Belle: recent results and future plans

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Contents

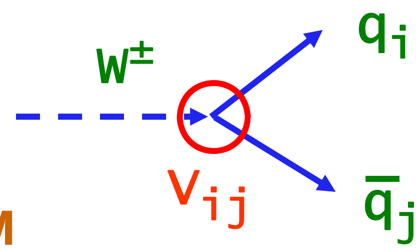
- Highlights from Belle
- Physics case for the Super B factories
- Accellerator and detector upgrade
- Summary

B factory physics program

B factory main task: **measure CP violation in the system of B mesons**

specifically: various measurements of complex elements of Cabbibo-Kobayashi-Maskawa matrix

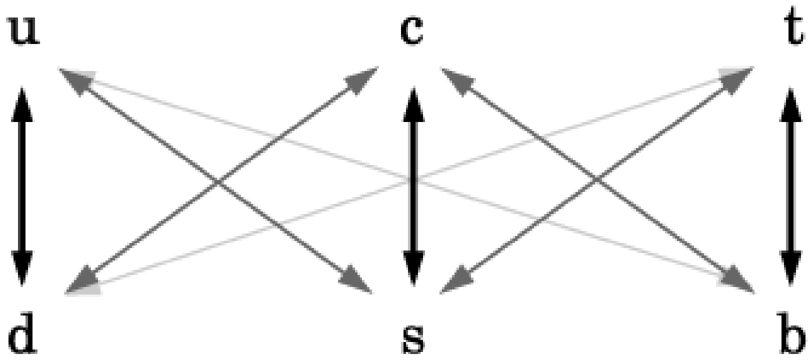
CKM matrix is unitary



deviations could signal processes not included in SM

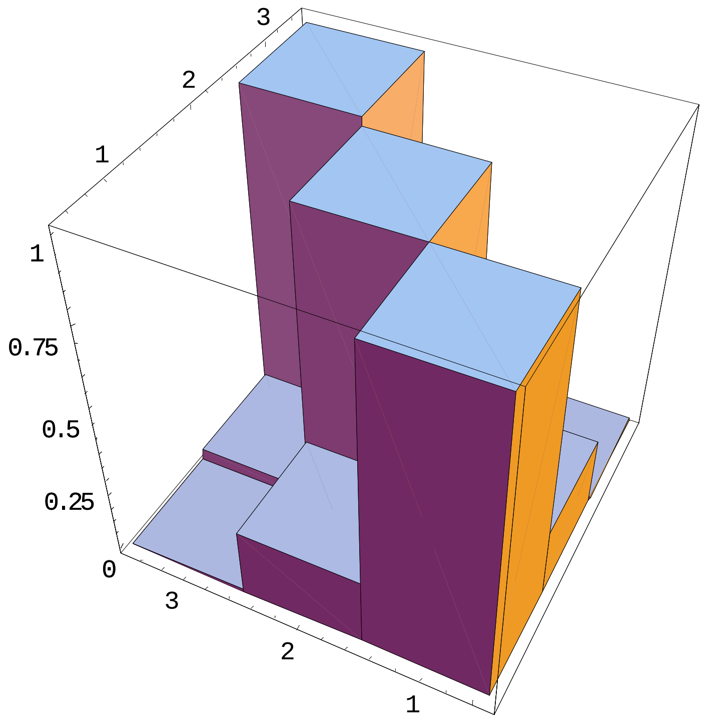
$$\begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} = \begin{pmatrix} 1-\lambda^2/2 & \lambda & A\lambda^3(\bar{\rho}-i\bar{\eta}) \\ -\lambda & 1-\lambda^2/2 & A\lambda^2 \\ A\lambda^3(1-\bar{\rho}-i\bar{\eta}) & -A\lambda^2 & 1 \end{pmatrix}$$

CKM matrix



Transitions between members of the same family more probable (=thicker lines) than others

→CKM: almost a diagonal matrix, but not completely →

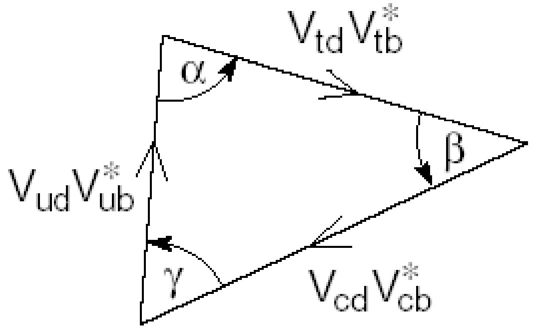


→CKM: almost real, but not completely...

Unitarity triangle

Unitarity condition:

$$V_{ud}V_{ub}^{\ *}+V_{cd}V_{cb}^{\ *}+V_{td}V_{tb}^{\ *}=0$$



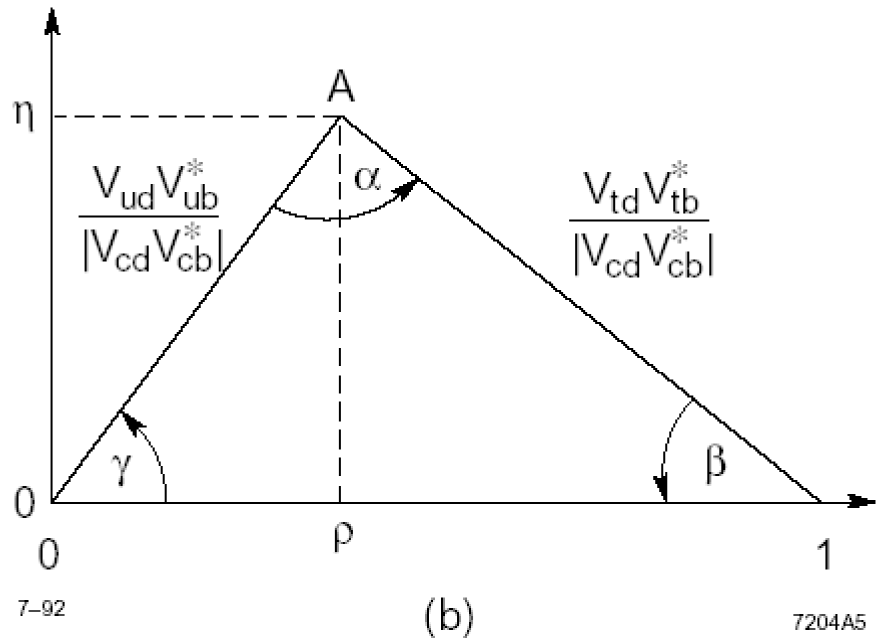
(a)

Another notation:

$\phi_1=\beta$

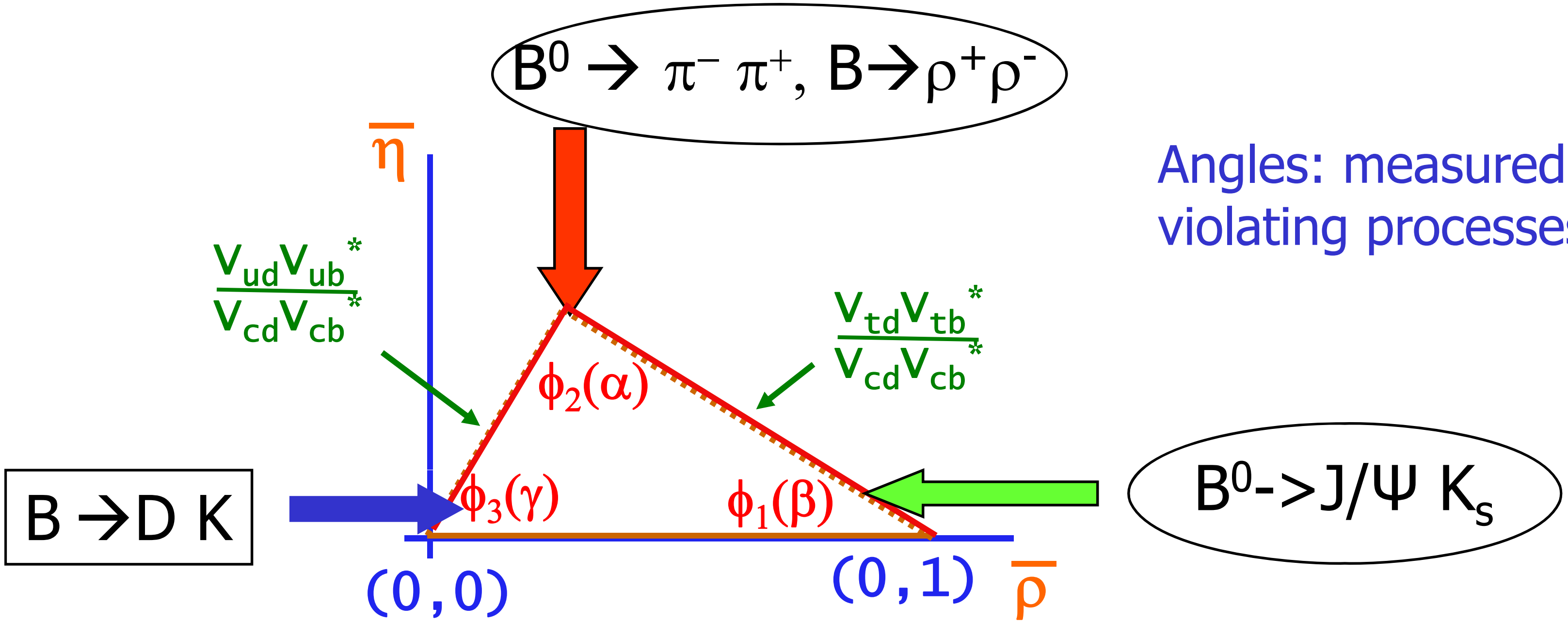
$\phi_2=\alpha$

$\phi_3=\gamma$



(b)

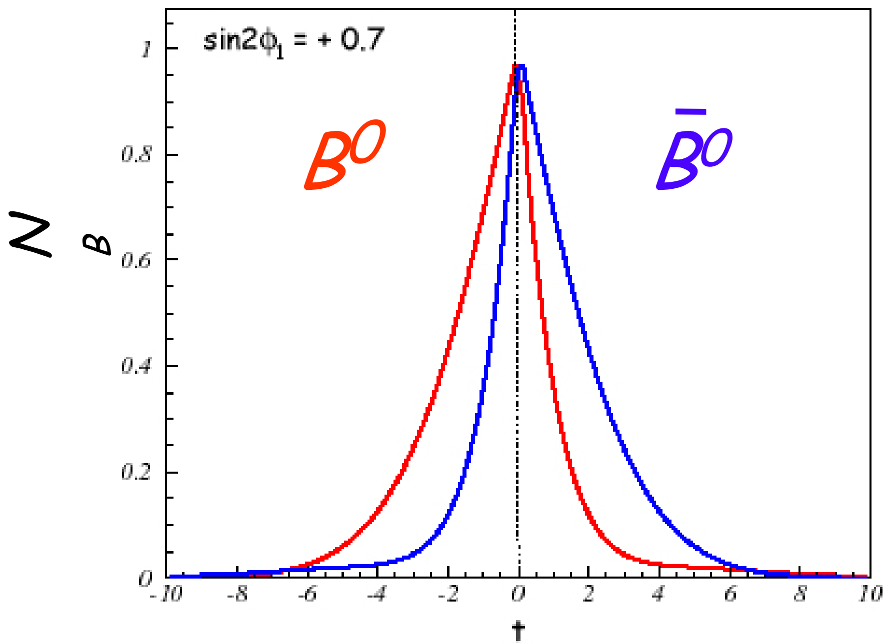
Three Angles: (ϕ_1, ϕ_2, ϕ_3) or (β, α, γ)

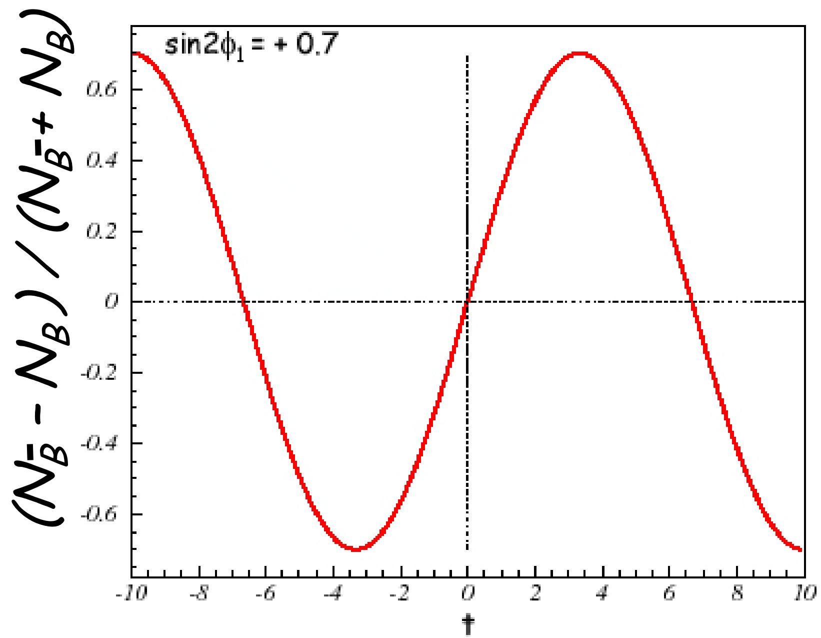


Angles: measured in CP violating processes

Big Questions: *Are determinations of angles consistent with determinations of the sides of the triangle? Are angle determinations from loop and tree decays consistent?*

