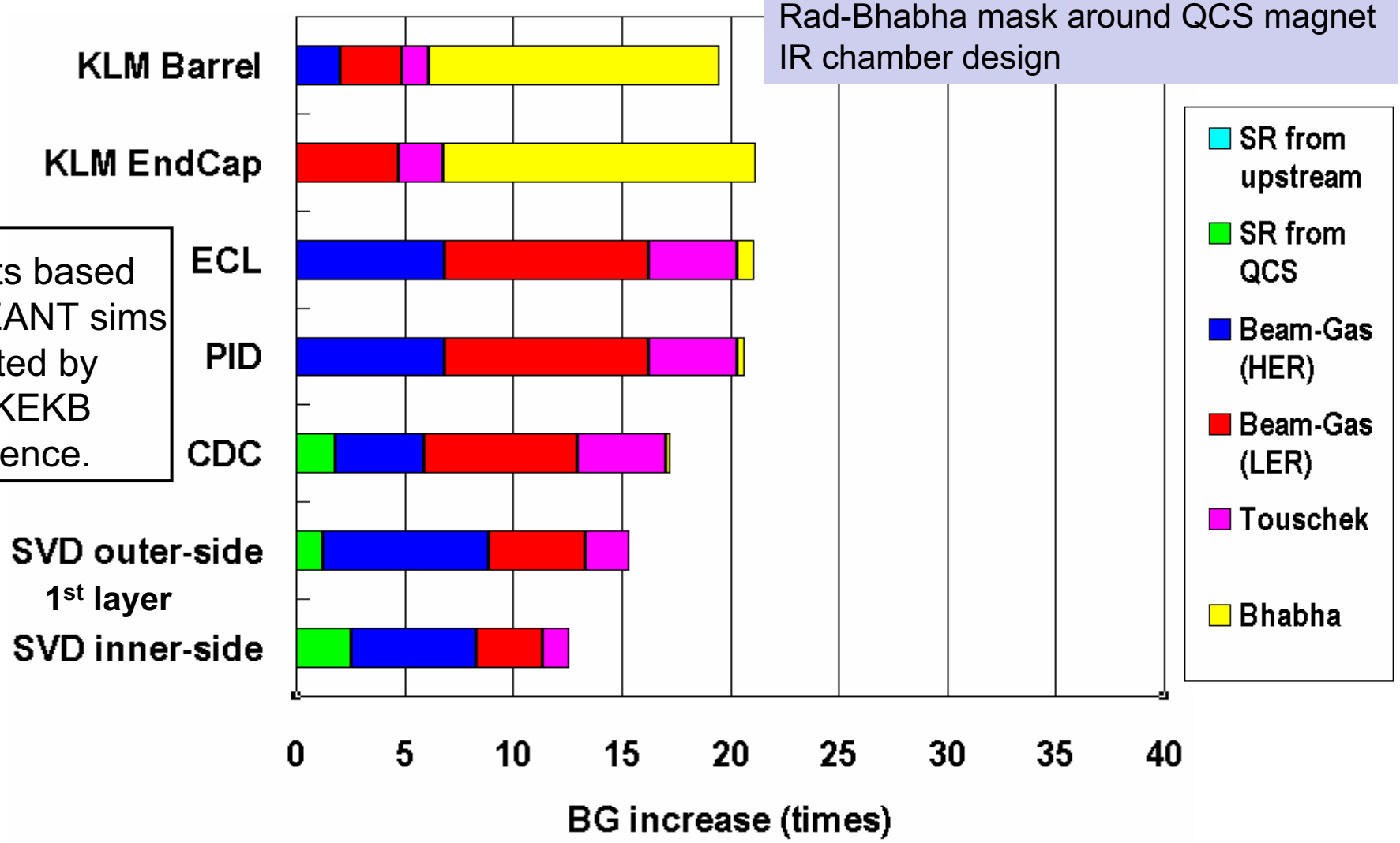
B physics' approach to the fundamental questions



Beam Background (after 1st optimization)

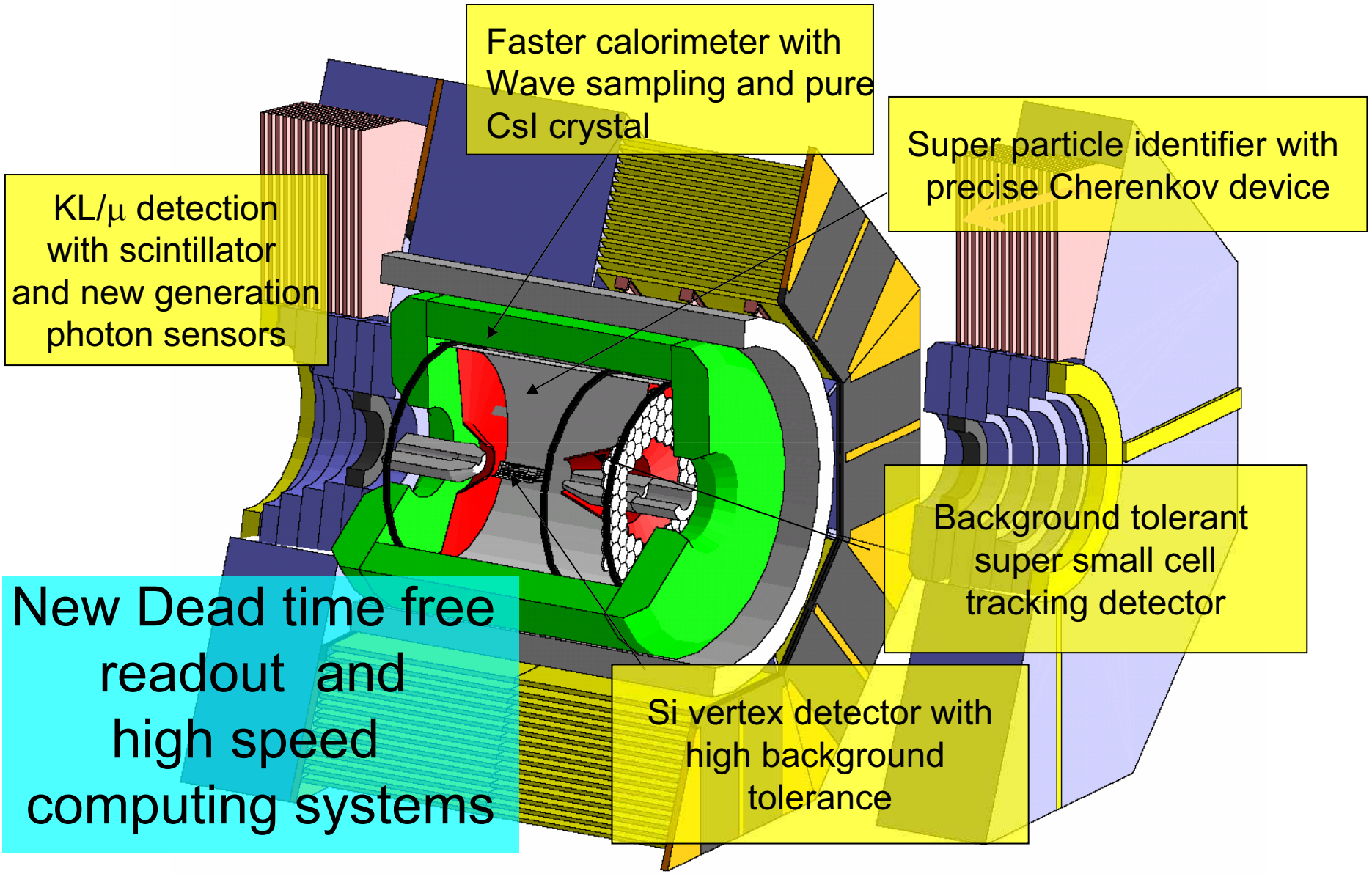
Rad-Bhabha mask around QCS magnet
IR chamber design

Results based on GEANT sims validated by Belle/KEKB experience.



Conservative, robust detector should be handle up to 20 times more background

Belle upgrade



New Dead time free readout and high speed computing systems

Table 1: Machine parameters of KEKB

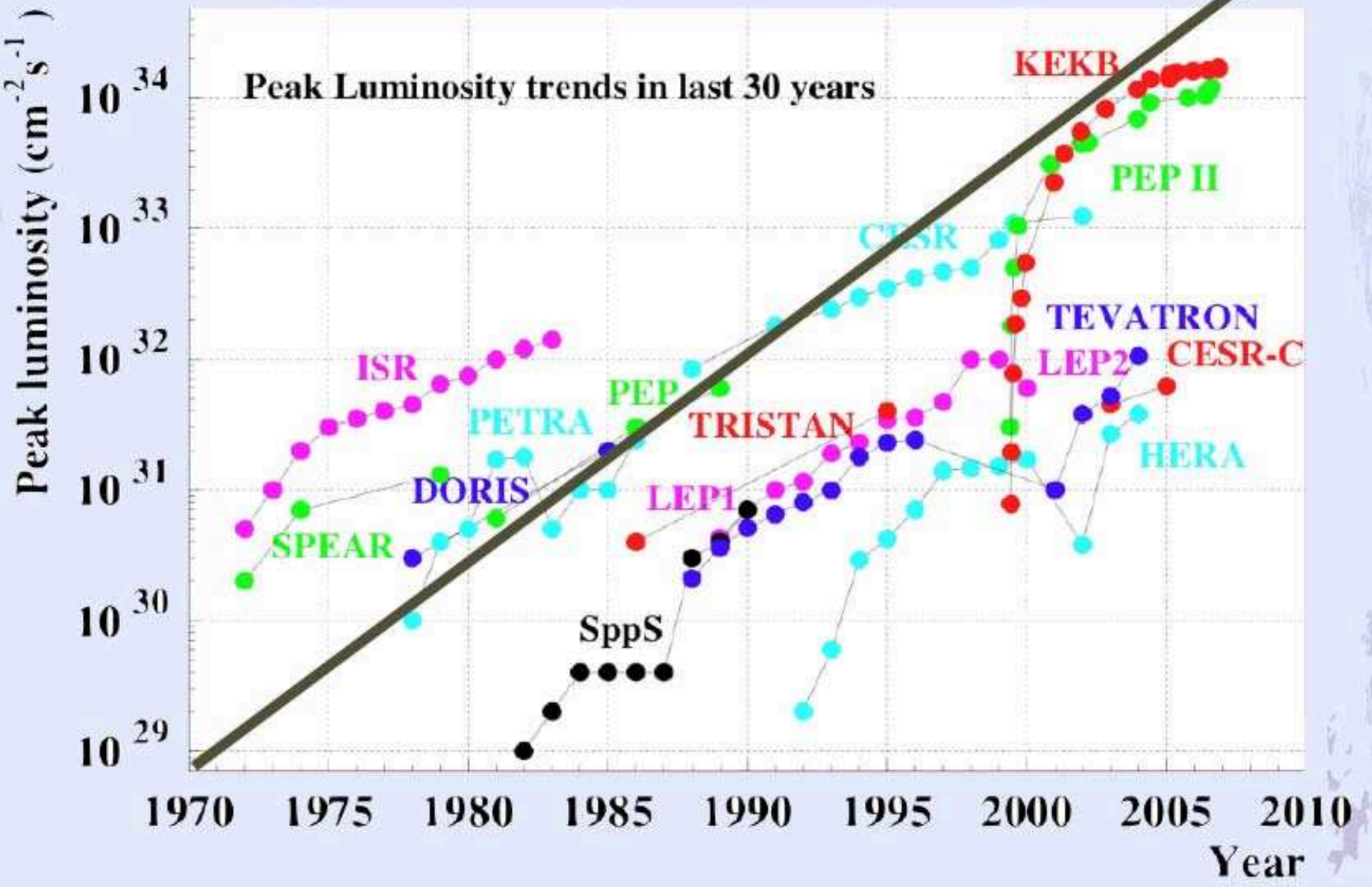
Date	**11/15/2006**		**Design**		
	LER	**HER**	**LER**	**HER**	
Current	1.65	1.33	2.6	1.1	A
Bunches/ring	1389		5000		
Bunch current	1.19	0.96	0.52	0.22	mA
Bunch spacing	1.8–2.4		0.6		m
Emittance ε_x	18	24	18	18	nm
β_x^*	59	56	33	33	cm
β_y^*	0.65	0.59	1.0	1.0	cm
Hor. size @ IP	103	116	77	77	μm
Ver. size @ IP	1.9	1.9	1.9	1.9	μm
Beam-beam ξ_x	0.115	0.075	.039	.039	
Beam-beam ξ_y	0.101	0.056	.052	.052	
Bunch length	7	6	4	4	mm
Luminosity	17.12		10		/nb/s
$\int$Lum./day	1232		$\sim$ 600		/pb
$\int$Lum./7 days	7.82		–		/fb
$\int$Lum./30 days	30.21		–		/fb

70% higher than the design

doubled the design

In Context:

Target: 5-8 × 10^{35} $cm^{-2}s^{-1}$
=30-50 x World Record (KEKB)





Crab cavities installed and undergoing testing in beam

e- 4.1 A

$\beta^*_y = \sigma_z = 3$ mm

SuperBelle

New IR

Crab cavities

New beam & bellows

SuperKEKB

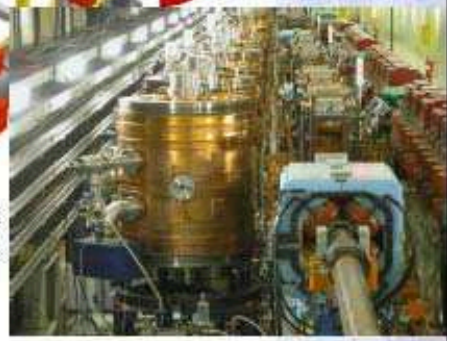
e+ 9.4 A

More RF sources

More RF cavities



The superconducting cavities will be upgraded to absorb more higher-order mode power up to 50 kW.



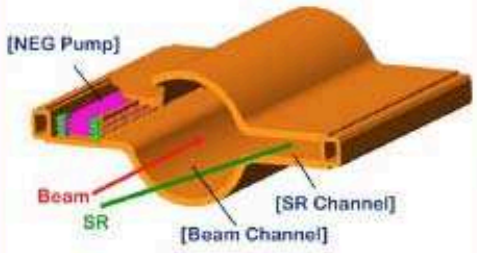
The state-of-art ARES copper cavities will be upgraded with higher energy storage ratio to support higher current.

Energy exchange C-band

Damping ring

Positron source

$$L = \frac{\gamma_\pm}{2er_e}\left(1+\frac{\sigma^*_y}{\sigma^*_x}\right)\frac{I_\pm \xi_{\pm y}}{\beta^*_y}\left(\frac{R_L}{R_y}\right)$$





The beam pipes and all vacuum components will be replaced with higher-current design.

will reach 5-8 × 10^{35} $cm^{-2}s^{-1}$.

Three factors that determine the luminosity:

Stored current:

1.7 / 1.4 A (e^+/ e^- KEKB)

→ 9.4 /4.1 A (SuperKEKB)

Beam-beam parameter:

0.059 (KEKB)

→ >0.24 (SuperKEKB)

Lorentz factor

$$L = \frac{\gamma_\pm}{2er_e}\left(1+\frac{\sigma_y^*}{\sigma_x^*}\right)\frac{I_\pm \xi_{\pm y}}{\beta_y^*}\left(\frac{R_L}{R_y}\right)$$

Classical electron radius

Beam size ratio

Geometrical reduction factors due to crossing angle and hour-glass effect

Luminosity:

0.17×10^{35} $cm^{-2}s^{-1}$ (KEKB)

$5\text{-}8 \times 10^{35}$ $cm^{-2}s^{-1}$ (SuperKEKB)

Vertical β at the IP:

6.5/5.9 mm (KEKB)

→ 3.0/3.0 mm (SuperKEKB)

Strategy for Achieving Higher Luminosity

- Higher Currents
- Smaller Bunches
- Electron-cloud suppression
- Crab Cavities

Challenges for vacuum system

Key parameters for vacuum system:

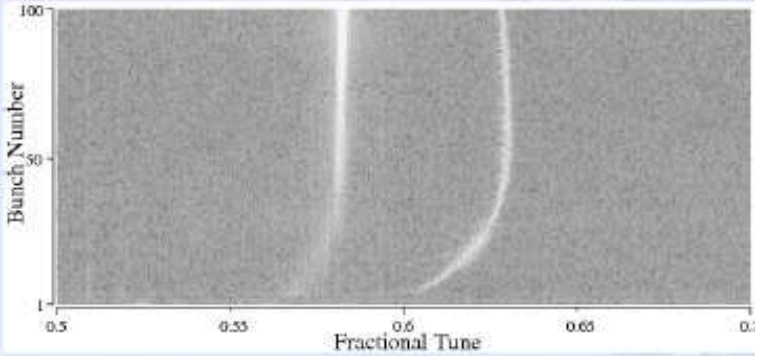
- High current (LER:9.4 A, HER:4.1 A)
- Short bunch (σ_z = 3 mm)

- **Intense SR power**
  - Max. power density of 28 kW/m (40 W/mm^2) even a half aperture of 110 mm, for example.
- **High photon density**
  - Photon density ~1x10^{19} photons/m/s in average
  - Large gas desorption
    - Gas load ~ 5x10^{-8} Pa m^3/s/m (for η = 1x10^{-6} molecules/photon)
    - Average pressure ~ 5x10^{-7} Pa for S ~ 0.1 m^3/s/m
  - Electron Cloud Instability (ECI) becomes a big issue in positron ring
- **Intense HOM (higher order mode) power**
  - For a loss factor of 1 V/pC, loss power ~ 200 kW

The Problem of Electron Clouds

- Photo-electrons produced at the beam pipe wall by synchrotron radiation, and secondary electrons produced by electron-wall collisions, are trapped in the region of the beam orbit in the positron ring (LER).
- The KEKB LER has suffered beam blow-up and luminosity loss due to interactions with these electron clouds, which cause a fast head-tail instability.
- Bunch-current blowup threshold can be raised by the use of solenoids around the beam pipe.

However, KEKB performance is still limited by electron clouds.



Bunch spectral signature of e-cloud instability observed at KEKB LER.
J.W. Flanagan et al., PRL 94, 054801 (2005).

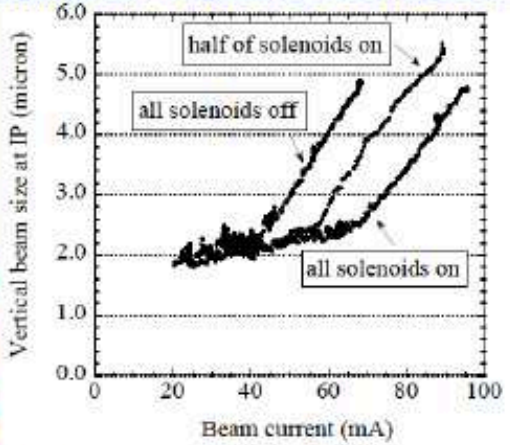


Figure 2: Vertical beam size as a function of the beam current. In the measurement two trains were injected on opposite sides in the ring. Each train contained 60 bunches. Bunch spacing was 4 rf buckets.

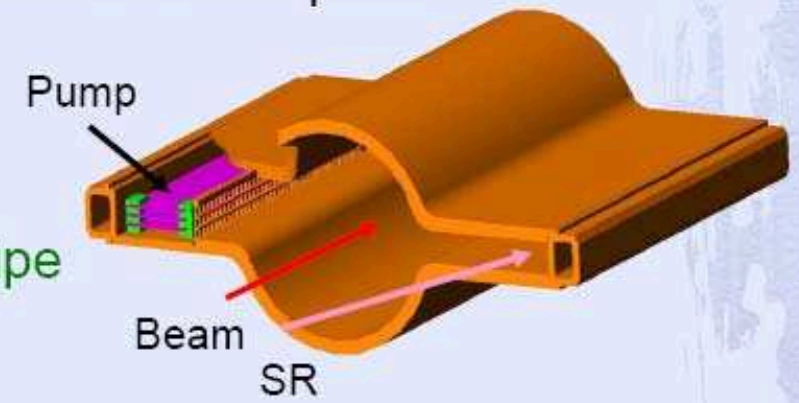
Fukuma et al., "Study of Vertical Beam Blow-up in KEKB LER," HEAC01 proceedings

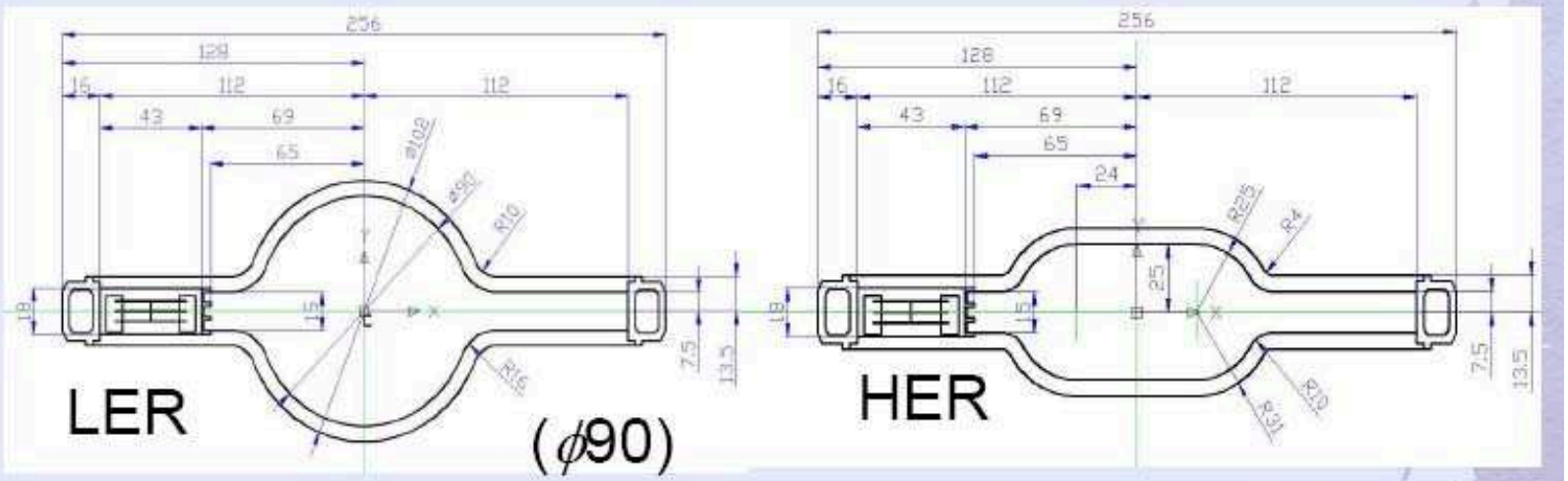


Figure 1: Solenoids in the LER tunnel. The three solenoids on the right side are those installed in bellows-NEG pump sections. The long solenoid on the left side was installed in the first installation.

Beam duct

- Copper beam duct with ante-chambers
  - Copper is required to withstand intense SR power
- Features (compared to simple pipe):
  - Low SR power density
  - Low photoelectrons in beam pipe
  - Low beam impedance
  - Expensive

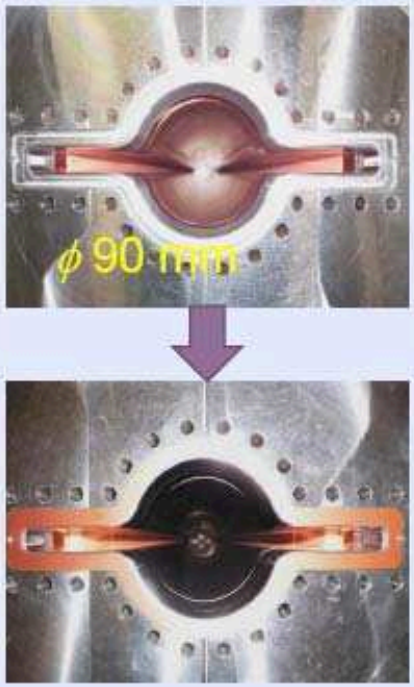


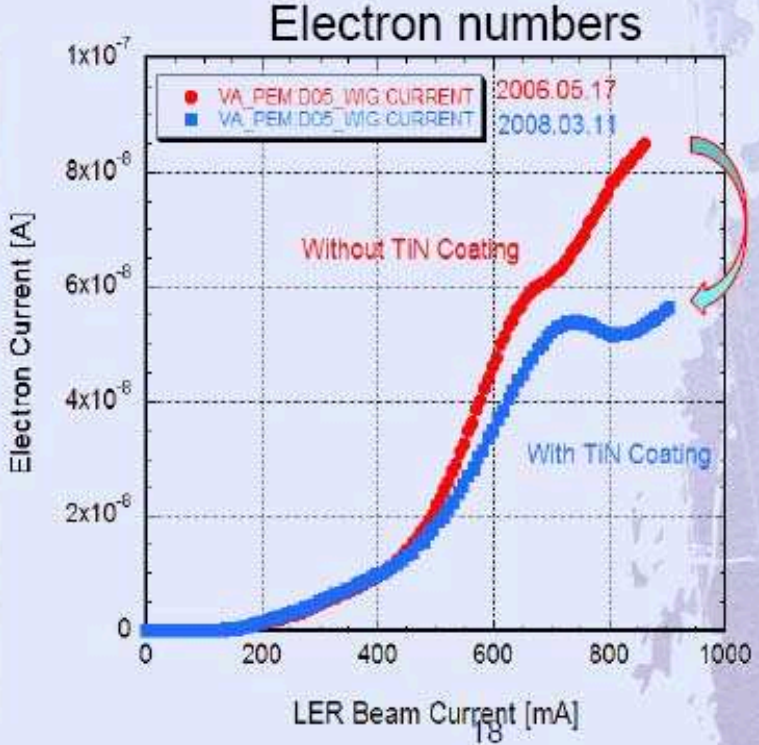


Cure for Electron Clouds (1)

- A critical issue for positron ring
- TiN coating on inner surface
  - Decrease secondary electron yield (SEY): Max. SEY ~0.9
  - A test stand for the coating was built in KEK, and applied to a test duct with ante-chambers.
    - Decrease of electrons at high current region was demonstrated.