CP Violation in B decays to CP eigenstates f_{CP}

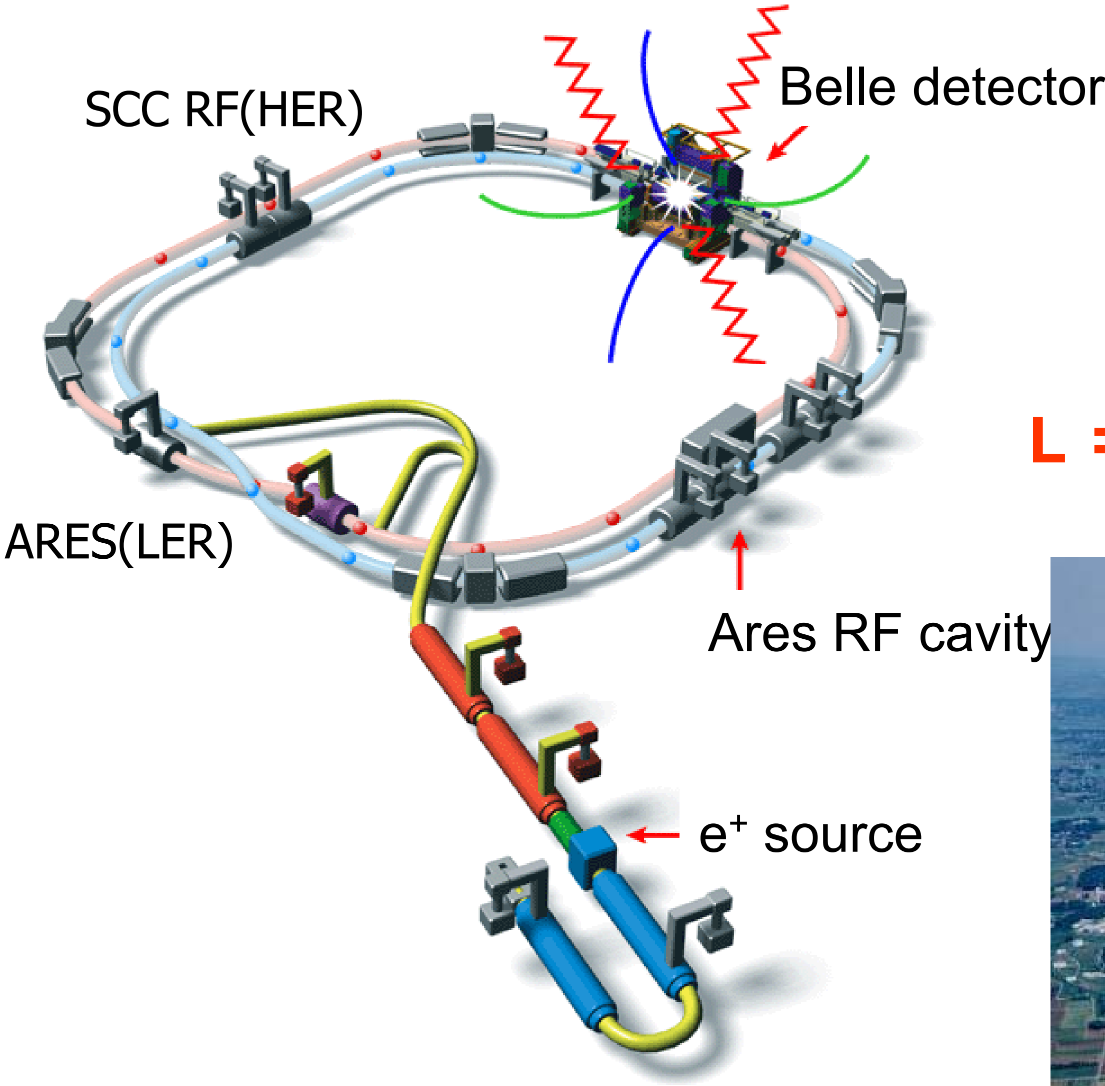




$$A_{CP}(t) = \frac{\Gamma(\bar{B}^0(t) \to f_{CP}) - \Gamma(B^0(t) \to f_{CP})}{\Gamma(\bar{B}^0(t) \to f_{CP}) + \Gamma(B^0(t) \to f_{CP})} = -\xi_f \sin 2\phi_1 \sin \Delta m_B t$$

$\xi_f = \pm 1$ ***for*** $CP = \pm 1$

The KEKB Collider

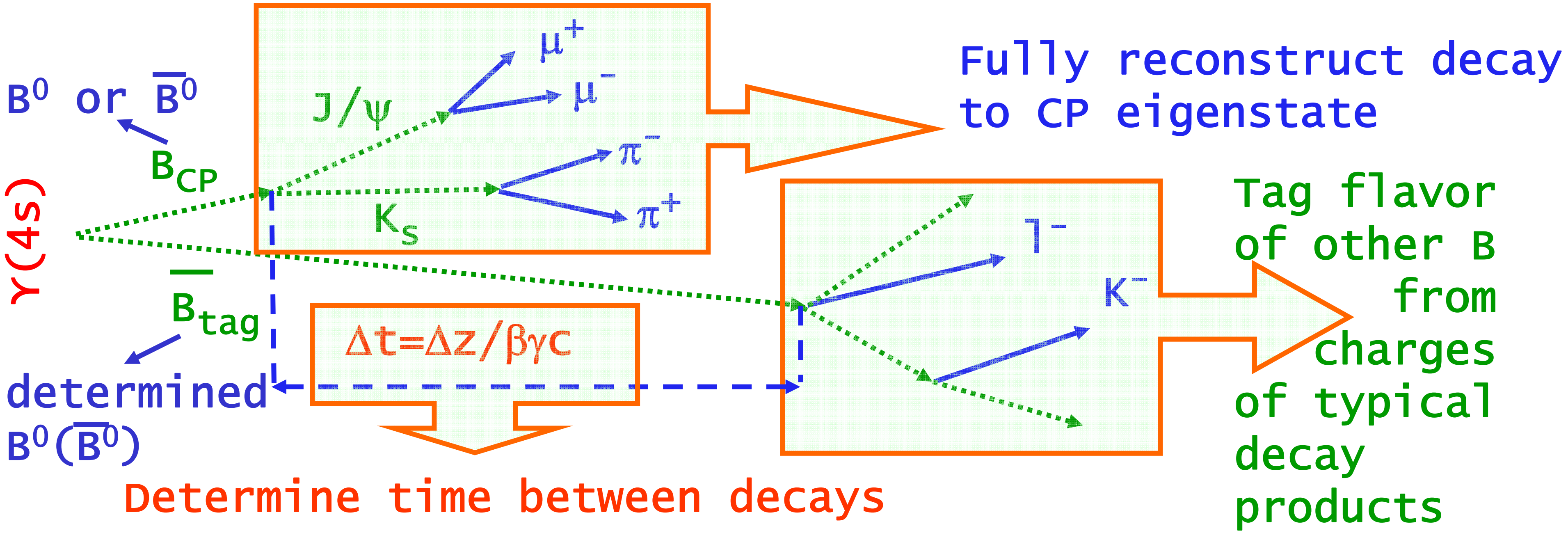


8 x 3.5 GeV
22mrad crossing angle

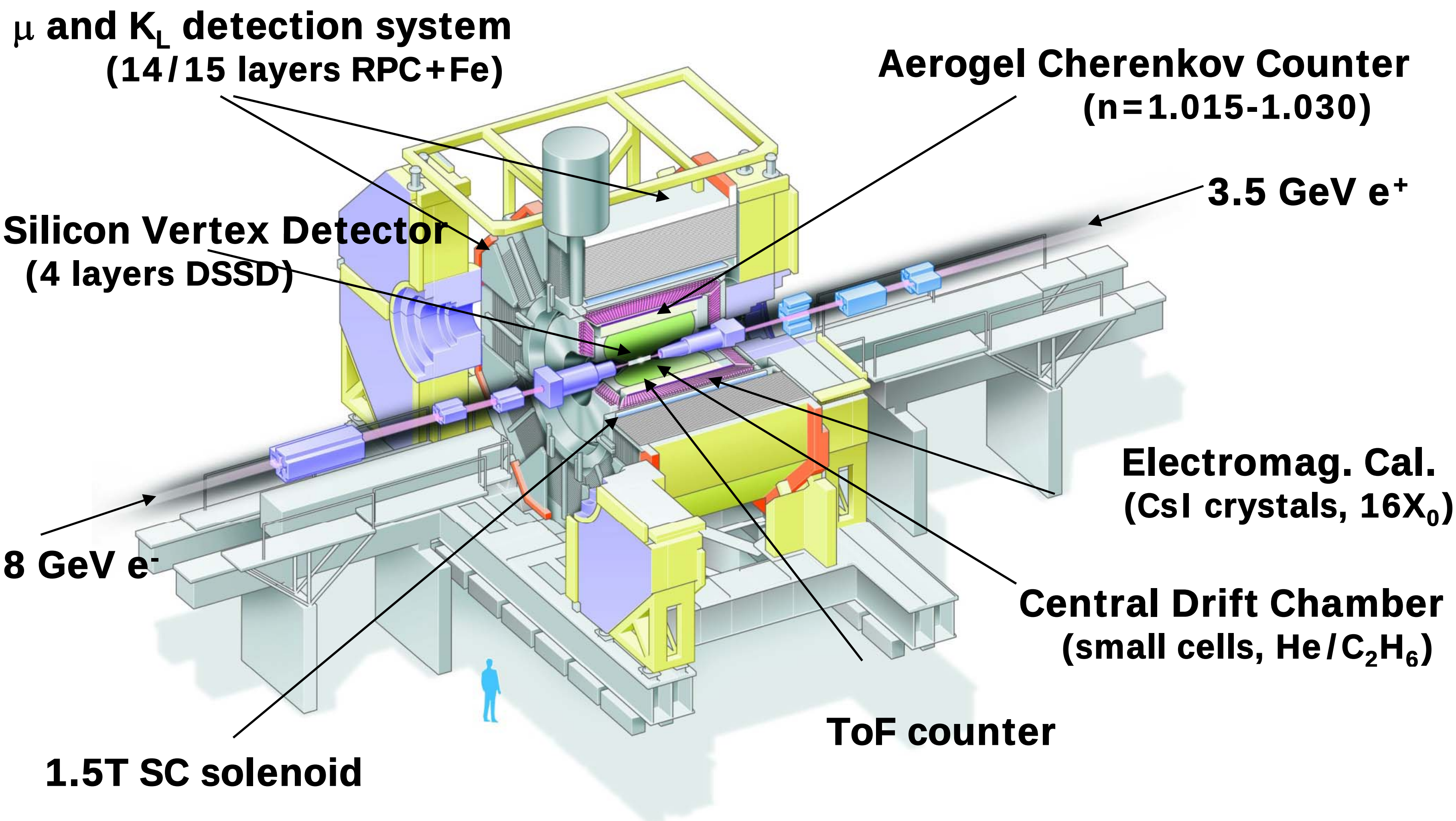
World record:

$L = 1.7 \times 10^{34} / cm^2 / sec$

Principle of measurement



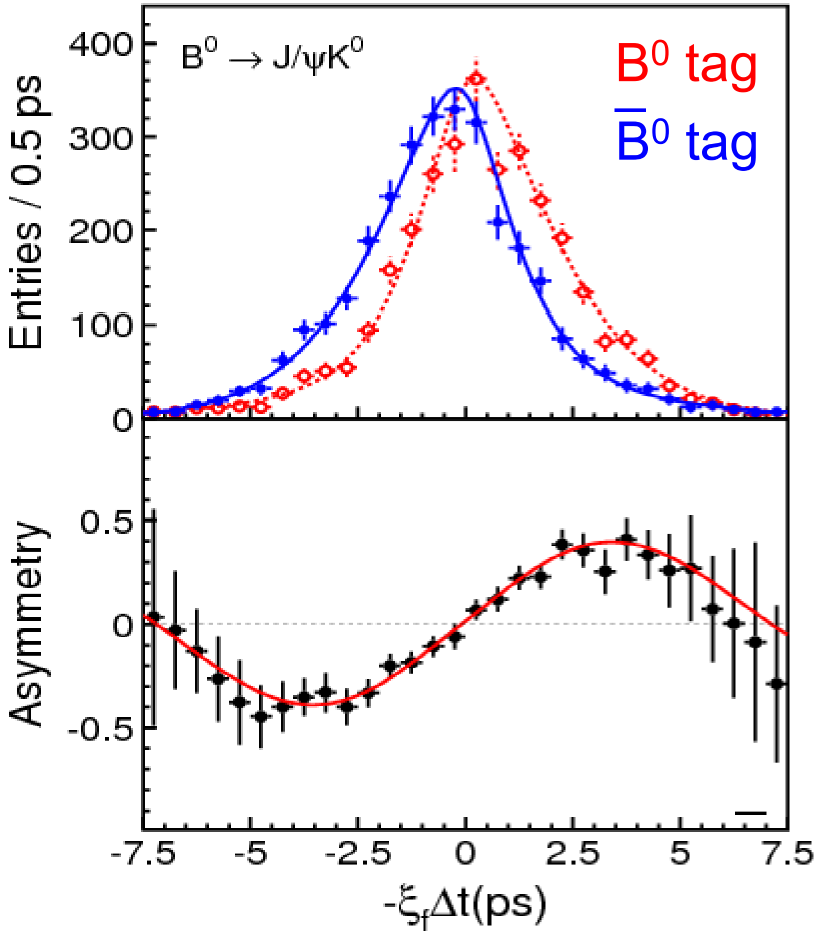
Belle spectrometer at KEK-B



+ an extremely well operating KEK-B collider →

CP violation in the B system

CP violation in B system: from the discovery (2001) to a precision measurement (2006)