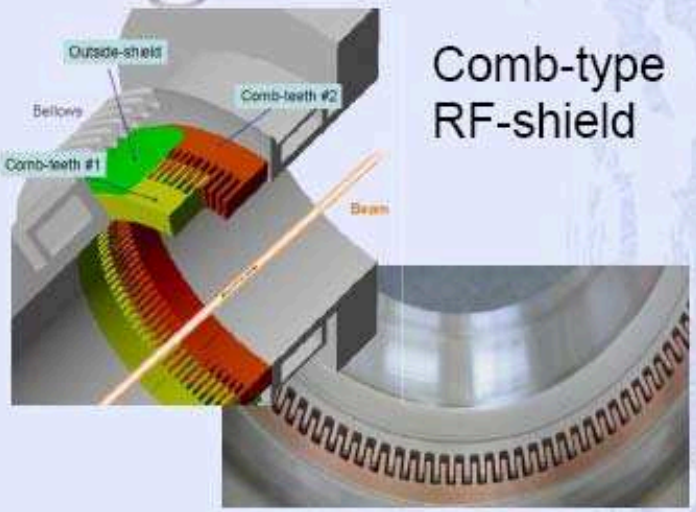






RF shielding

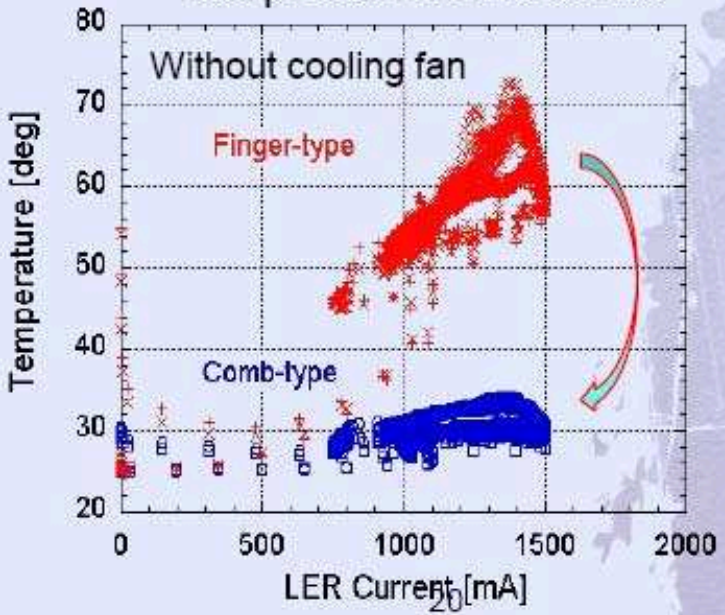
- Comb-type RF shield



Comb-type RF-shield

- Features (compared to finger type):
  - Low beam impedance
  - High thermal strength
  - Applicable to complex aperture
  - Little flexibility (offset)

Temperature of bellows



- Effect of RF shielding was demonstrated in KEKB.
- Finger-type as an option
  - If more flexibility is required.

RF systems

Need RF systems which can store high beam currents and handle shorter bunches.

ARES (normal-conducting cavity) for LER
ARES + SCC (Single-cell Superconducting cavity) for HER

- Adopt the same RF frequency as KEKB and use the existing RF system as much as possible, with improvements as necessary to meet the requirements for SuperKEKB.

→Construction cost is greatly reduced.

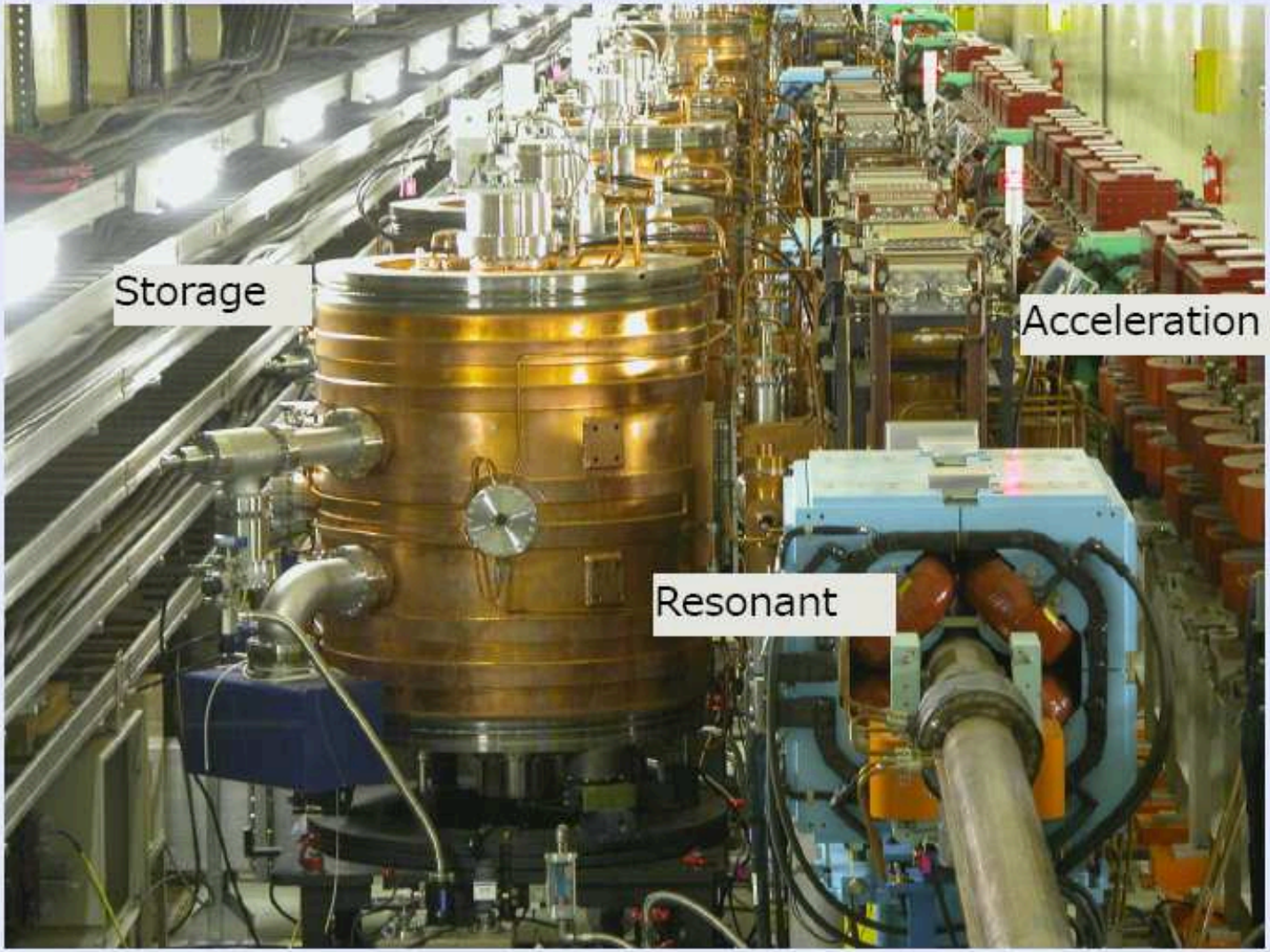
→Technical uncertainties are relatively small.

The ARES Cavity

Accelerator Resonantly-coupled Energy Storage

T. Kageyama, et al

- Passive stabilization with huge stored energy.
- Eliminate unnecessary modes by coupling of 3 cavities.
- Higher order mode dampers and absorbers.
- No need for longitudinal bunch-by-bunch feedback.
- No transverse instability arises from the cavities.



Superconducting Cavity

SuperKEKB challenges:
The expected power load to the HOM absorber is 50 kW/cavity at 4.1 A, (even) with a larger beam pipe of 220 mm).

HOM damper upgrade may be needed.



S. Mitsunobu, et al

Main Ring Magnets

- Outside of the IR, will largely reuse present KEKB magnets & power supplies.
- The following magnets (& some power supplies) will have to be newly designed and fabricated.
- Magnet re-assembling due to the beam pipe replacement.

Magnet type	# of magnets	comments
HER Quad. (RF section)	19+1	Larger bore radius 80→120mm
LER Quad. (RF section)	2	The same type as the present LER Q
HER Sext.	49	~50% stronger field
V dipole corrector	~450	Ante-chamber

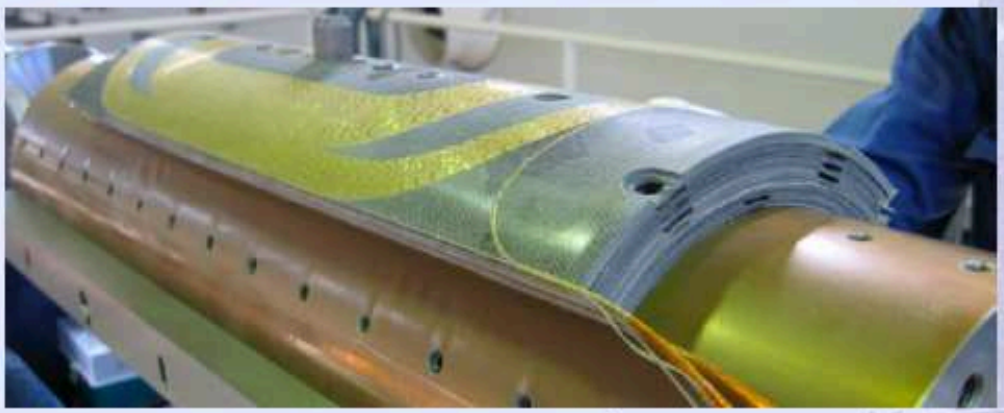
Construction of QCS R&D Magnet

N. Ohuchi

(2-4) 12 Cured Coils and curing 6 layer coils all at once



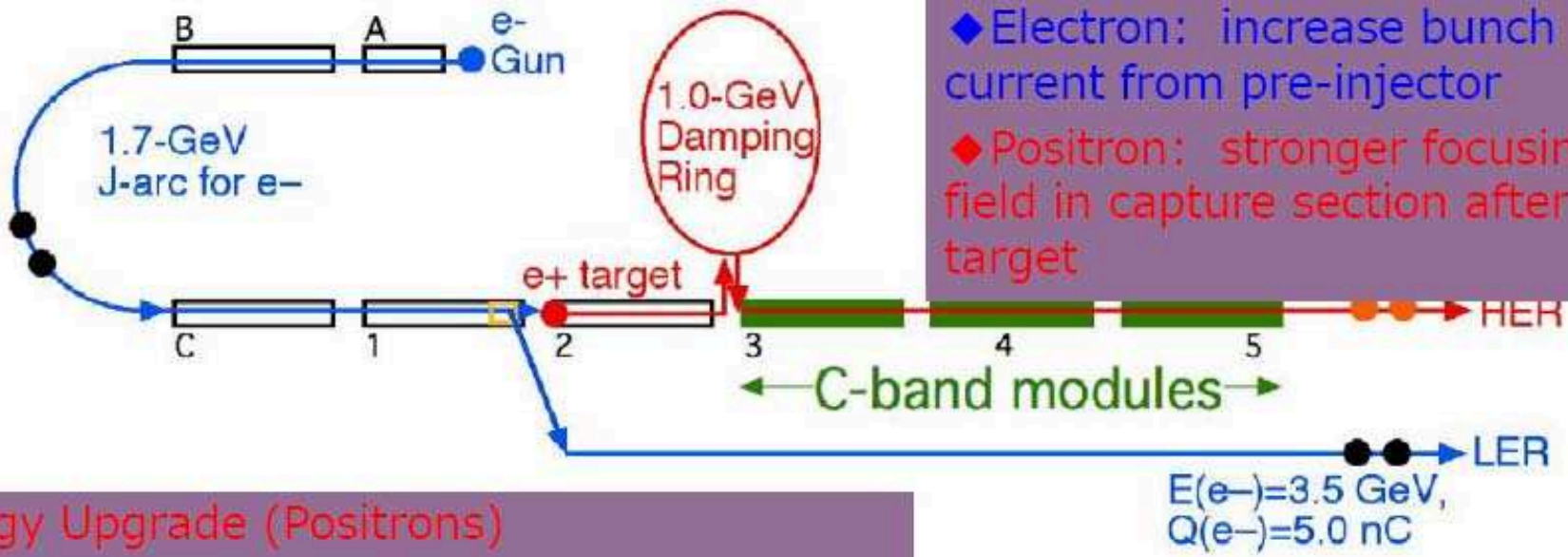




(1) 12 cured double pan-cake coils.

(2) Curing process of 6 layer coils. This process is necessary for improving the field quality in the magnet straight section (magnet body).

Linac Upgrade



Intensity Upgrades

- Electron: increase bunch current from pre-injector
- Positron: stronger focusing field in capture section after target

Energy Upgrade (Positrons)

Replace S-band (2856 MHz) RF system with C-band (5712 MHz) system to double field gradient in downstream section of linac. (The present max. energy gain is 4.8 GeV)

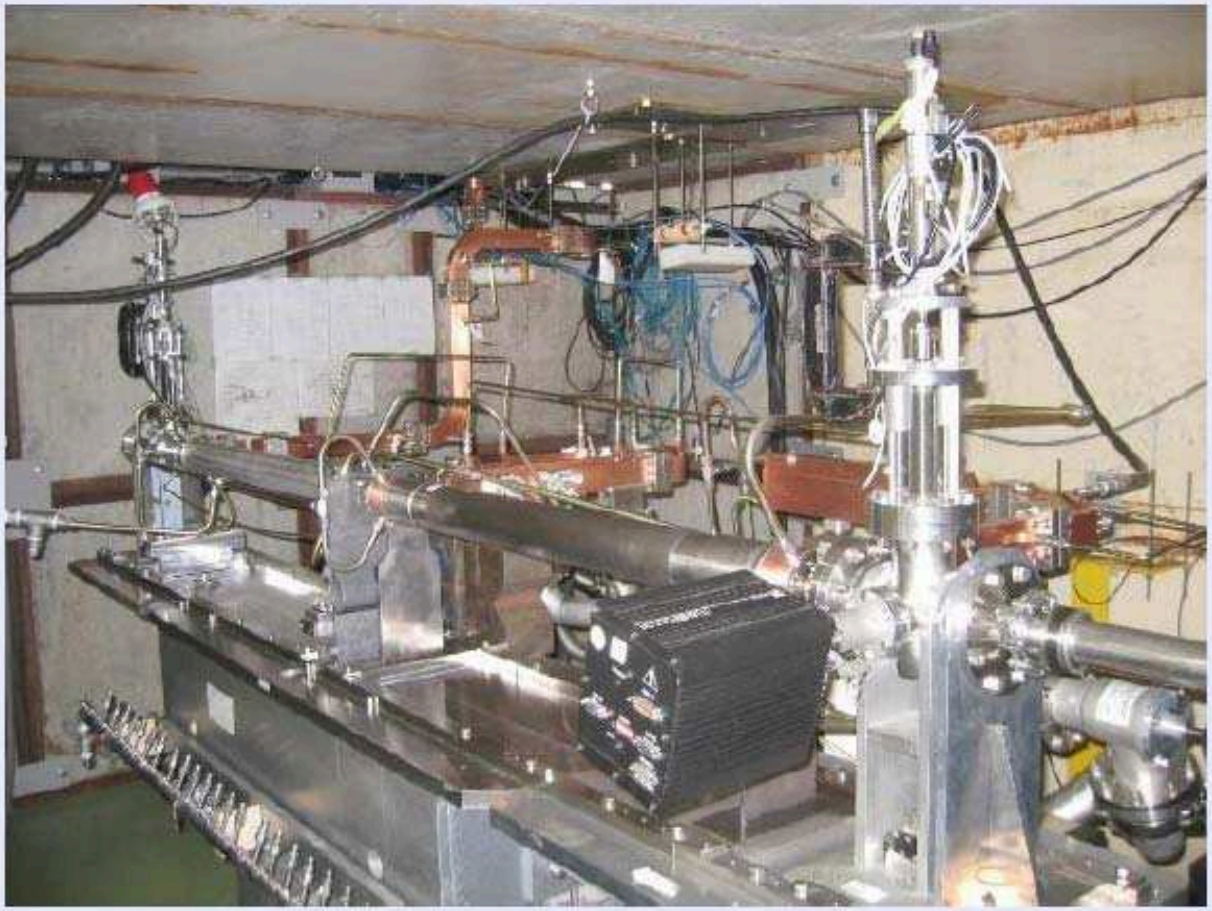
Pulse beam kicker installed before positron target for quick switching between beams (50 Hz).

Start testing this Fall

Talks by Michizono, Akemoto, Kamitani, Satoh

- C-band linac: completed a single section in the linac with 4 structures.
- Performance was satisfactory with the beam.

T. Kamitani, et al



Damping Ring

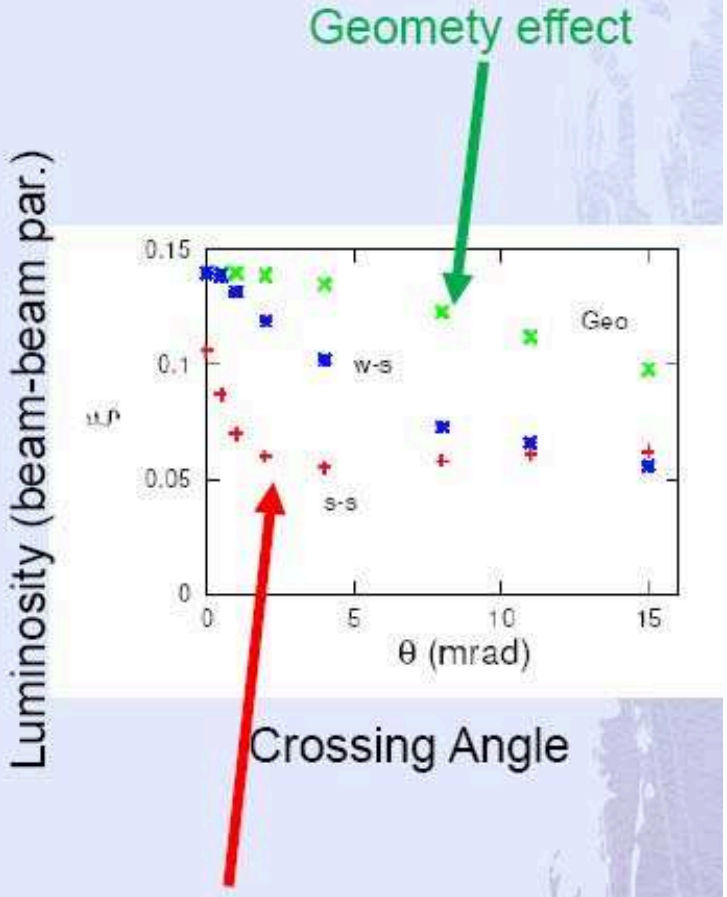
- Positron emittance needs to be damped, to pass reduced aperture of C-Band section and to meet IR dynamic aperture restrictions.
  - Electron DR may also be considered later to reduce injection backgrounds in physics detector, but for now only positron DR considered.
- Damping ring located downstream of positron target, before C-Band accelerating section.

M. Kikuchi



Beam-beam limit

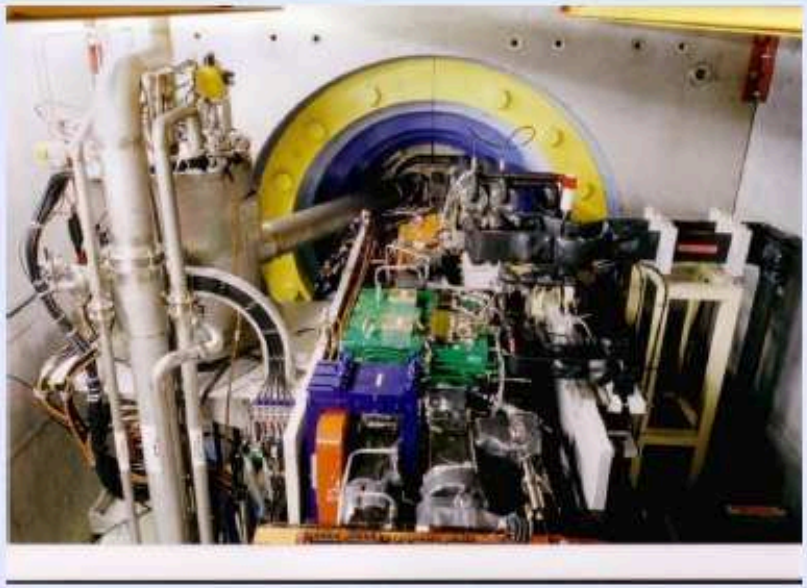
- Beam-beam parameter up to 0.059 has been achieved with a finite crossing angle at KEKB.
- Beam-beam simulations say:
  - A head-on collision greatly improves the luminosity, for two reasons:
    - Geometrical cross-section improvement
    - Improved beam dynamics (reduce non-Gaussian tails)
  - Crab crossing scheme (finite crossing angle but with crab cavity) effectively creates a head-on collision.
- The crab crossing scheme is being tested now.

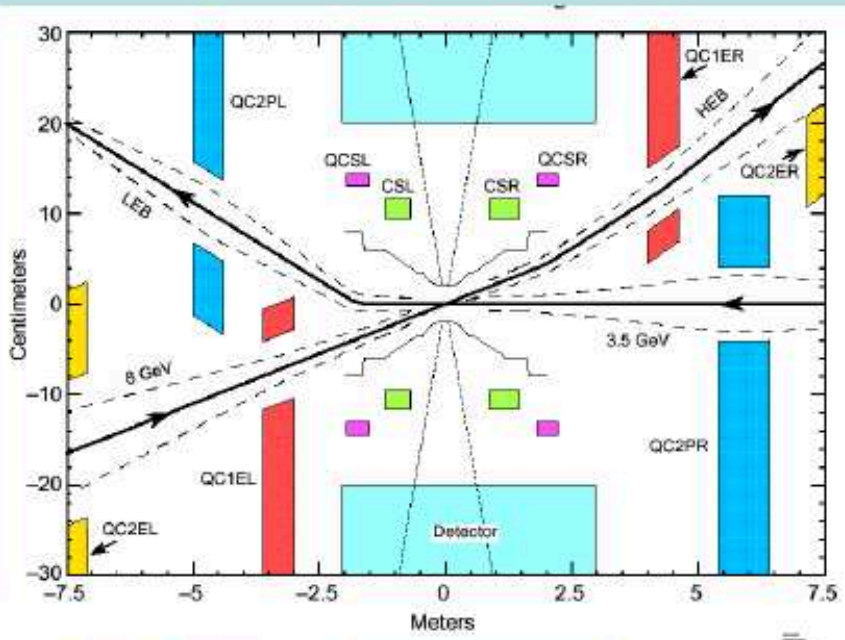


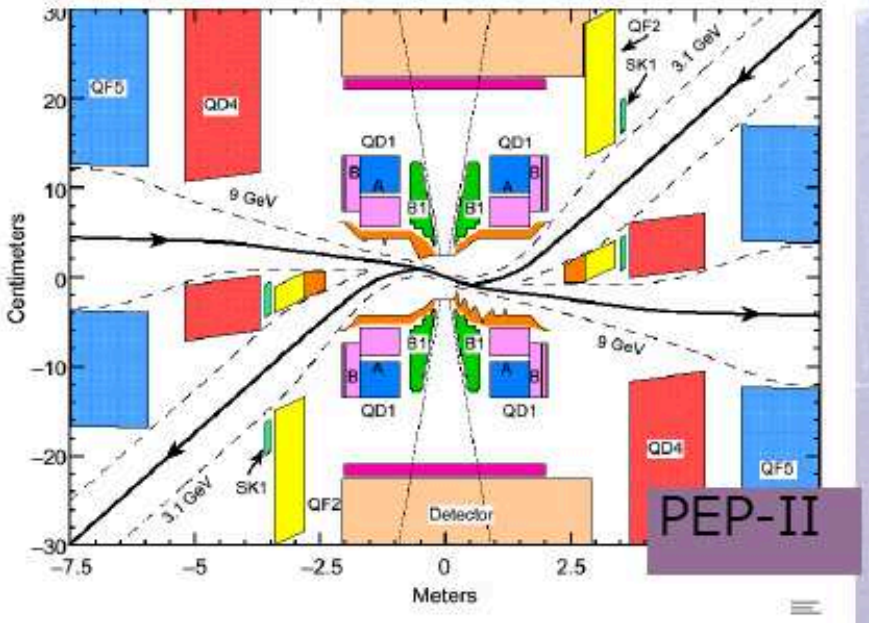
Crab Crossing

KEKB has 22 mrad horizontal crossing angle at the IP:

- Easier beam separation
- Simpler design around the IP.
- Less number of components.
- Less synchrotron radiation.
- Less luminosity-dependent background.
- Space for compensation solenoid, etc.