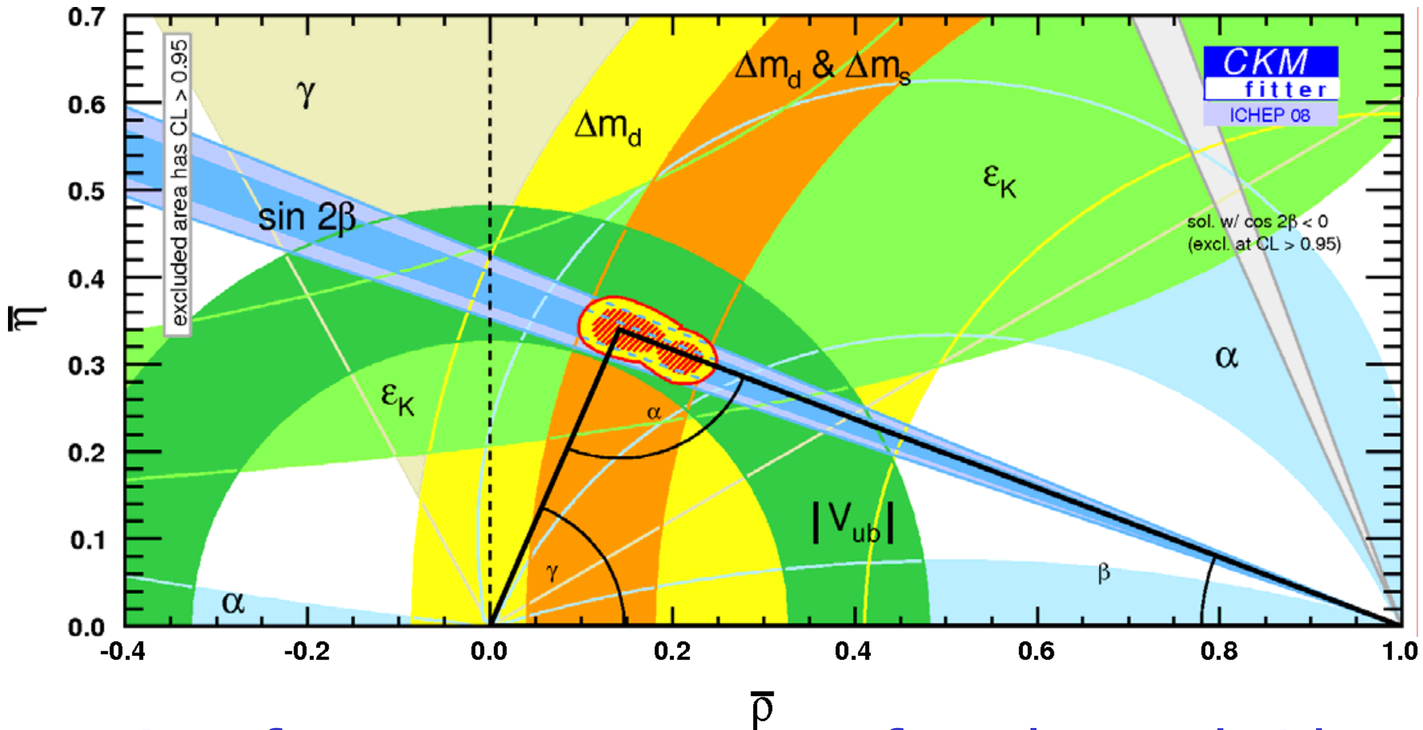


$\sin 2\phi_1 = \sin 2\beta$ from $b \to ccs$

535 M $B\overline{B}$ pairs

$\sin 2\phi_1$= 0.642 ±0.031 (stat) ±0.017 (syst)

All measurements combined...



Contraints from measurements of angles and sides of the unitarity triangle

→ Remarkable agreement

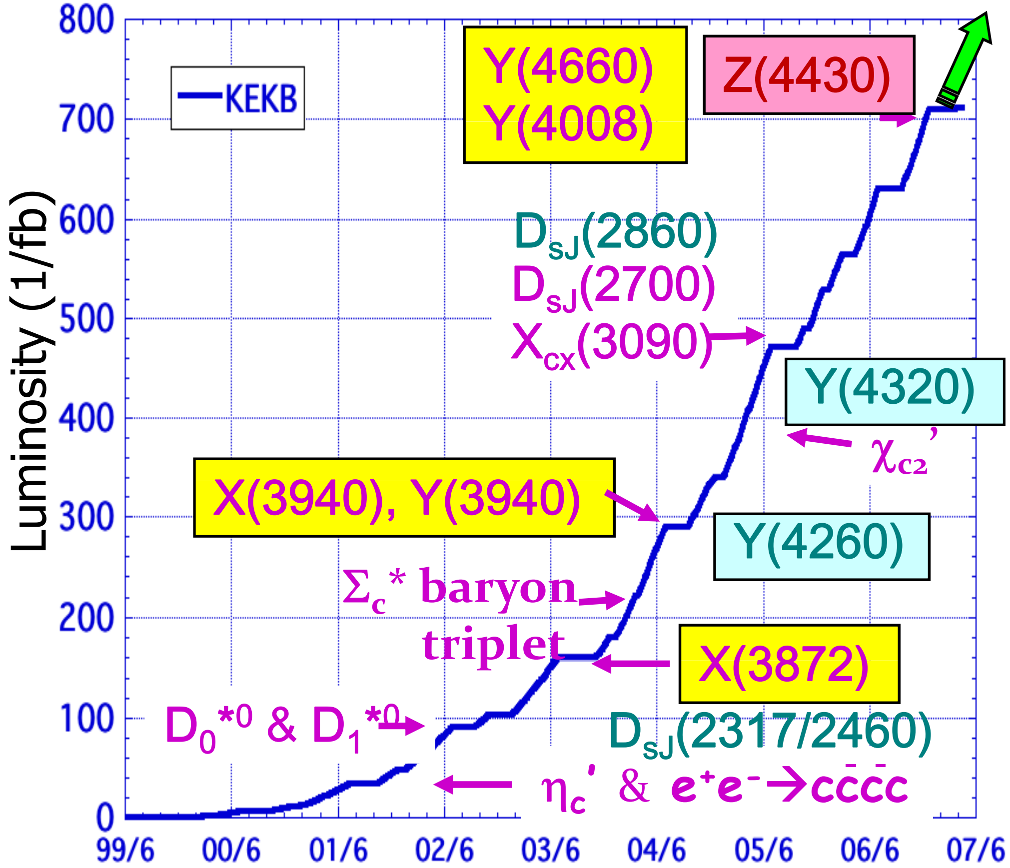
(appart from a small inconsistency in V_{ub})

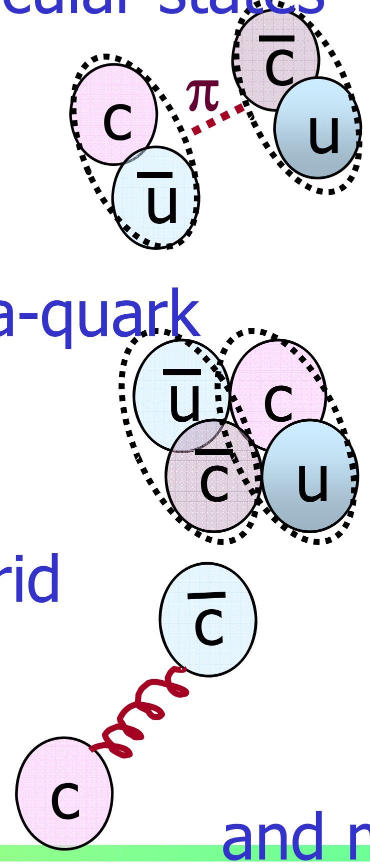
B factories: a success story

- Measurements of CKM matrix elements and angles of the unitarity triangle
- Observation of direct CP violation in B decays
- Measurements of rare decay modes (e.g., $B \rightarrow \tau\nu$, $D\tau\nu$) by fully reconstructing the other B meson
- Observation of D mixing
- CP violation in $b \rightarrow s$ transitions: probe for new sources if CPV
- Forward-backward asymmetry (A_{FB}) in $b \rightarrow s l^+ l^-$ has become a powerfull tool to search for physics beyond SM.
- Observation of new hadrons

New hadrons at B-factories

Discoveries of many new hadrons at B-factories have shed light on new class of hadrons beyond the ordinary mesons.

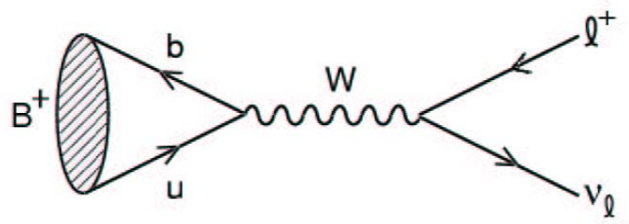




and more...

Purely leptonic decay $B \to \tau\, \nu$

- Challenge: B decay with at least two neutrinos
- Proceeds via W annihilation in the SM.



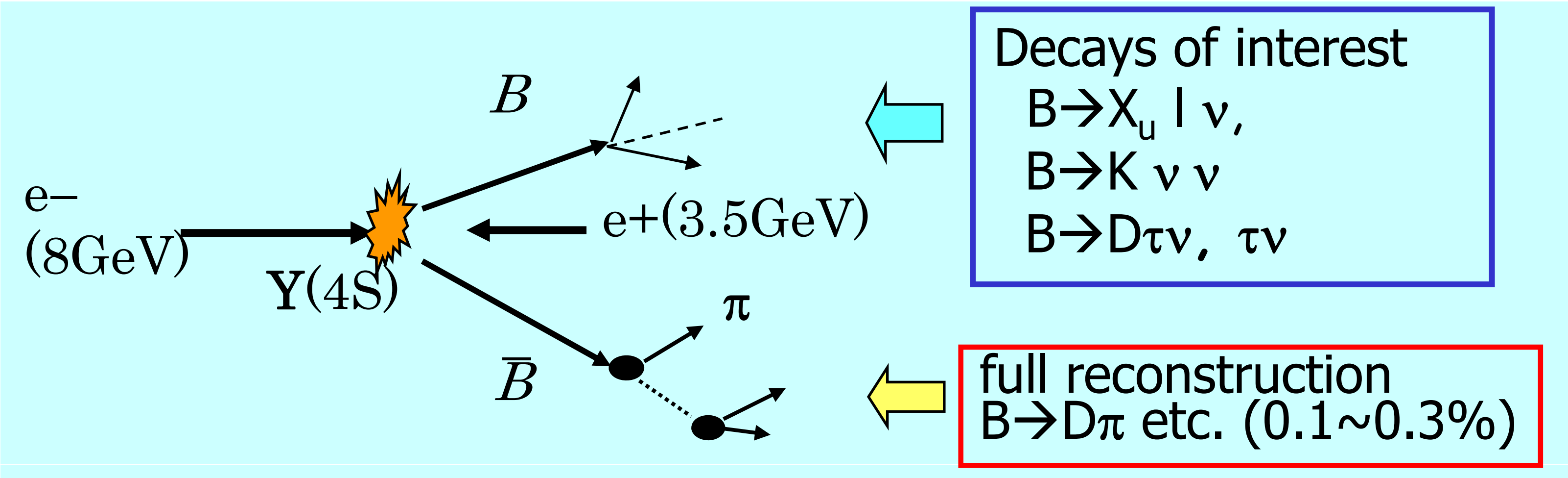
- Branching fraction

$$\mathcal{B}(B^- \to \ell^- \bar{\nu}) = \frac{G_F^2 m_B m_\ell^2}{8\pi}\left(1 - \frac{m_\ell^2}{m_B^2}\right)^2 f_B^2 |V_{ub}|^2 \tau_B$$

- Provide information of $f_B|V_{ub}|$
  - $|V_{ub}|$ from $B \to X_u\, l\, \nu$ → f_B ⟺ cf) Lattice
  - $Br(B \to \tau\nu)/\Delta m_d$ → $|V_{ub}|\, /\, |V_{td}|$
- Limits on charged Higgs

Full Reconstruction Method

- Fully reconstruct one of the B's to
  - Tag B flavor/charge
  - Determine B momentum
  - Exclude decay products of one B from further analysis

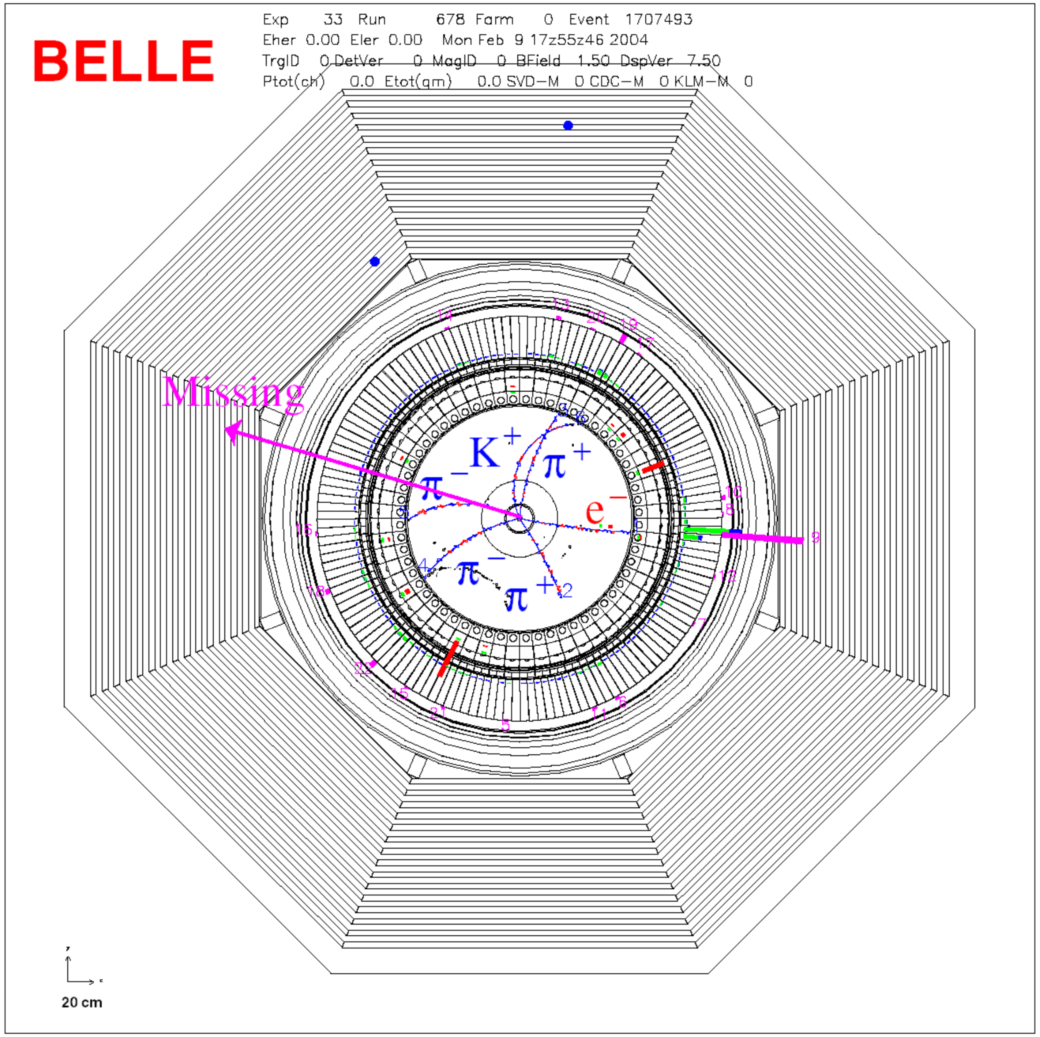


→ Offline B meson beam!

Powerful tool for B decays with neutrinos

Event candidate $B^- \rightarrow \tau^- \nu_\tau$

$$B^+ \to D^0 \pi^+$$
$$(\to K\pi^-\pi^+\pi^-)$$
$$B^- \to \tau(\to e\nu\bar{\nu})\nu$$



B→τ ν

Submitted to PRL, hep-ex/0604018

τ decay modes

$$\tau^- \rightarrow \mu^- \nu\bar{\nu}, e^- \nu\bar{\nu}$$

$$\tau^- \rightarrow \pi^- \nu, \pi^- \pi^0 \nu, \pi^- \pi^+ \pi^- \nu$$

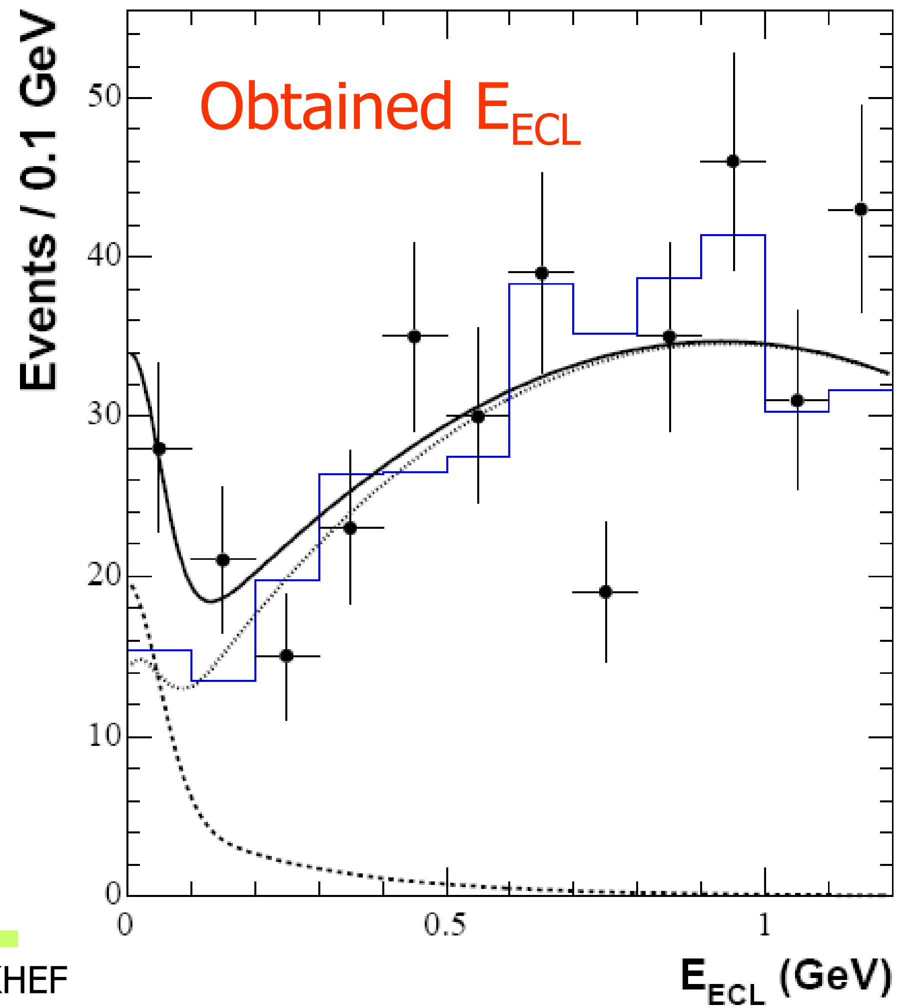
- Cover 81% of τ decays
- Efficiency 15.8%

Event selection

- Main discriminant: extra neutral ECL energy

Fit to $E_{residual}$ → $17.2^{+5.3}_{-4.7}$ signal events.

→3.5**σ** significance including systematics



$B \to \tau\, \nu_\tau$

$$BF(B^+ \to \tau^+ \nu_\tau) = (1.79^{+0.56+0.46}_{-0.49-0.51}) \times 10^{-4}$$

$$\Gamma^{SM}(B^+ \to \ell^+ \nu) = \frac{G_F^2}{8\pi} |V_{ub}|^2 f_B^2 m_B m_\ell^2 \left(1 - \frac{m_\ell^2}{m_B^2}\right)$$

→ Product of B meson decay constant f_B and CKM matrix element $|V_{ub}|$

$$f_B \times V_{ub} = \left(10.1^{+1.6+1.3}_{-1.4-1.4}\right) \times 10^{-4}\, GeV$$

Using $|V_{ub}| = (4.39 \pm 0.33) \times 10^{-3}$ from HFAG

$$f_B = 229^{+36+34}_{-31-37}\, MeV$$

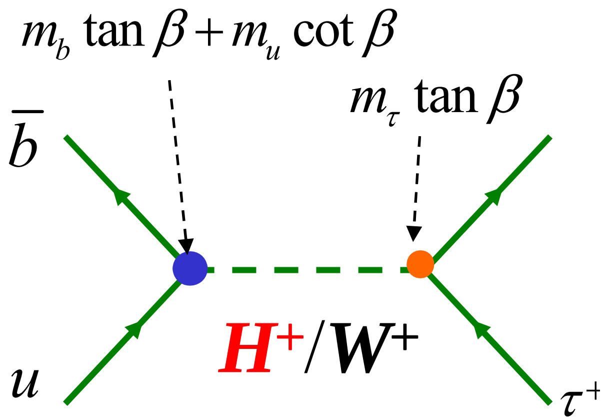
15% 15% = 13%(exp.) + 8%(V_{ub})

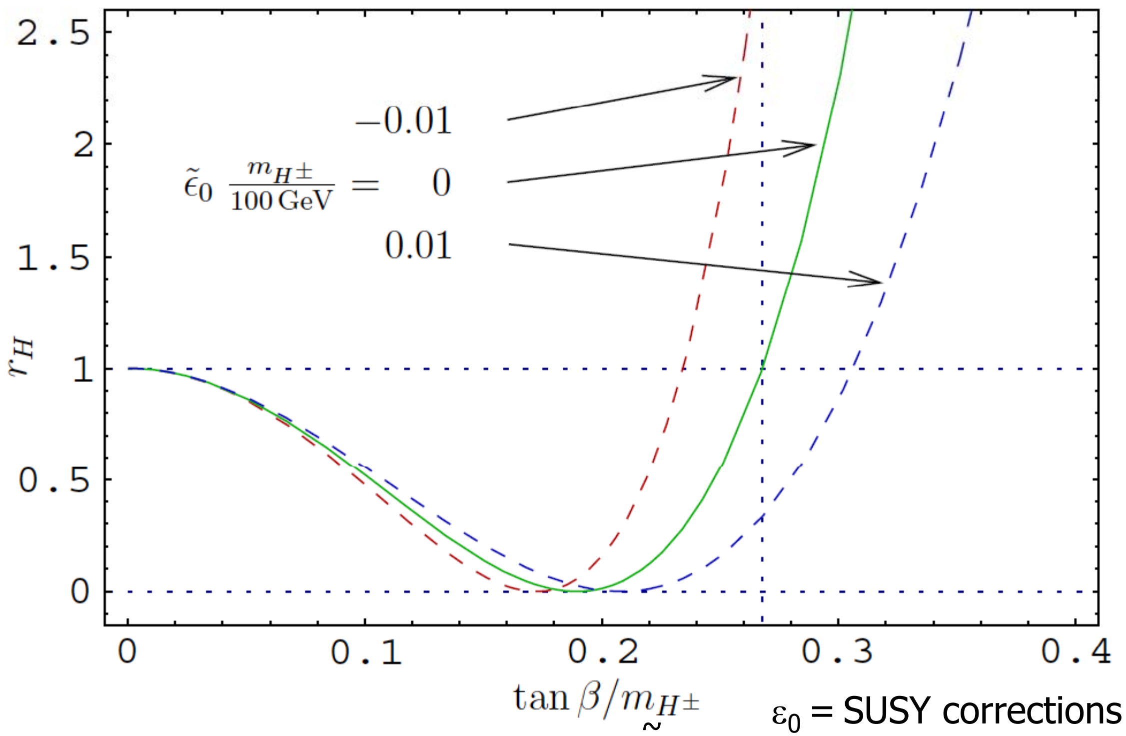
First measurement of f_B!

f_B = (216 ± 22) MeV from unquenched lattice calculation

[HPQCD, Phys. Rev. Lett. 95, 212001 (2005)]

Charged Higgs contribution to B→τ ν





ε_0 = SUSY corrections to b Yukawa coupling

$$\mathcal{B}(B \to \tau\nu) = \mathcal{B}(B \to \tau\nu)_{\mathrm{SM}} \times r_H,$$

$$r_H = \left(1 - \frac{m_B^2}{m_H^2}\tan^2\beta\right)^2$$

The interference is destructive in 2HDM (type II). B >B_{SM} implies that H^+ contribution dominates

Phys. Rev. D **48**, 2342 (1993)

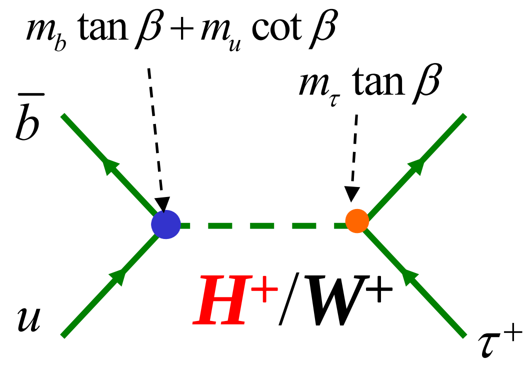
SM: B (B→τν)= ($0.78\ ^{+0.09}_{-0.13}$) x 10^{-4} (CKM fitter 2008 prediction)

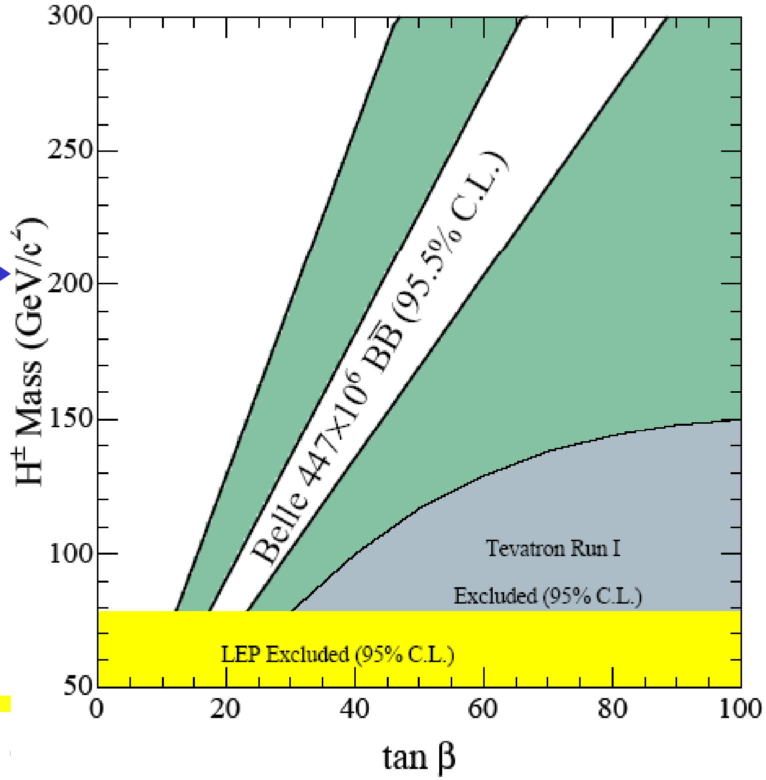
Charged Higgs limits from $B^- \to \tau^- \nu_\tau$

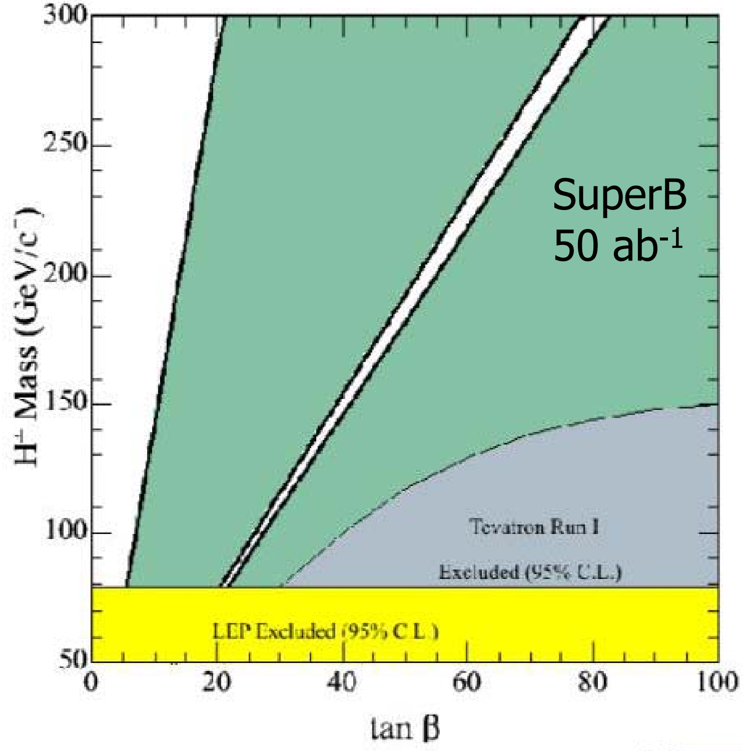
If the theoretical prediction is taken for $\mathbf{f_B}$

→ limit on charged Higgs mass vs. tanβ

$$r_H = \frac{BF(B\to\tau\nu)}{BF(B\to\tau\nu)_{SM}} = \left(1-\frac{m_B^2}{m_H^2}\tan^2\beta\right)^2$$