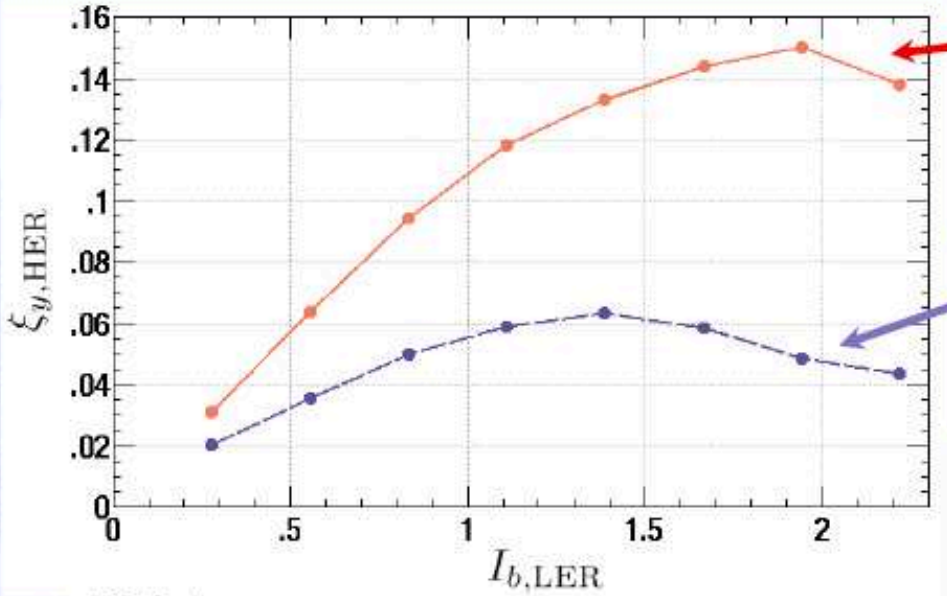






Crab Crossing @ KEKB

- Crab Crossing can boost the beam-beam parameter higher than 0.15 ! K. Ohmi

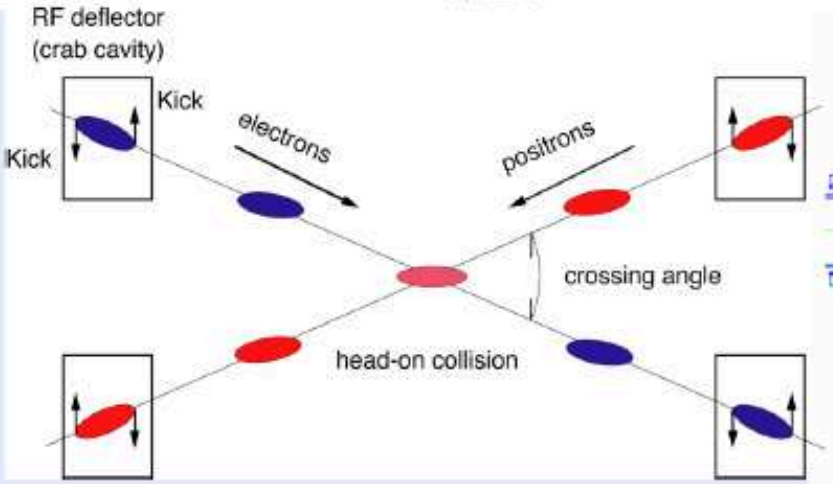


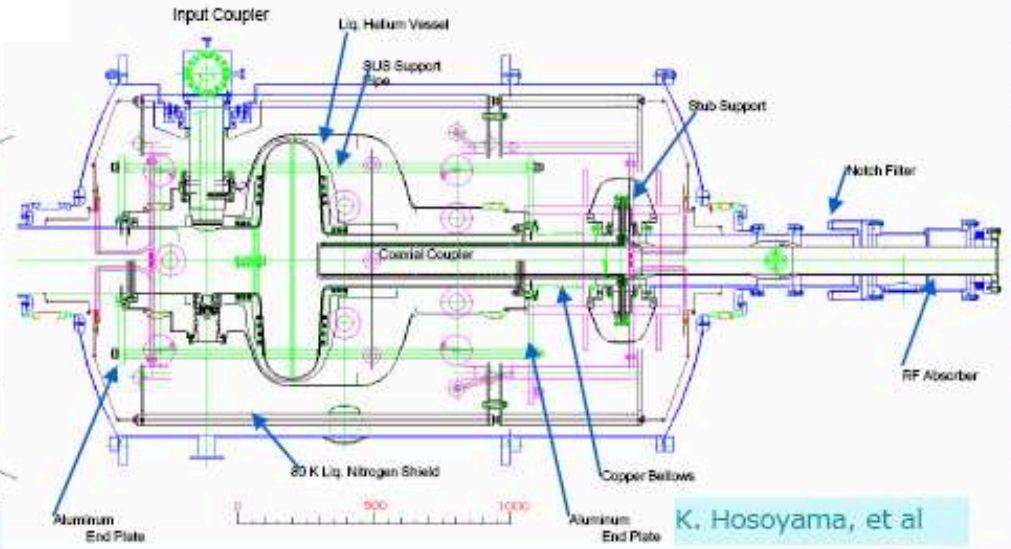
Head-on (crab)

(Strong-strong simulation)

Crossing angle 22 mrad

- Crab cavities were successfully produced and beam study started in Feb. 2007.



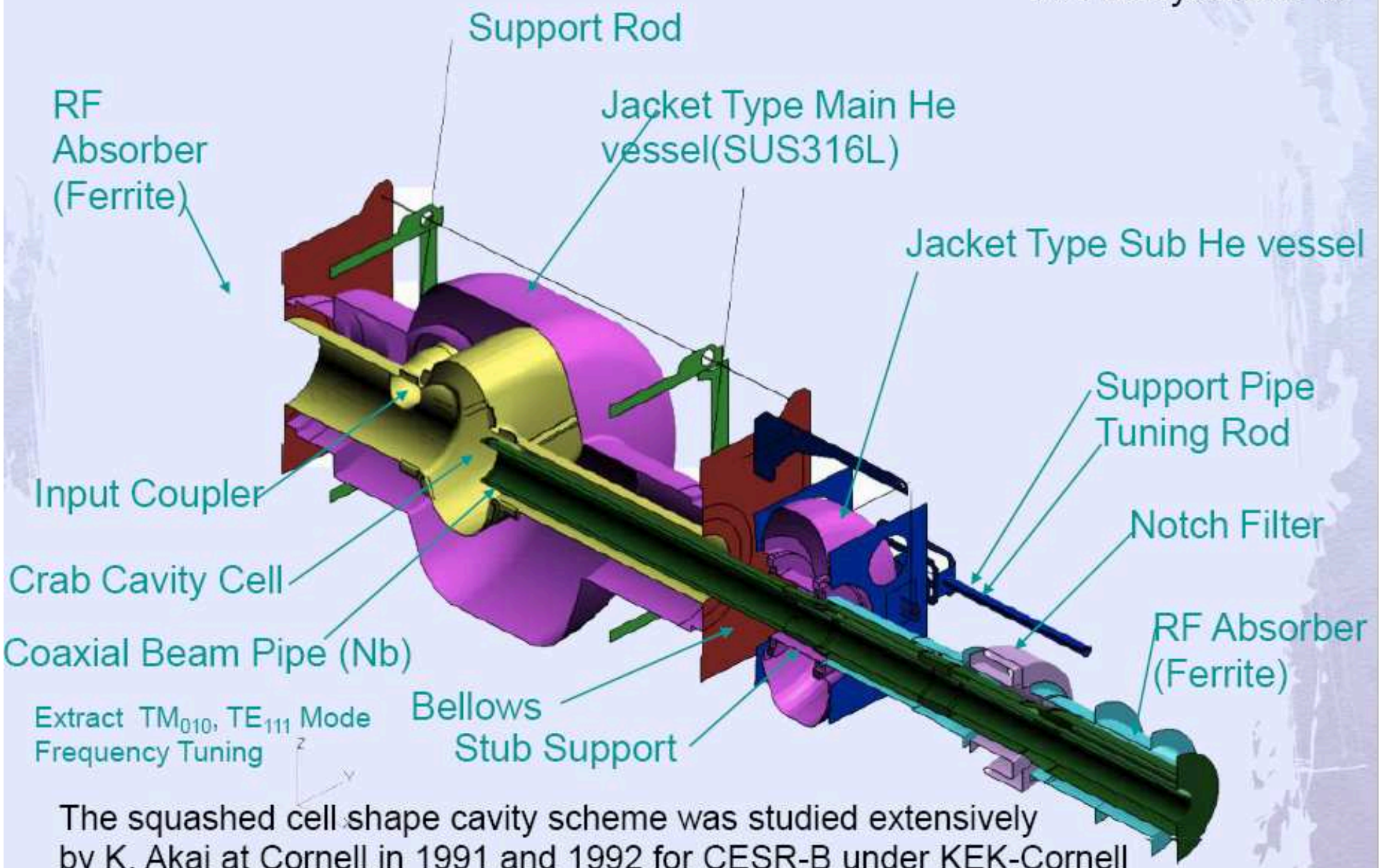


K. Hosoyama, et al

First proposed by R. B. Palmer in 1988 for linear colliders.

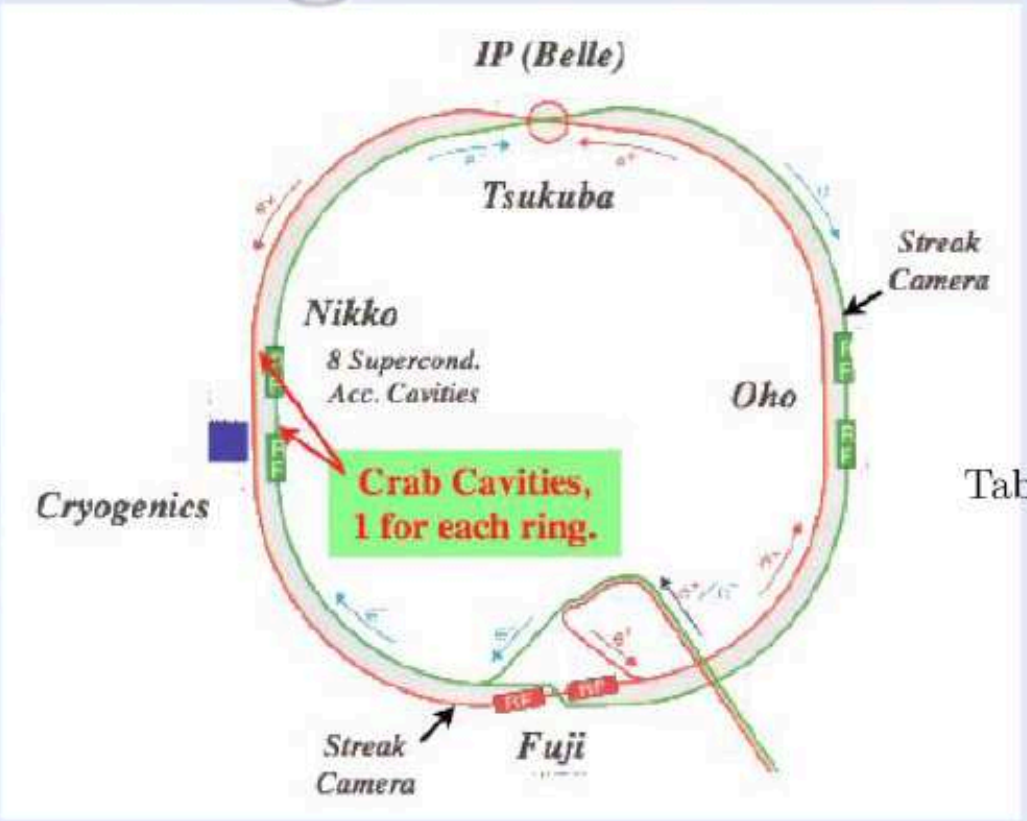
Crab Cavity & Coaxial Coupler in Cryomodule

K. Hosoyama et al



The squashed cell shape cavity scheme was studied extensively by K. Akai at Cornell in 1991 and 1992 for CESR-B under KEK-Cornell collaboration. We adopted this design as “base design.”