EF

New Belle result on $B^+ \to \tau^+ \nu$

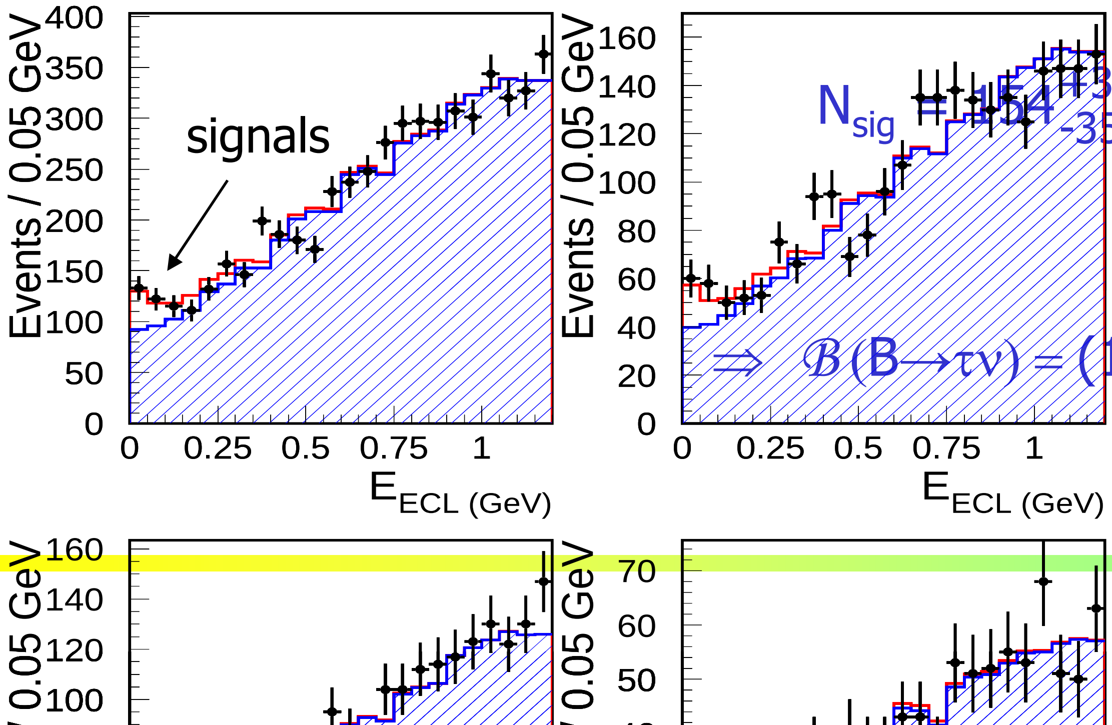
Method: Tag B on one side with the semileptonic decay $B \to D^{(*)} l \nu$

→ Neutrino not reconstructed in the tagging B decay sequence → more background than in fully reconstructed hadronic decays

Again look for τ signature with "extra" energy in the ECAL

NEW with 3.8σ

657 M $B\bar{B}$ with $D^{(*)} l \nu$ tag



$N_{sig} = 154 ^{+36}_{-35}$ (stat) $^{+20}_{-22}$ (syst)

$\Rightarrow \mathcal{B}(B \to \tau\nu) = (1.65 ^{+0.38}_{-0.37} {}^{+0.35}_{-0.37})\ 10^{-4}$

$B \to K^{(*)}\nu\nu$

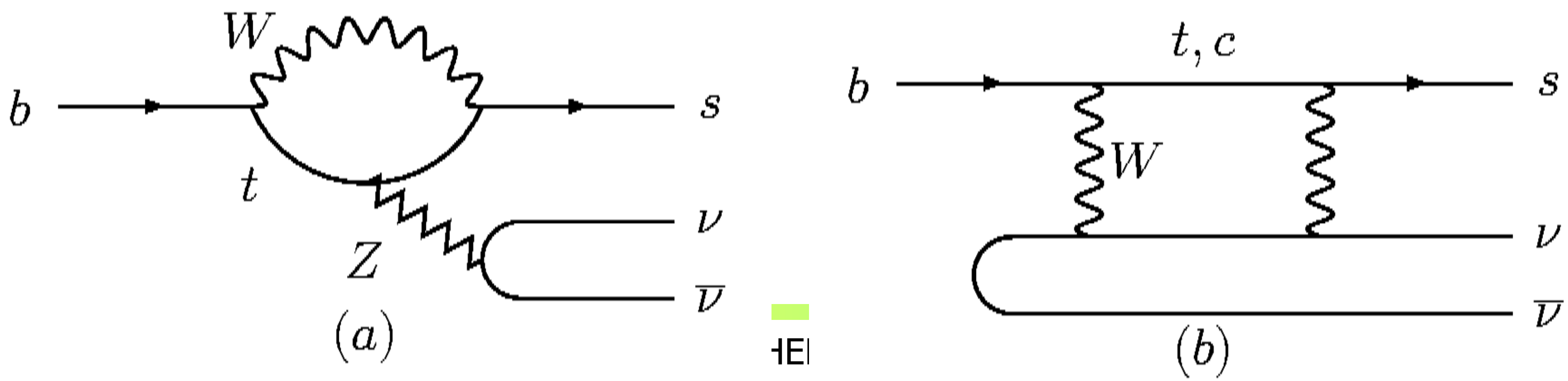
$B \to K^{(*)}\nu\nu$ is a particularly interesting and challenging mode (with $B \to \tau\nu$ as a small background), theoretically clean

Experimental signature: $B \to K$ + nothing

The "nothing" can also be light dark matter with mass of order 1 GeV. Direct dark-matter searches cannot see the M<10 GeV region.

SM prediction for $B^+ \to K^+\nu\nu$: $(3.8^{+1.2}_{-0.6}) \times 10^{-6}$

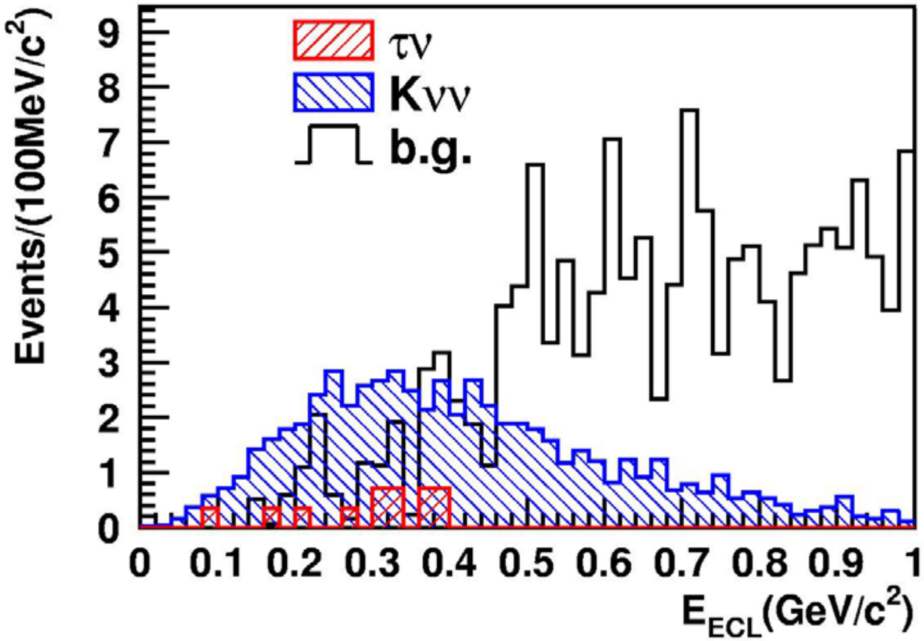
$B \to \tau\nu$ analysis is a proof that such a one prong decay can be studied at a B factory



$B^- \rightarrow K^- \nu \nu$ prospects

MC extrapolation to 50 ab^{-1}

5σ Observation of $B^\pm \rightarrow K^\pm \nu \nu$



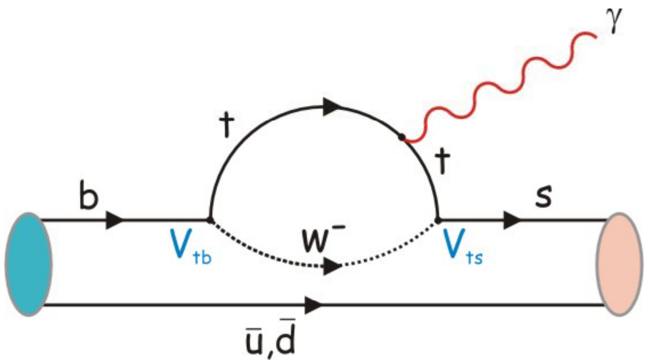
Extra EM calorimeter energy

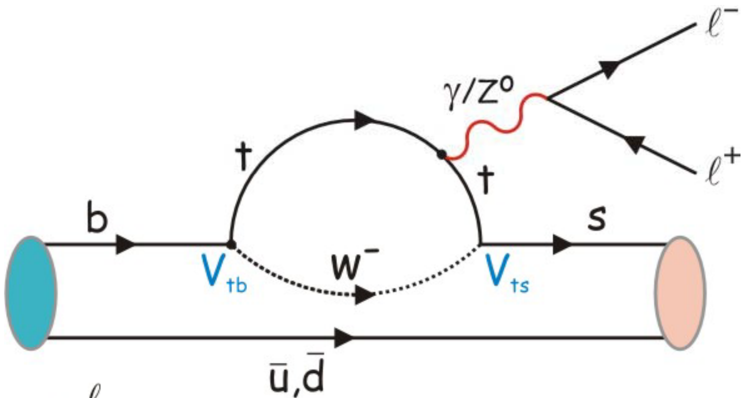
Fig. from SuperKEKB LoI

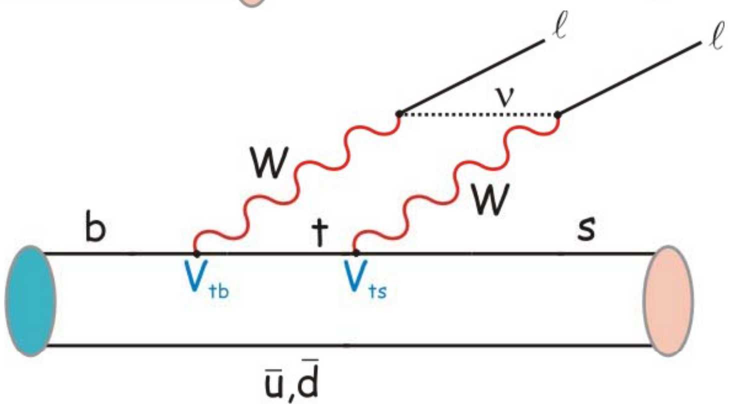
SM prediction:
G.Buchalla, G.Hiller, G.Isidori
(PRD 63 014015)

Why FCNC decays?

Flavour changing neutral current (FCNC) processes (like b→s, b→d) are fobidden at the tree level in the Standard Model. Proceed only at low rate via higher-order loop diagrams. Ideal place to search for new physics.



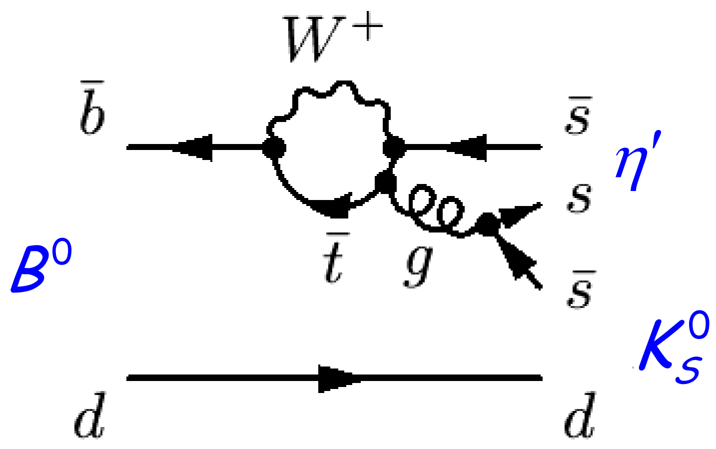




How can New Physics contribute to b→s?

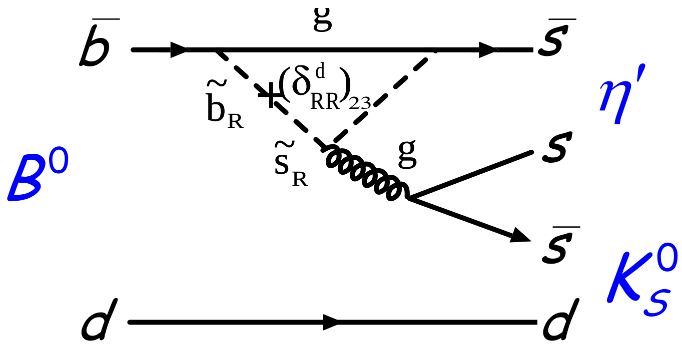
For example in the process:

$B^0 \to \eta' K^0$



Ordinary penguin diagram with a t quark in the loop

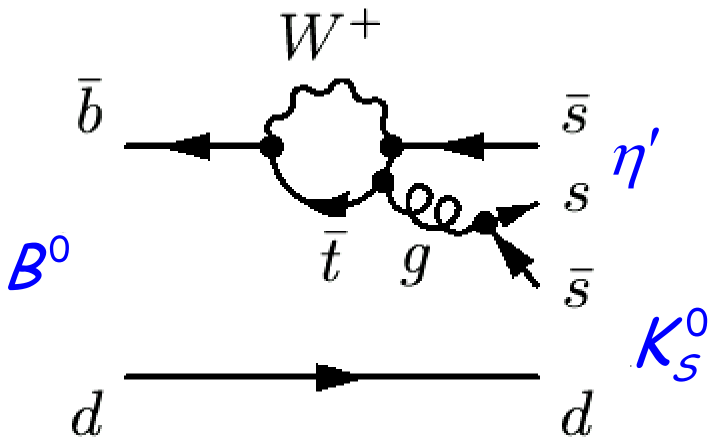
Diagram with supersymmetric particles



Searching for new physics phases in CP violation measurements in b→s decays

Prediction in SM:

$B^0 \to \eta' K^0$



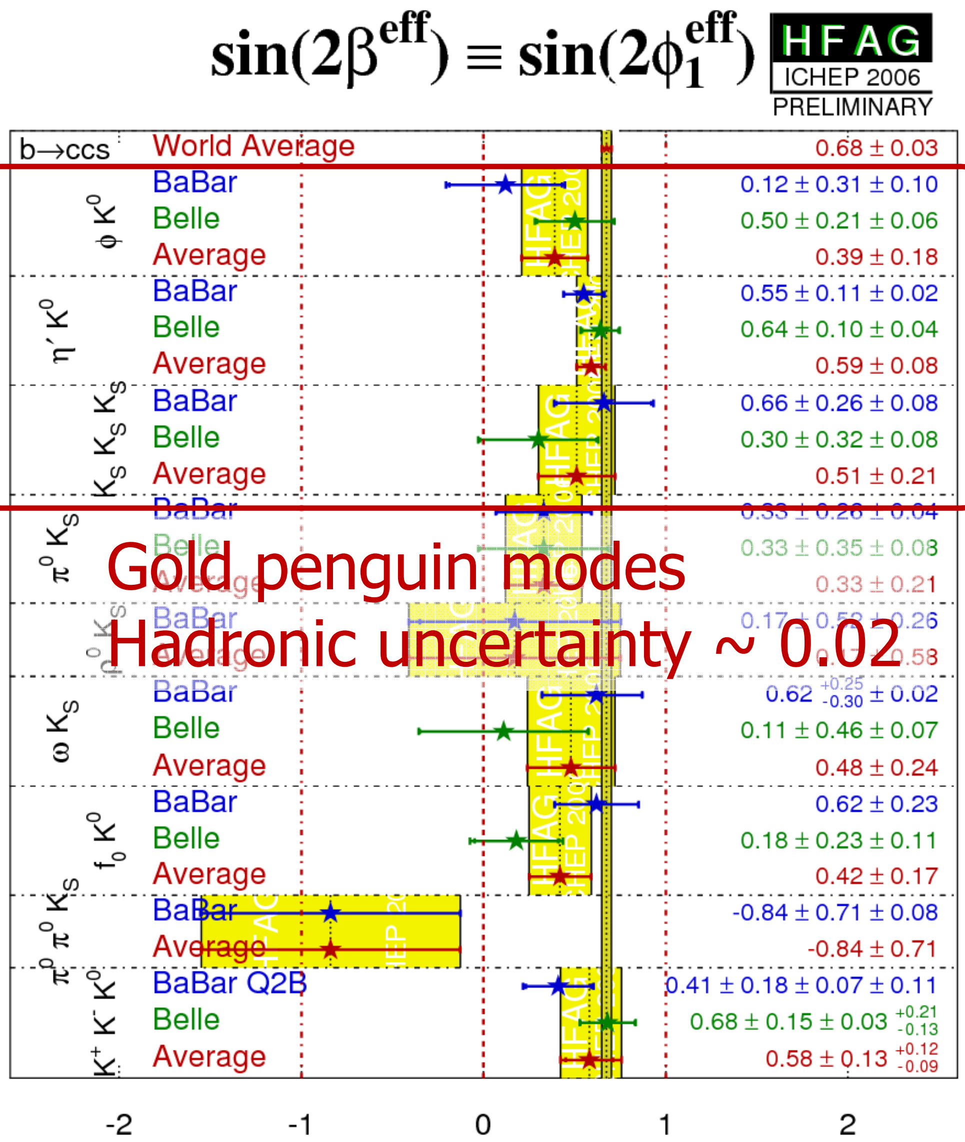
$$a_f = -\mathrm{Im}(\lambda_f)\sin(\Delta m t)$$

$$\mathrm{Im}(\lambda_f) = \xi_f \sin 2\phi_1$$

The same value as in the decay $B^0 \to J/\psi\ K_S$!

This is only true if there are no other particles in the loop! In general the parameter can assume a different value $\sin 2\phi_1^{eff}$

Search for NP: $b \to s q \bar{q}$



Gold penguin modes

Hadronic uncertainty ~ 0.02

ICHEP08

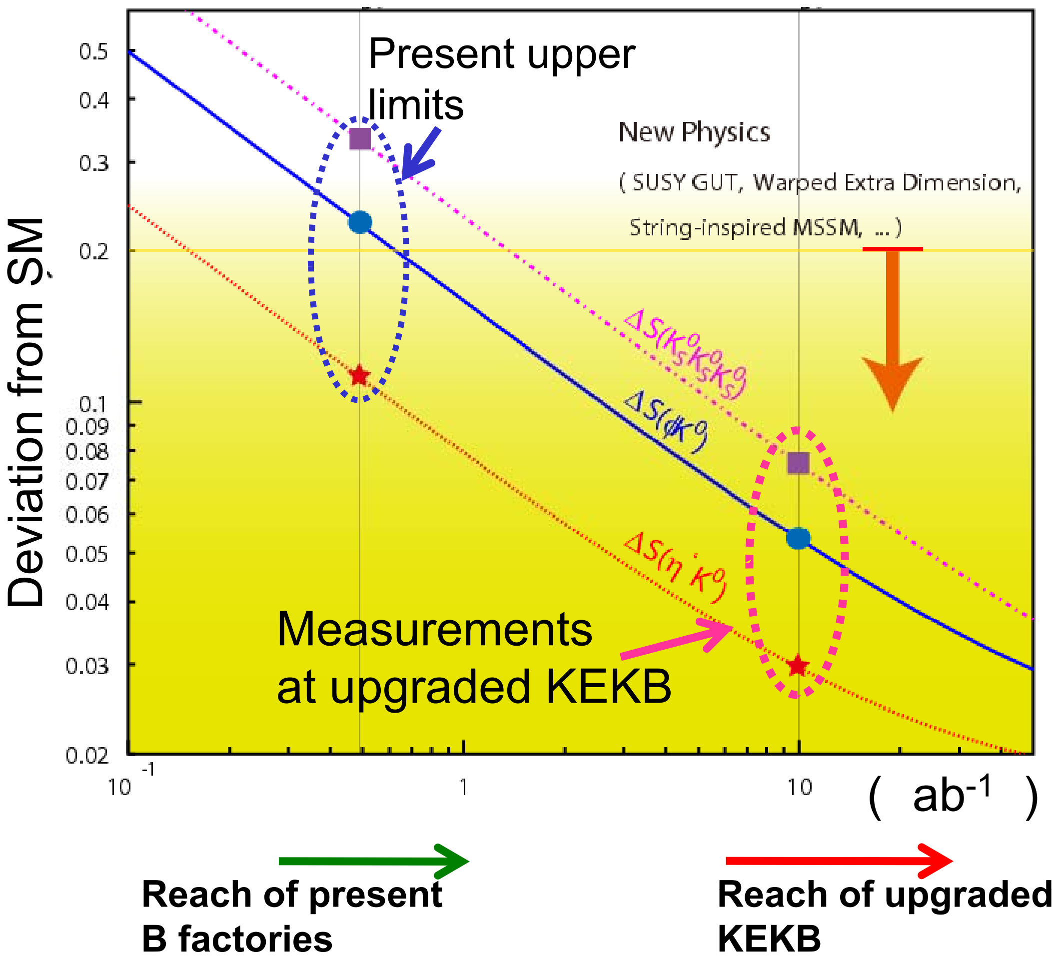
BaBar
Belle
Naïve average

BaBar	0.26±0.25±0.04
Belle	$0.67\pm^{0.25}_{0.27}\pm0.07$
Naïve average	0.45±0.18
BaBar	0.57±0.08±0.02
Belle	0.64±0.10±0.04
Naïve average	0.60±0.07
BaBar	0.71±0.24±0.04
Belle	0.30±0.32±0.08
Naïve average	0.57±0.20

Need much more data to clarify the issue

Searches for new sources of quark mixing and CP violation

CP asymmetries of penguin dominated B decays



Deviation from SM

New source of CP violation

Relevant to baryogenesis?

A difference in the direct violation of CP symmetry in B^+ and B^0 decays

CP asymmetry

$$\mathcal{A}_f = \frac{N(\overline{B} \to \bar{f}) - N(B \to f)}{N(\overline{B} \to \bar{f}) + N(B \to f)}$$


nature International weekly journal of science

nature Vol 452|20 March 2008|doi:10.1038/nature06827

LETTERS

Difference in direct charge-parity violation between charged and neutral *B* meson decays

The Belle Collaboration*

Difference between B^+ and B^0 decays

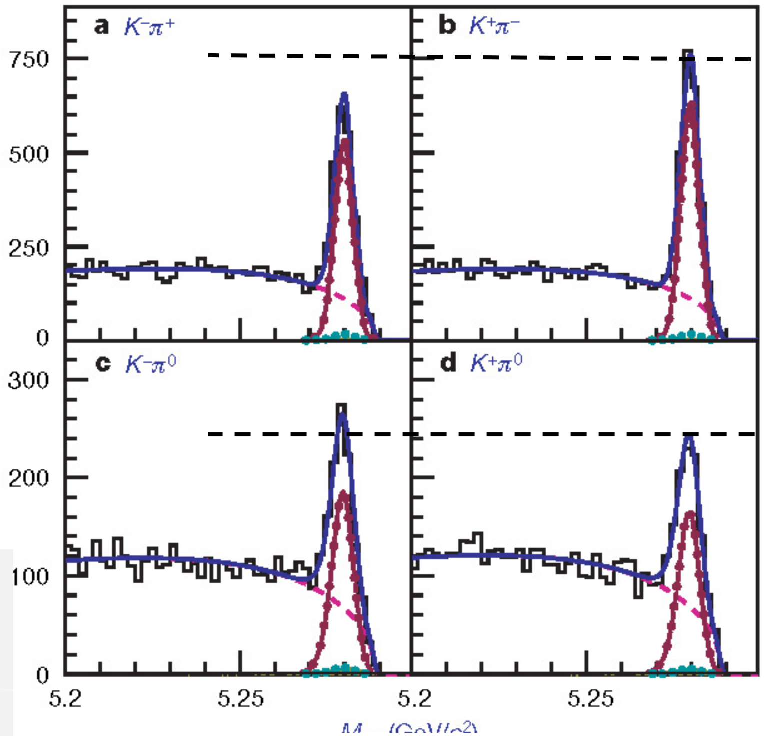
In SM expect $\mathcal{A}_{K^\pm\pi^\mp} \approx \mathcal{A}_{K^\pm\pi^0}$

Measure:

$$\mathcal{A}_{K^\pm\pi^\mp} = -0.094 \pm 0.018 \pm 0.008$$

$$\mathcal{A}_{K^\pm\pi^0} = +0.07 \pm 0.03 \pm 0.01$$

$$\Delta\mathcal{A} = +0.164 \pm 0.037$$

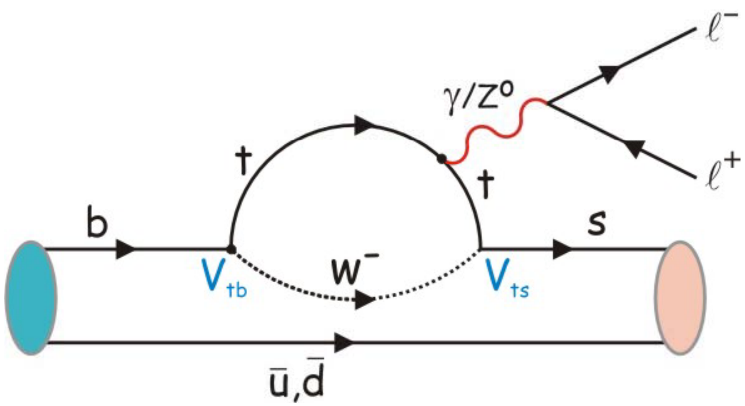


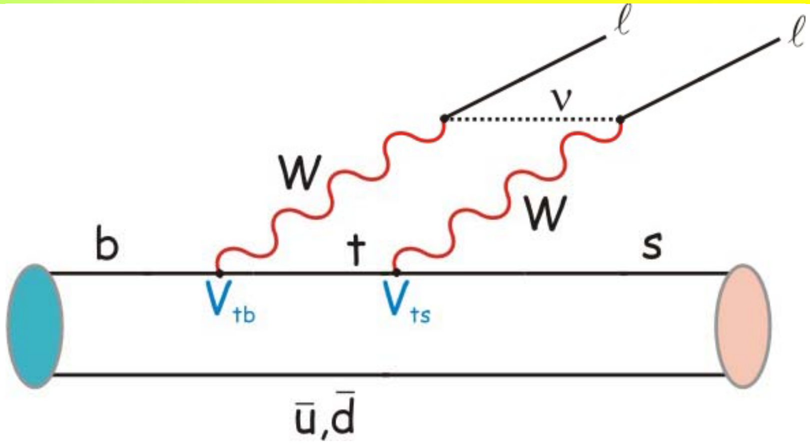
A problem for a SM explanation
(in particular when combined with other measurements)
A hint for new sources of CP violation?

~1 in 10^5 B mesons decays in this decay mode

Belle, Nature 452, 332 (2008)

Another FCNC decay: $B \rightarrow K^{*} l^{+} l^{-}$





$b \rightarrow s\, l^{+}l^{-}$ was first measured in $B \rightarrow K\, l^{+}l^{-}$ by Belle (2001).

Important for further searches for the physics beyond SM

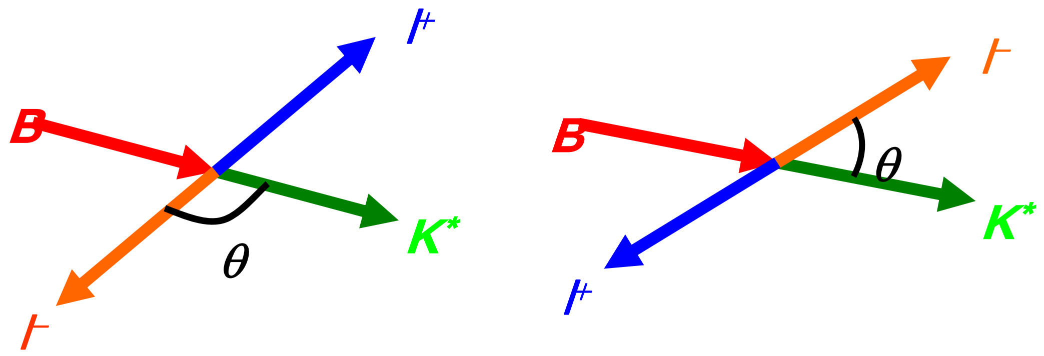
Particularly sensitive: backward-forward asymmetry in $K^{*}\, l^{+}l$

$$A_{FB} \propto \Re\left[C_{10}^{*}\left(sC_{9}^{eff}(s) + r(s)C_{7}\right)\right]$$

C_i : Wilson coefficients, abs. value of C_7 from $b \rightarrow s\gamma$

s=lepton pair mass squared

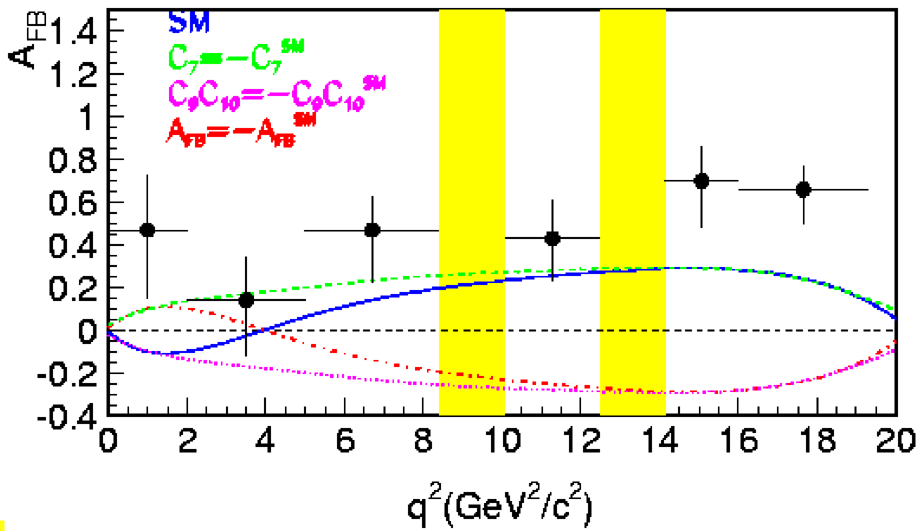
Backward-forward asymmetry in $K^* l^+ l$



Backward event

Forward event

[γ* and Z* contributions in B→K* l l interfere and give rise to forward-backward asymmetries c.f. $e^+e^- \to \mu^+ \mu^-$]



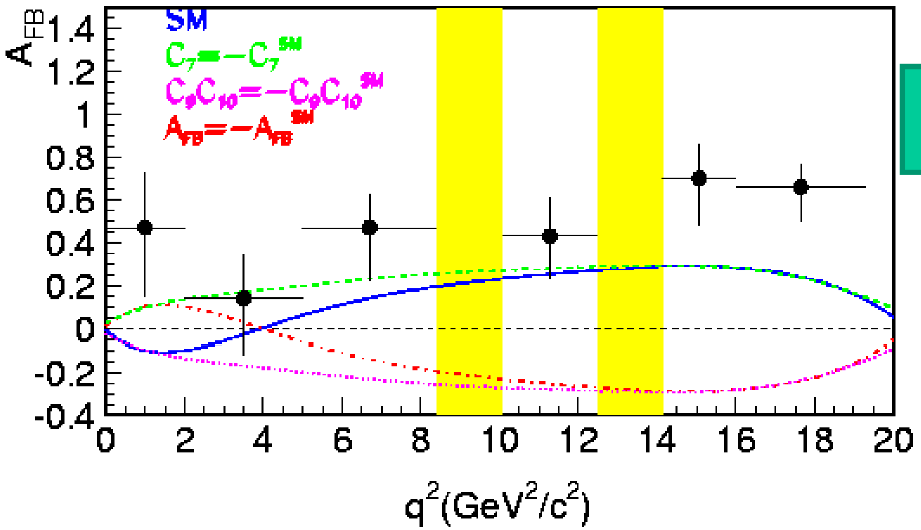
657 M BB

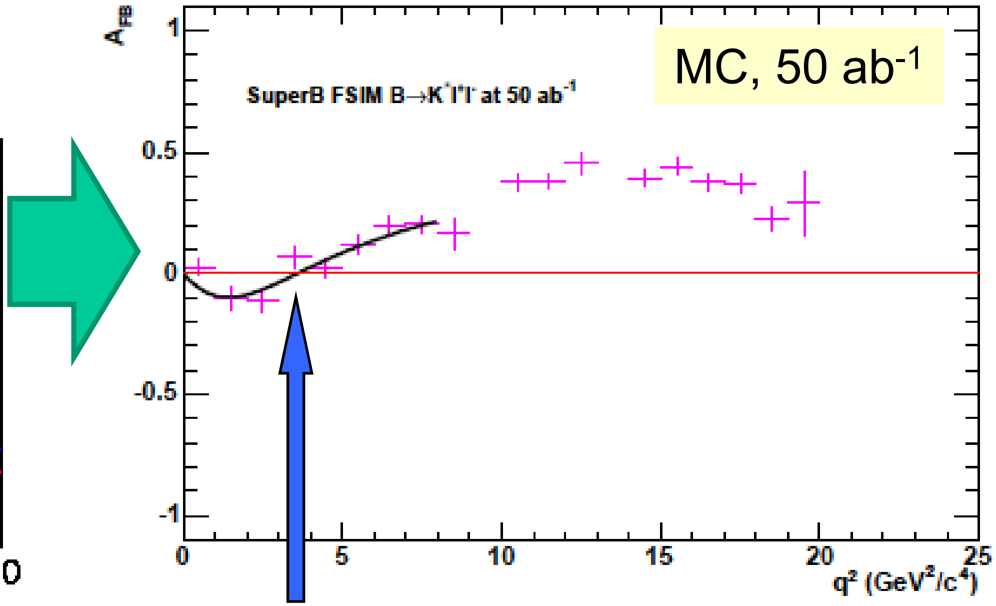
New

$$A_{FB} \propto \Re\left[C_{10}^* (s C_9^{eff}(s) + r(s) C_7) \right]$$

$A_{FB}(B \to K^* l^+ l^-)[q^2]$ at a Super B Factory

657 M BB





- Zero-crossing q^2 for A_{FB} will be determined with a 5% error with 50ab^{-1}.

Strong competition from LHCb and ATLAS/CMS

D^0 mixing in K^+K^-, $\pi^+\pi^-$

$D^0 \to K^+K^- / \pi^+\pi^-$

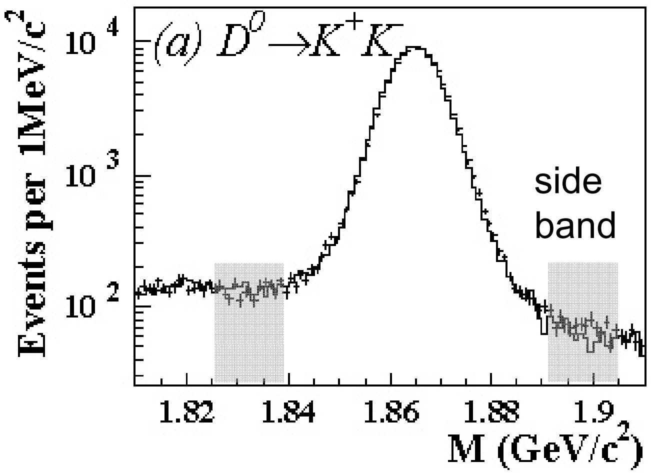
CP even final state;
in the limit of no CPV: CP|D_1> = |D_1>
$\Rightarrow$ measure $1/\Gamma_1$

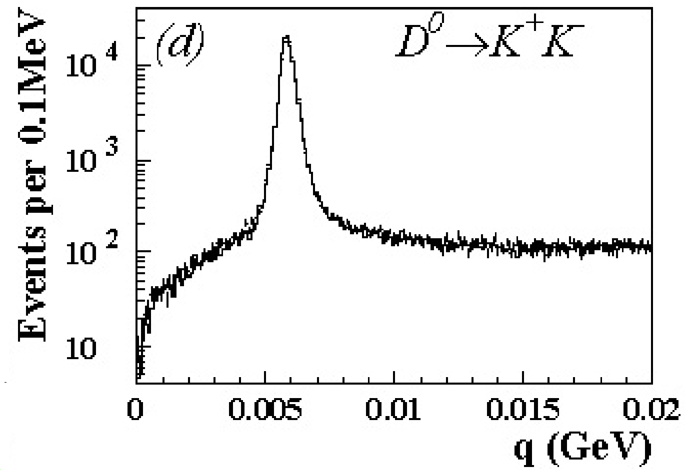
$$|D_{1,2}\rangle = p|D^0\rangle \pm q|\overline{D}^0\rangle$$

$$y_{CP} \equiv \frac{\tau(K^-\pi^+)}{\tau(K^-K^+)} - 1 = y\cos\varphi - \frac{1}{2}A_M x \sin\varphi = \underset{no\ CPV}{=} y$$

S. Bergman et al., PLB486, 418 (2000)

A_M, ϕ: CPV in mixing and interference





Signal: $D^0 \to K^+K^- / \pi^+\pi^-$ from D^*

M, Q, σ_t selection optimized in MC

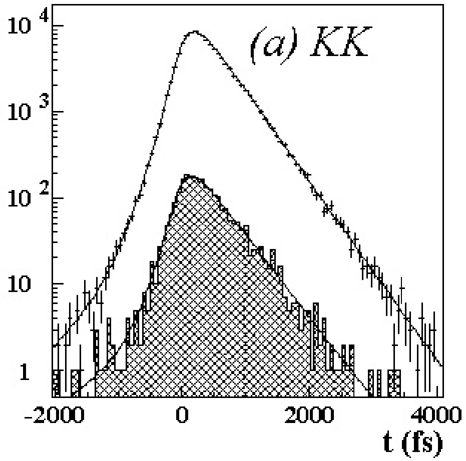
	K^+K^-	$K^-\pi^+$	$\pi^+\pi^-$
N_{sig}	111×10^3	1.22×10^6	49×10^3
purity	98%	99%	92%

PRL 98, 211803 (2007), 540fb^{-1}

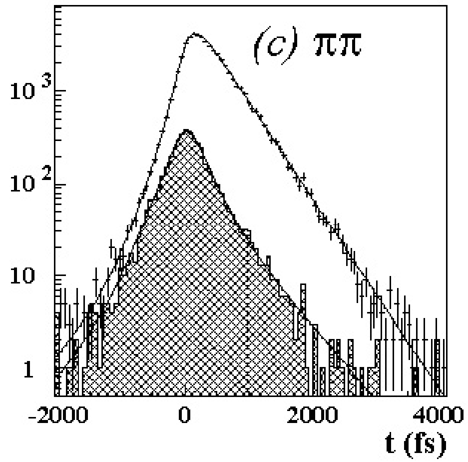
Super KEKB Quest for BSM

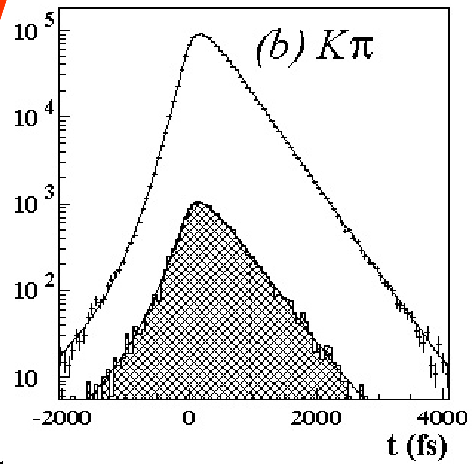
D^0 mixing in K^+K^-, $\pi^+\pi^-$

Decay time distributions for KK, ππ, Kπ



+

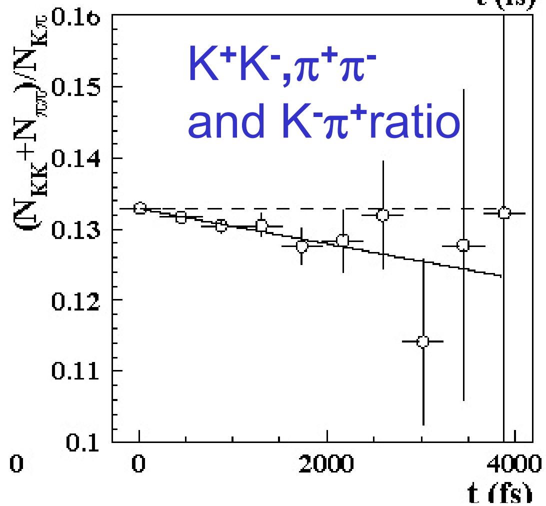




Difference of lifetimes visually observable

in the ratio of the distributions →

Real fit:



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

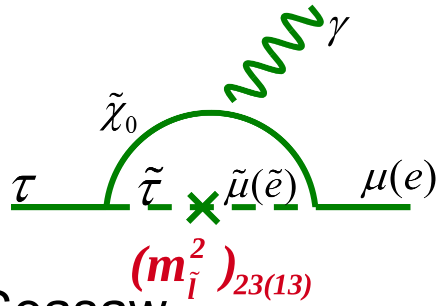
evidence for D^0 mixing

(regardless of possible CPV)

→ y_{CP} is on the high side of SM expectations

LFV and New Physics

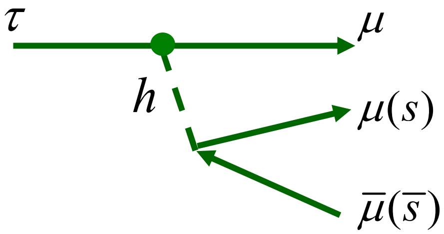
τ→lγ



- SUSY + Seasaw
- Large LFV Br(τ→μγ)=O(10$^{-7\sim9}$)

$$Br(\tau \to \mu\gamma) \cong 10^{-6} \times \left(\frac{(m^2_{\tilde{L}})_{32}}{\bar{m}^2_{\tilde{L}}} \right) \left(\frac{1\,TeV}{m_{SUSY}} \right)^4 \tan^2\beta$$