Single Crab Cavity Scheme



- Beam tilts all around the ring.
- z-dependent horizontal closed orbit.
- tilt at the IP:

$$\frac{\theta_x}{2} = \frac{\sqrt{\beta_x^C \beta_x^*}\cos(\psi_x^C - \mu_x/2)}{2\sin(\mu_x/2)} \frac{V_C \omega_{\rm rf}}{Ec}$$

Table 1: Typical parameters for the crab crossing.

Ring	LER	HER	
θ_x	22		mrad
β_x^*	80	80	cm
β_x^C	73	162	m
$\mu_x/2\pi$	0.505	0.511	
$\psi_x^C/2\pi$	~ 0.25	~ 0.25	
V_C	0.95	1.45	V
$\omega_{\rm rf}/2\pi$	509		MHz

- 1 crab cavity per ring.
- saves the cost of the cavity and cryogenics.
- avoids synchrotron radiation hitting the cavity.

Finally two crab cavity was installed in KEKB, one for each ring in January 2007.



HER (e-, 8 GeV)



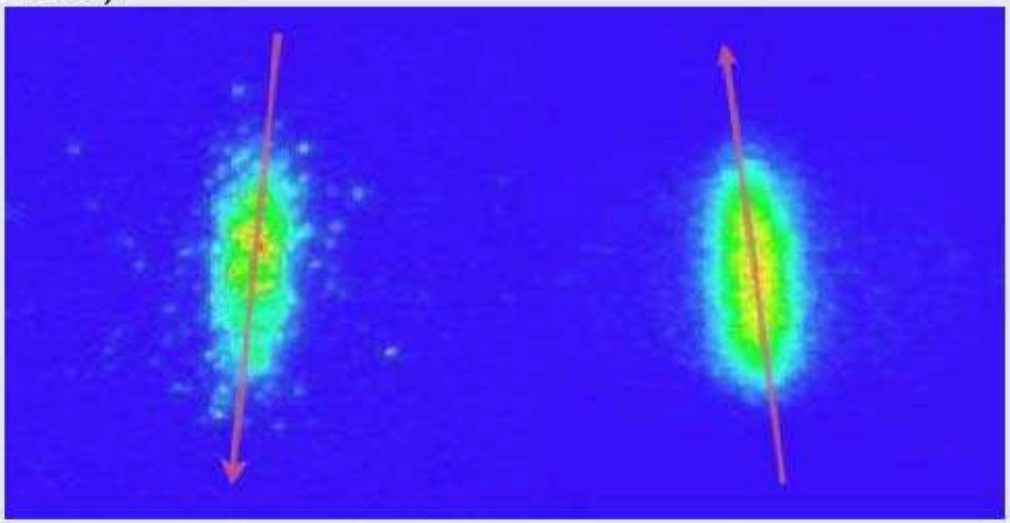
LER (e+, 3.5 GeV)

Beams has indeed tilted!

- Observation with Streak Cameras (H. Ikeda et al, FRPMN035)

inside of the rings

outside of the rings

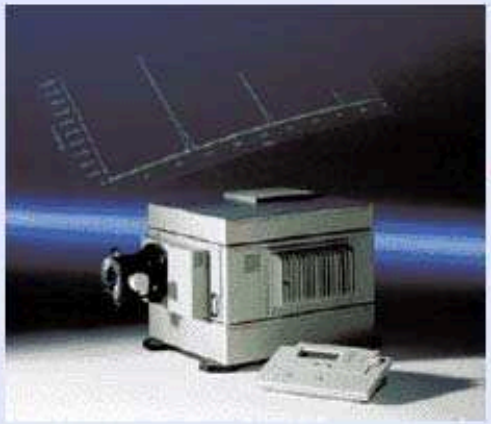


longitudinal

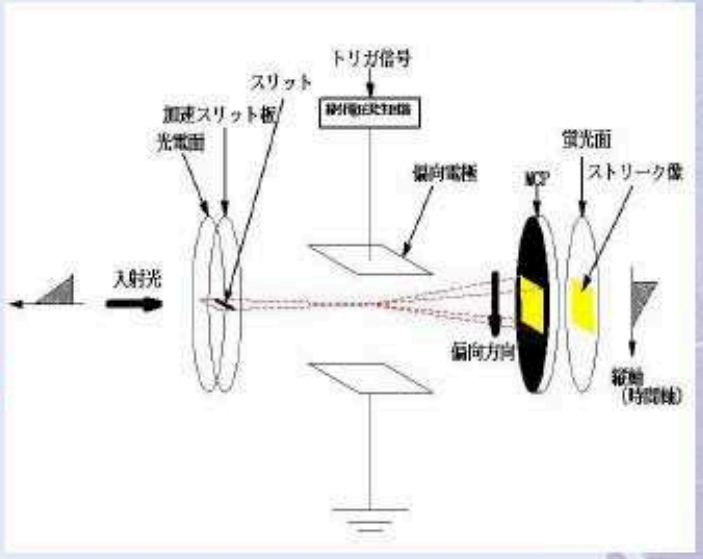
LER

HER

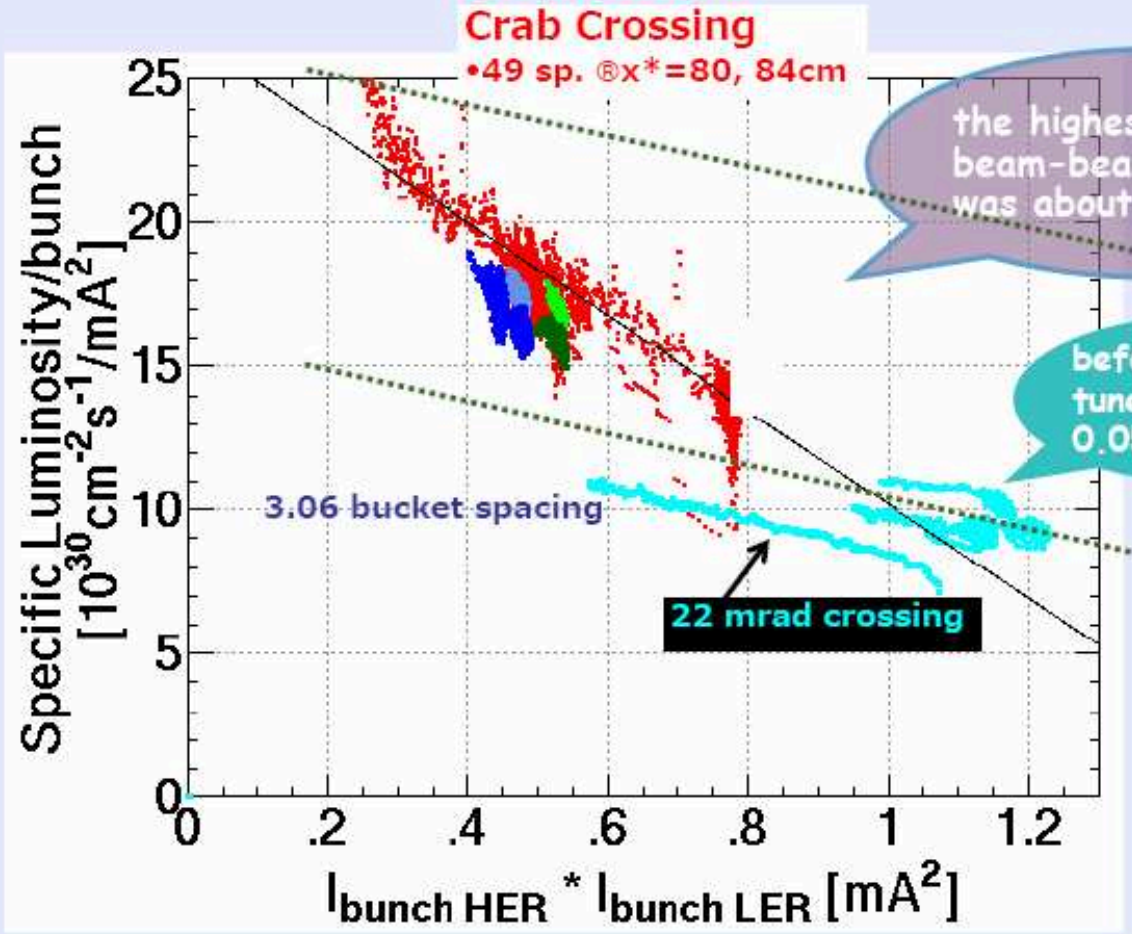
horizontal



The streak camera



Specific Luminosity With Crab Crossing

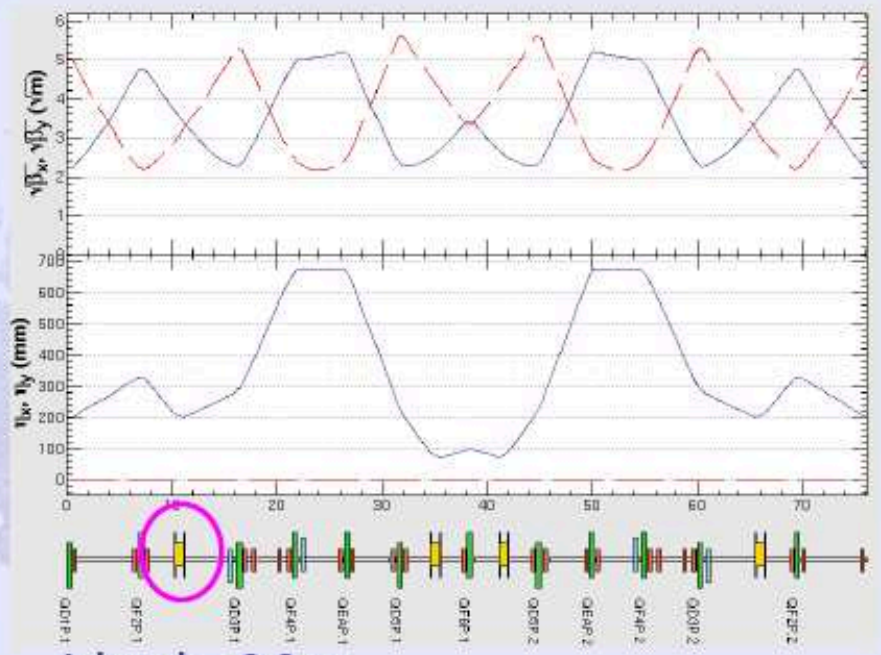


- **A number of measurements indicate effective head-on collision.**
- **The vertical tune shift went from 0.055 to 0.088.**
- **The specific luminosity/bunch improved by more than just the geometrical gain.**
- **Need more time to achieve the goal (X2 specific luminosity).**

Compatibility with Italian option

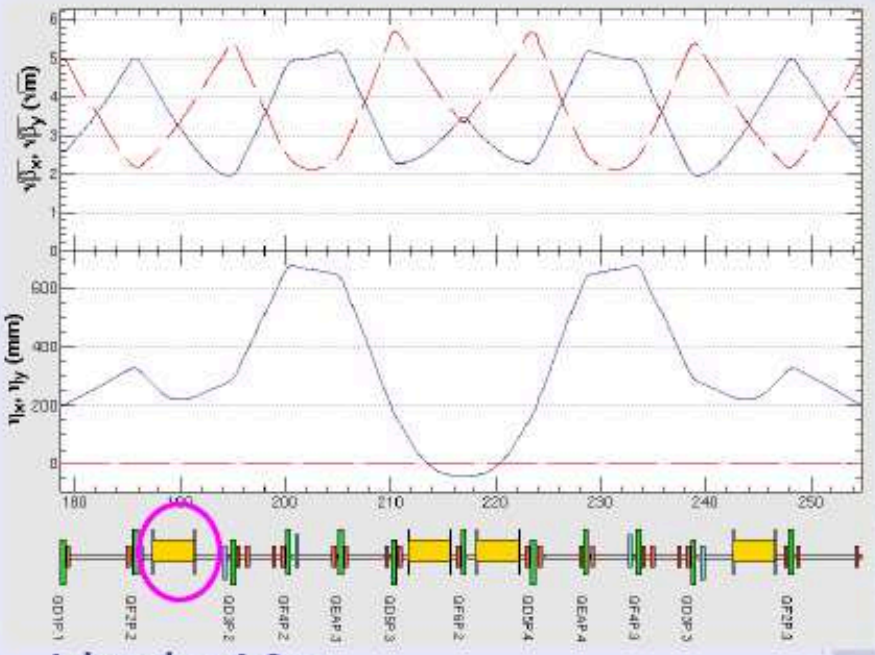
LER arc cell

Preliminary



L bend = 0.9 m

ε_x = 6.8 nm



L bend = 4.0 m

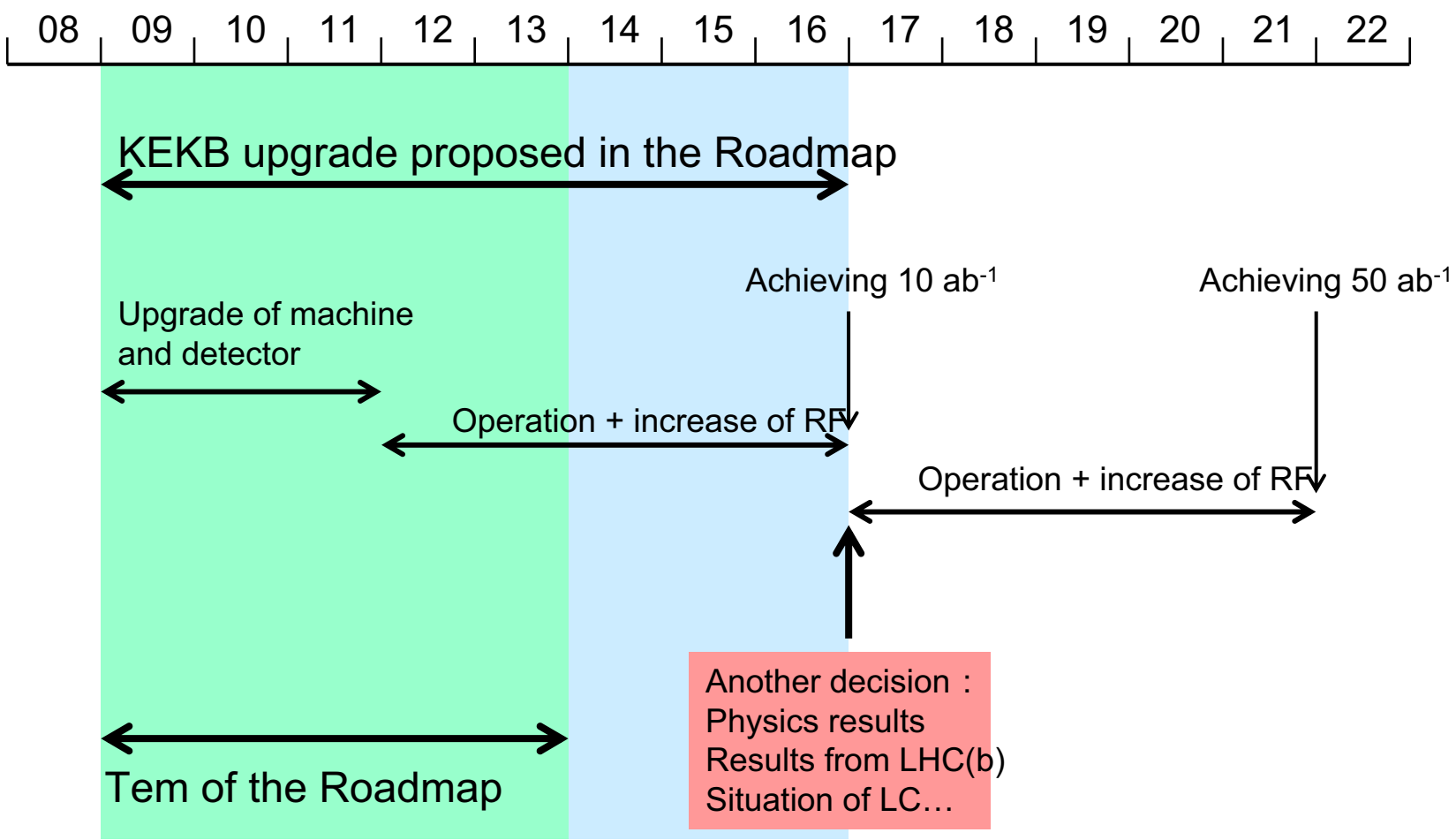
ε_x = 2.2 nm

- The arc cell lattice of the KEKB LER (left) can be modified to the low-emittance version (right), by weakening the magnetic field of the dipoles.
- No need for changing other components, beam pipes, geometry.
- The interaction region must be rebuilt.
- The HER's emittance is not reduced, but unequal emittance may be OK.

H. Koiso

Long term strategy

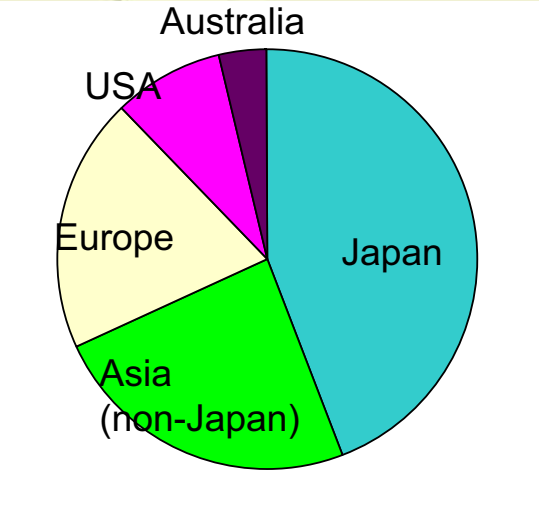
- Assumption: Crab scheme works as expected.
- 10 ab^{-1} : Initial target 50 ab^{-1} : Final goal



Internationalization of the project

KEK is willing to conduct this program as an endeavor with strong international commitment.

- Belle is an international collaboration consisting of ~400 physicists from 55 institutions in 14 countries.



- It will be practical to build new detector by upgrading existing Belle, but the experimental group will be a new group, not a simple extension of the present Belle collaboration.

- New participants are all welcomed to work on detector construction/physics, and accelerator construction.

A.Suzuki, Feb.08

Summary

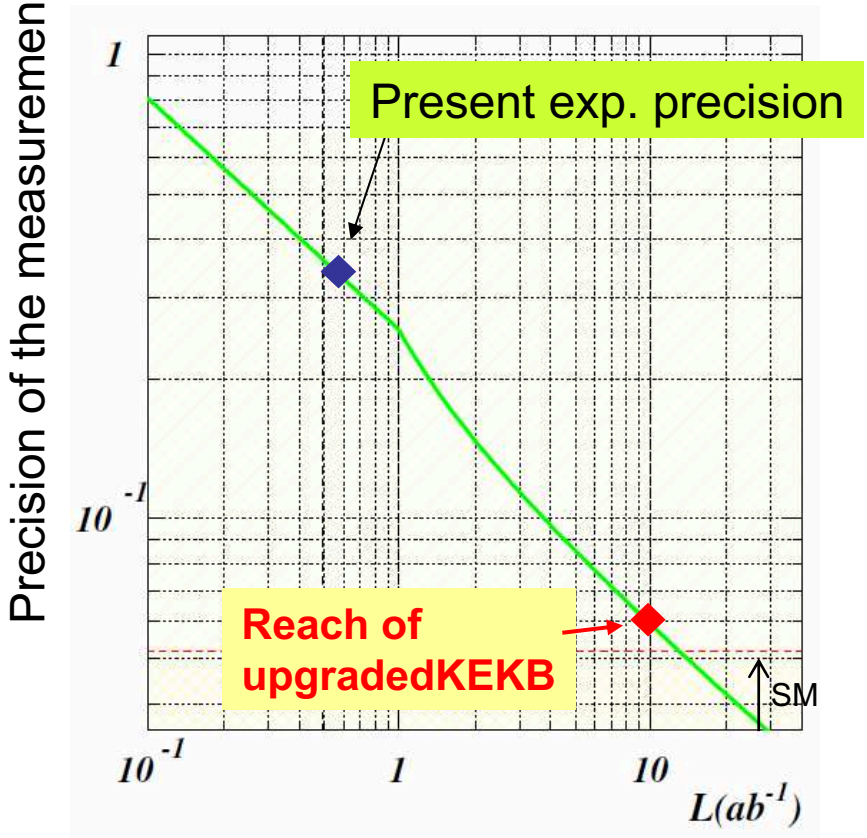
- KEKB/Belle and PEP-II/BaBar have been running successfully, and brought important scientific and technical achievements.
- Next generation e^+e^- *B* factory with $L\sim10^{36}$ will be very useful to study the new sources of flavor mixing and CP violation.
  - Search for new CPV in $b\to s$ transition
  - Very precise test of CKM scheme
  - Search for lepton flavor violating τ decays
  - Studies of $H^\pm$ interactions with fermions
  - Very precise measurements of α_S(@10GeV), $\sin^2\theta_W$(@10GeV)…
- KEK Roadmap endorses the project, and serious negotiation is going on with the Japanese Government for the early approval.
- KEKB machine upgrade plan: Beam current + smaller βy^* + crab scheme
- Detector upgrade necessary to improve BKG/rate immunity.
- New collaboration to be formed soon. Open meeting is scheduled on July 3-4 at KEK.

BACK UP SLIDES

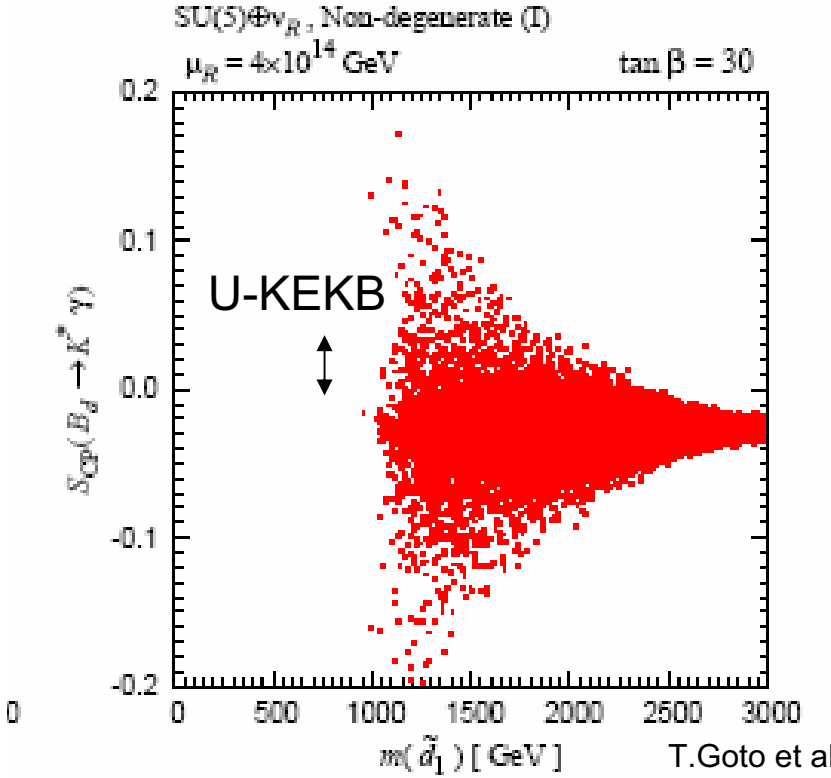
Search for right handed interaction

Left-right summetry in new physics?

CP violation in $B \to K_S \pi^0 \gamma$



Sizable CP asymmetry is expected in $B^0 \to X\gamma$ decay, if right-handed interaction exists in new physics.

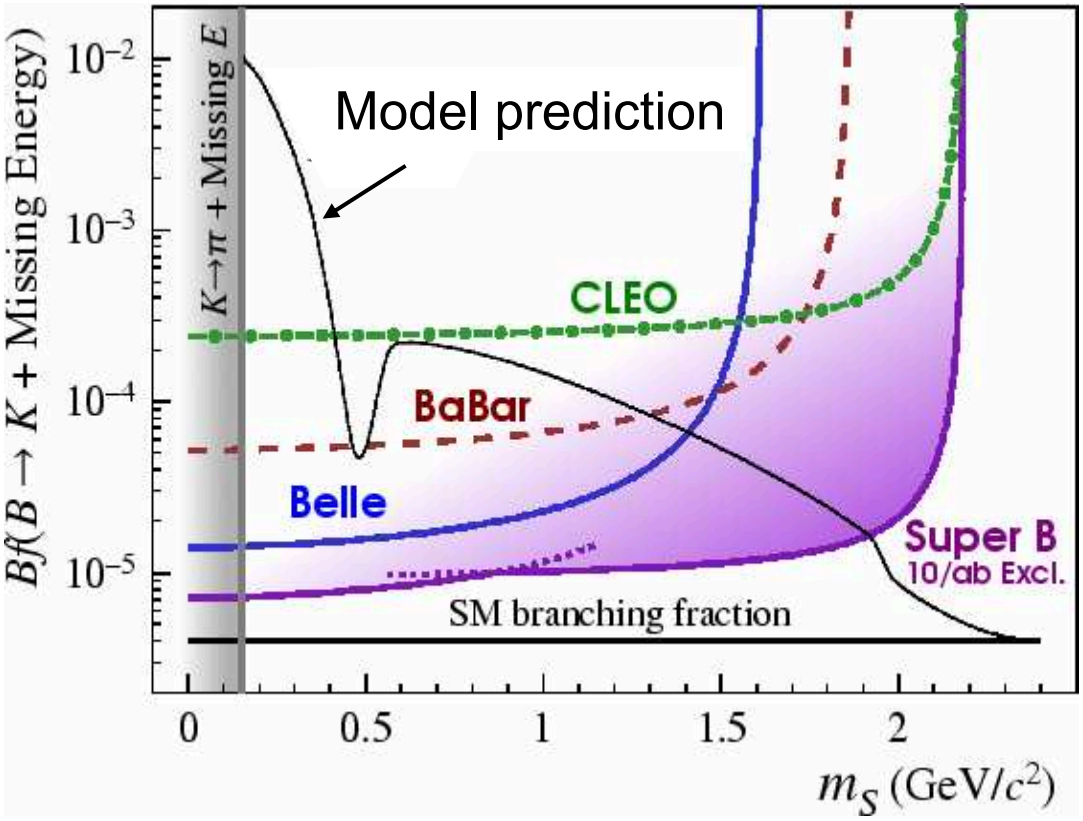


T.Goto et al., 2007

B decays into invisible particles?

Light dark matter?

$$B \to K^{(*)} \nu\bar{\nu} \; [\text{or } \chi\chi]$$

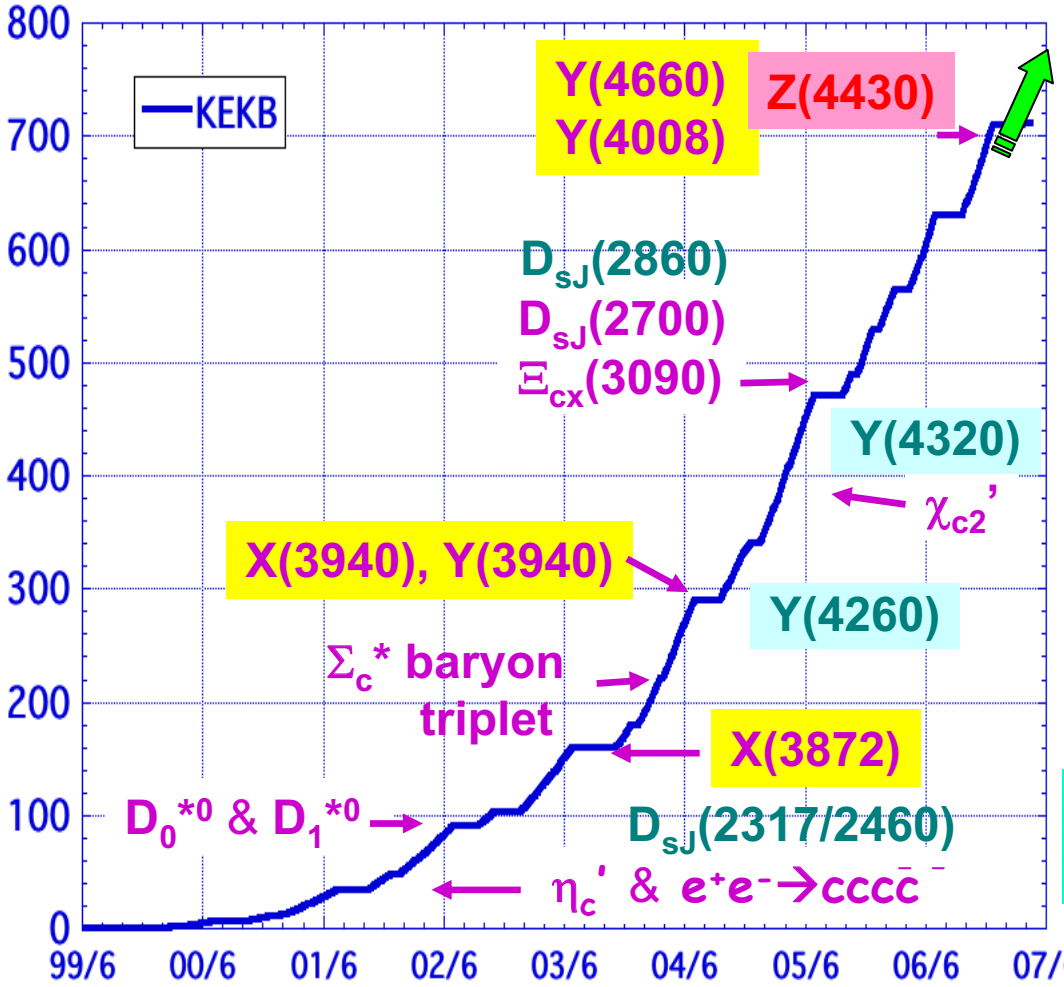


Heavy darm matter is being searched for in direct detection experiments.

Light dark matter can be Searched for in the upgraded KEKB.

New resonances

New resonances found at Belle



More than 10 new resonances have been found at Belle

Among them X (3872) and Z (4430) are considered to be "exotic" states.



More and more exotic states will be Observed by the upgraded KEKB.

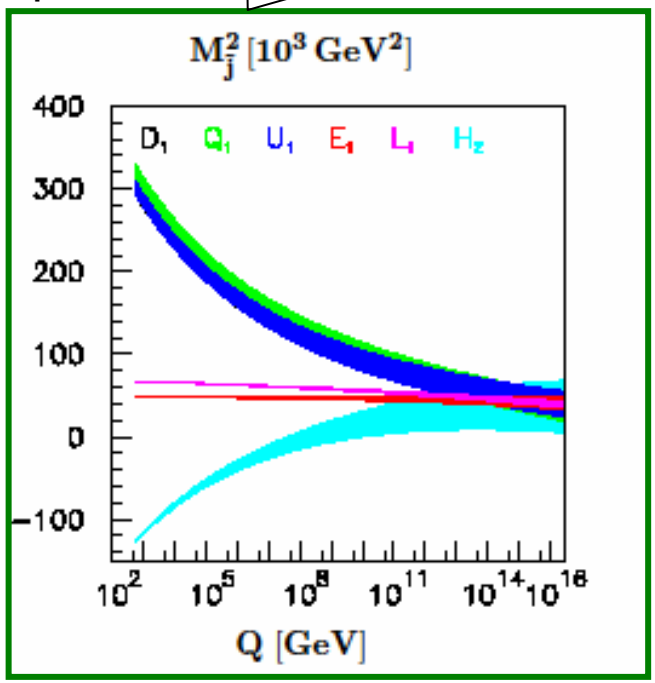
SUSY flavour physics: mass matrix of squark and slepton will be determined by their direct production at the energy frontier and flavour physics measurements.

$$(m^2_{\tilde{q}})_{ij} = \begin{pmatrix} m^2_{11} & m^2_{12} & m^2_{13} \\ m^2_{21} & m^2_{22} & m^2_{23} \\ m^2_{31} & m^2_{32} & m^2_{33} \end{pmatrix}$$

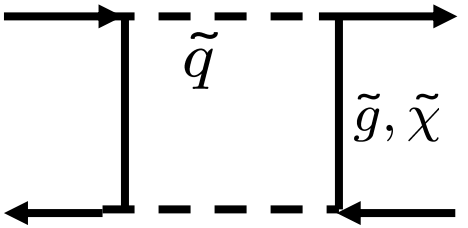
Diagonal

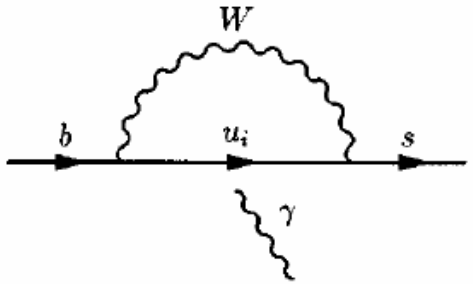
Off-diagonal

LHC/ILC
SUSY mass spectrum

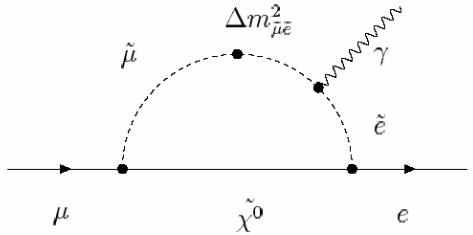


Quark flavor changing processes



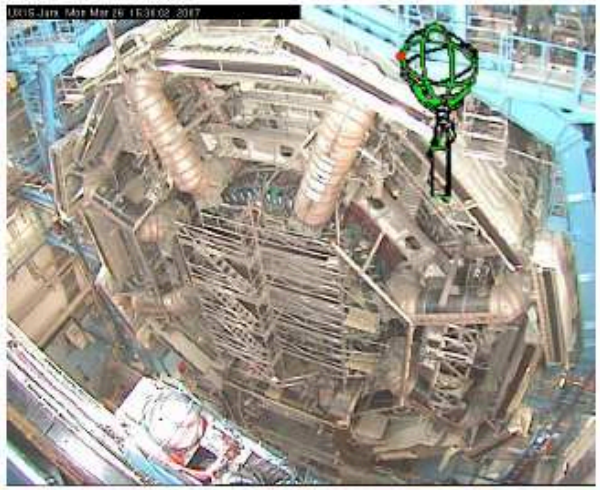


Lepton flavor violation



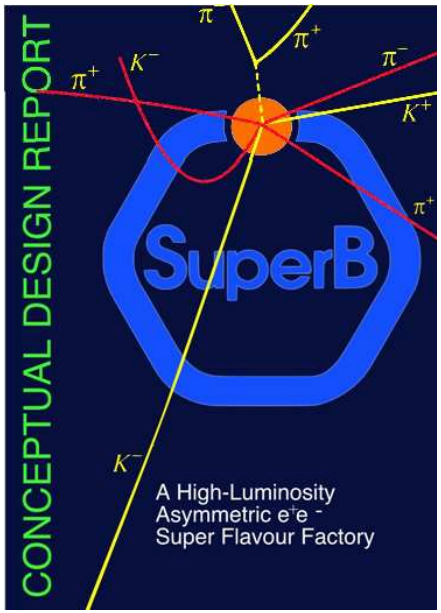
Y.Okada, Nov. 2007

Strong competitors









Comparison with LHCb

e^+e^- is advantageous in…	LHCb is advantageous in…
CPV in $B\to\phi K_S$, $\eta' K_S$,…	CPV in $B\to J/\psi K_S$
CPV in $B\to K_S\pi^0\gamma$	Most of B decays not including ν or γ
$B\to K\nu\nu$, $\tau\nu$, $D^{(*)}\tau\nu$	Time dependent measurements of B_S
Inclusive $b\to s\mu\mu$, *see* $\tau\to\mu\gamma$ and other LFV	$B_{(s,d)}\to\mu\mu$
$D^0\overline{D^0}$ mixing	B_c and bottomed baryons

These are complementary to each other !!