τ→3l,lη



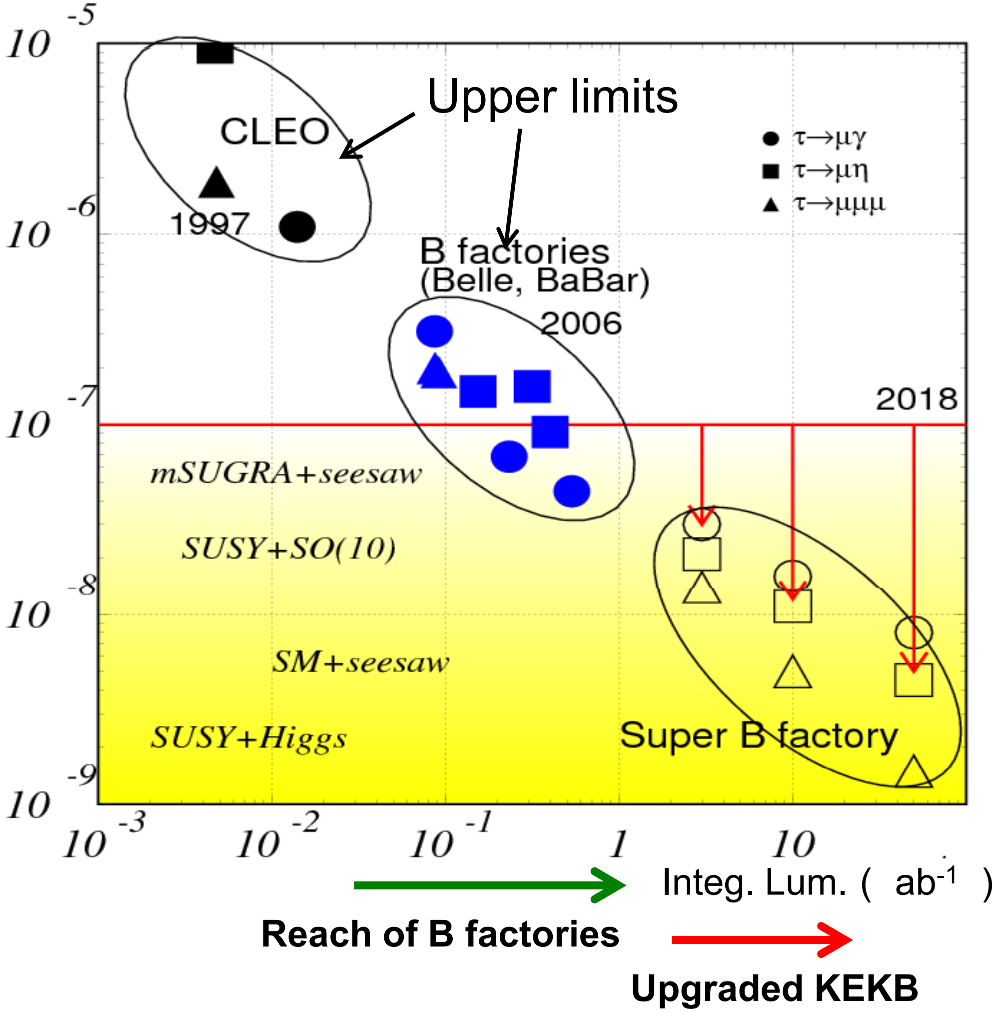
- Neutral Higgs mediated decay.
- Important when MSUSY >> EW scale.

$$Br(\tau \to 3\mu) = 4 \times 10^{-7} \times \left(\frac{(m^2_{\tilde{L}})_{32}}{\bar{m}^2_{\tilde{L}}} \right) \left(\frac{\tan\beta}{60} \right)^6 \left(\frac{100\,GeV}{m_A} \right)^4$$

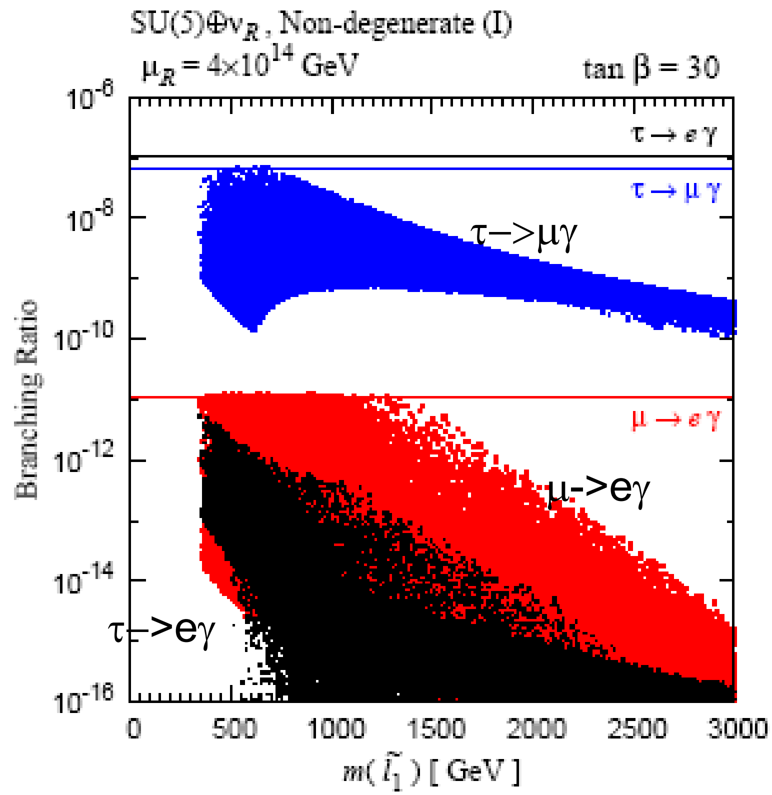
model	Br(τ→μγ)	Br(τ→lll)
mSUGRA+seesaw	10^{-7}	10^{-9}
SUSY+SO(10)	10^{-8}	10^{-10}
SM+seesaw	10^{-9}	10^{-10}
Non-Universal Z’	10^{-9}	10^{-8}
SUSY+Higgs	10^{-10}	10^{-7}

Precision measurements of τ decays

LF violating τ decay?



Theoretical predictions compared to present experimental limits



T.Goto et al., 2007

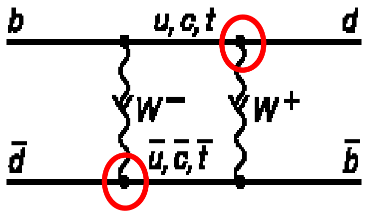
Physics at a Super B Factory

- There is a good chance to see new phenomena;
  - **CPV in B decays from the new physics (non KM).**
  - **Lepton flavor violations in τ decays.**
- They will help to diagnose (if found) or constraint (if not found) new physics models.
- Even in the worst case scenario (such as MFV), $B \rightarrow \tau\nu$, $D\tau\nu$ can probe the charged Higgs in large tanβ region.
- **Physics motivation is independent of LHC.**
  - If LHC finds NP, precision flavour physics is compulsory.
  - If LHC finds no NP, high statistics B/τ decays would be an unique way to search for the TeV scale physics.

Super B Factory Motivation 2

- A lesson from history: the top quark

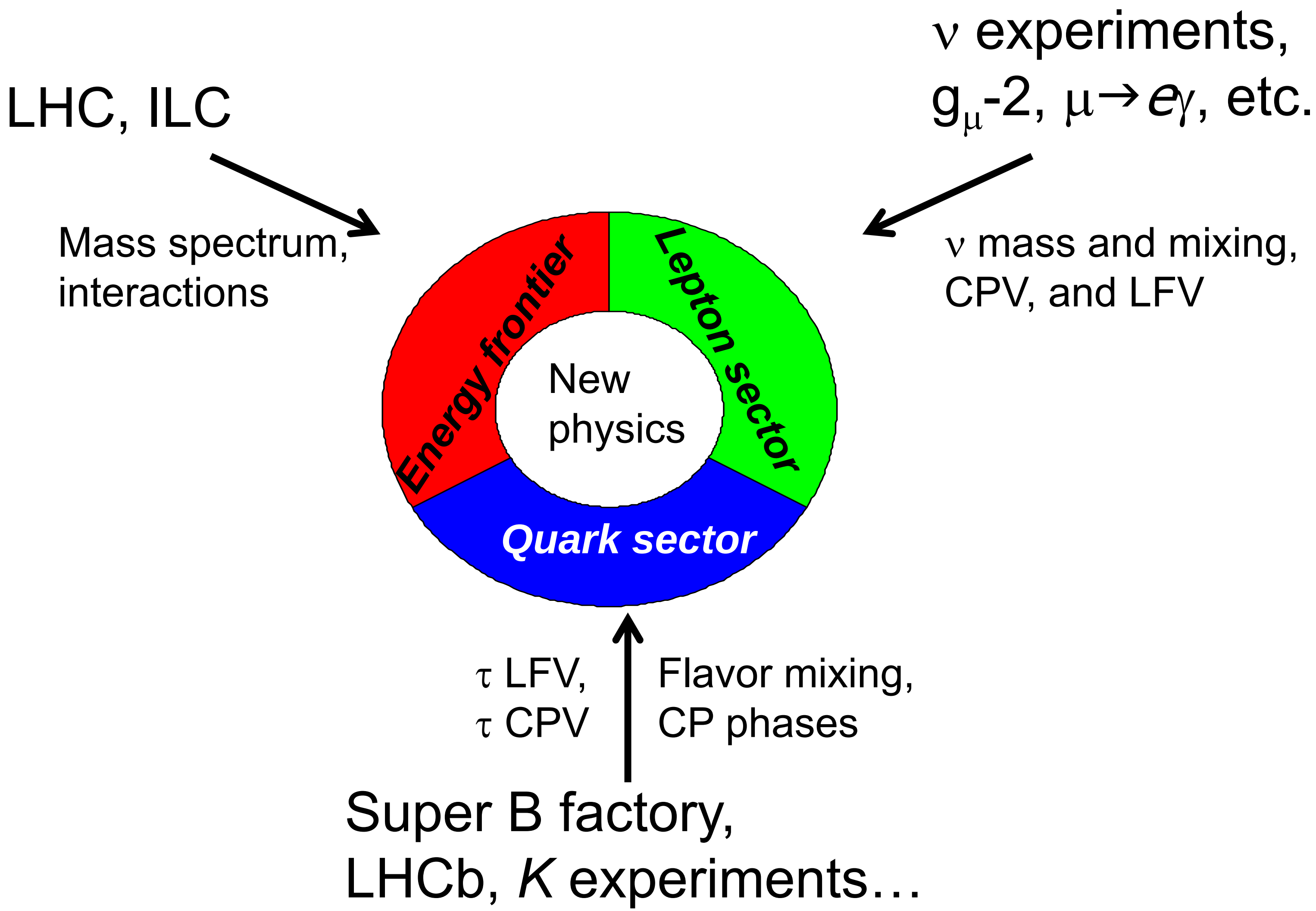
<u>Physics of top quark</u>
First estimate of mass: BB mixing → ARGUS
Direct production, Mass, width etc. → CDF/D0
Off-diagonal couplings, phase → BaBar/Belle



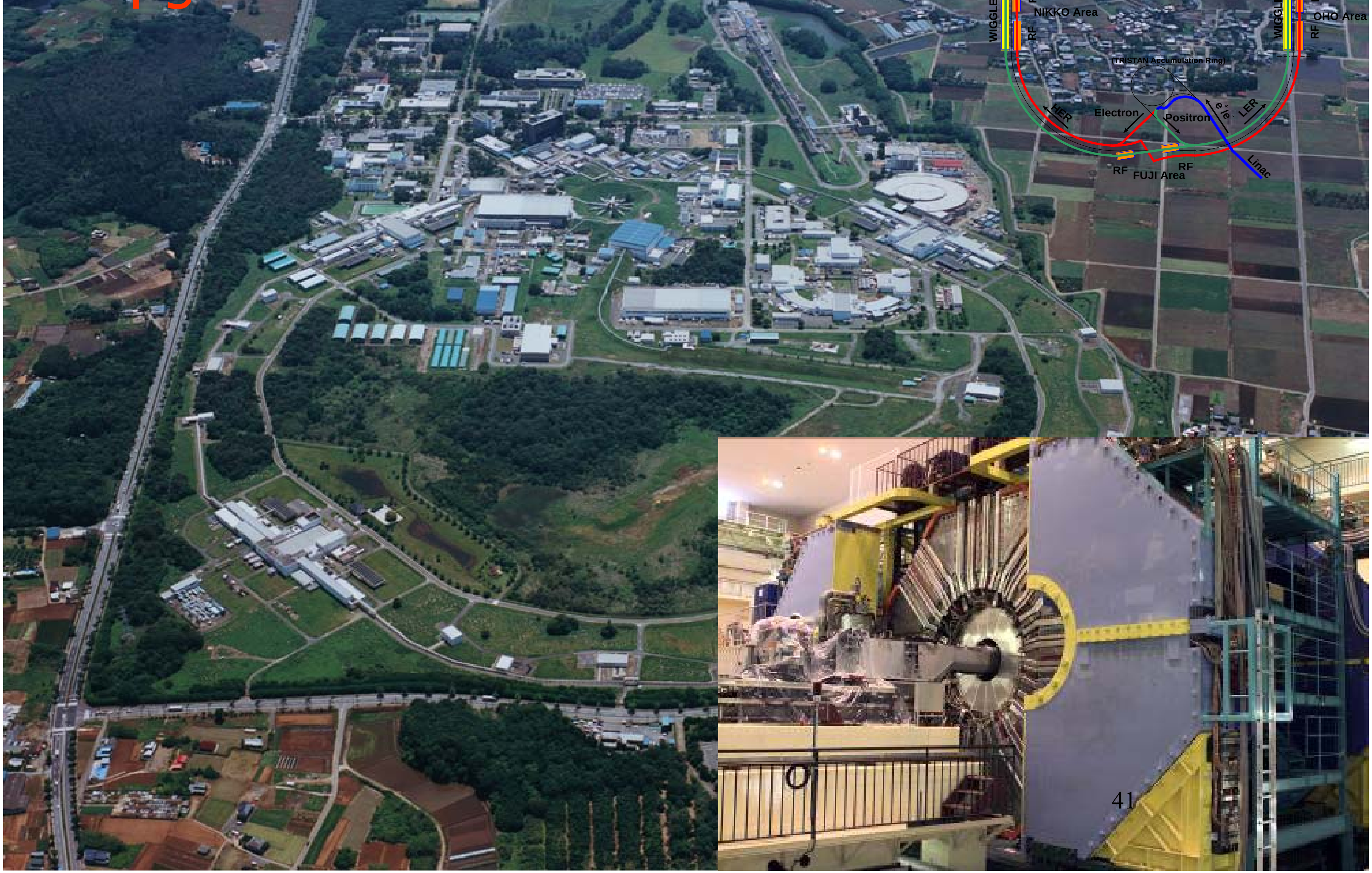
$$V_{CKM} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}$$

- There are many more topics: CPV in charm, new hadrons, …

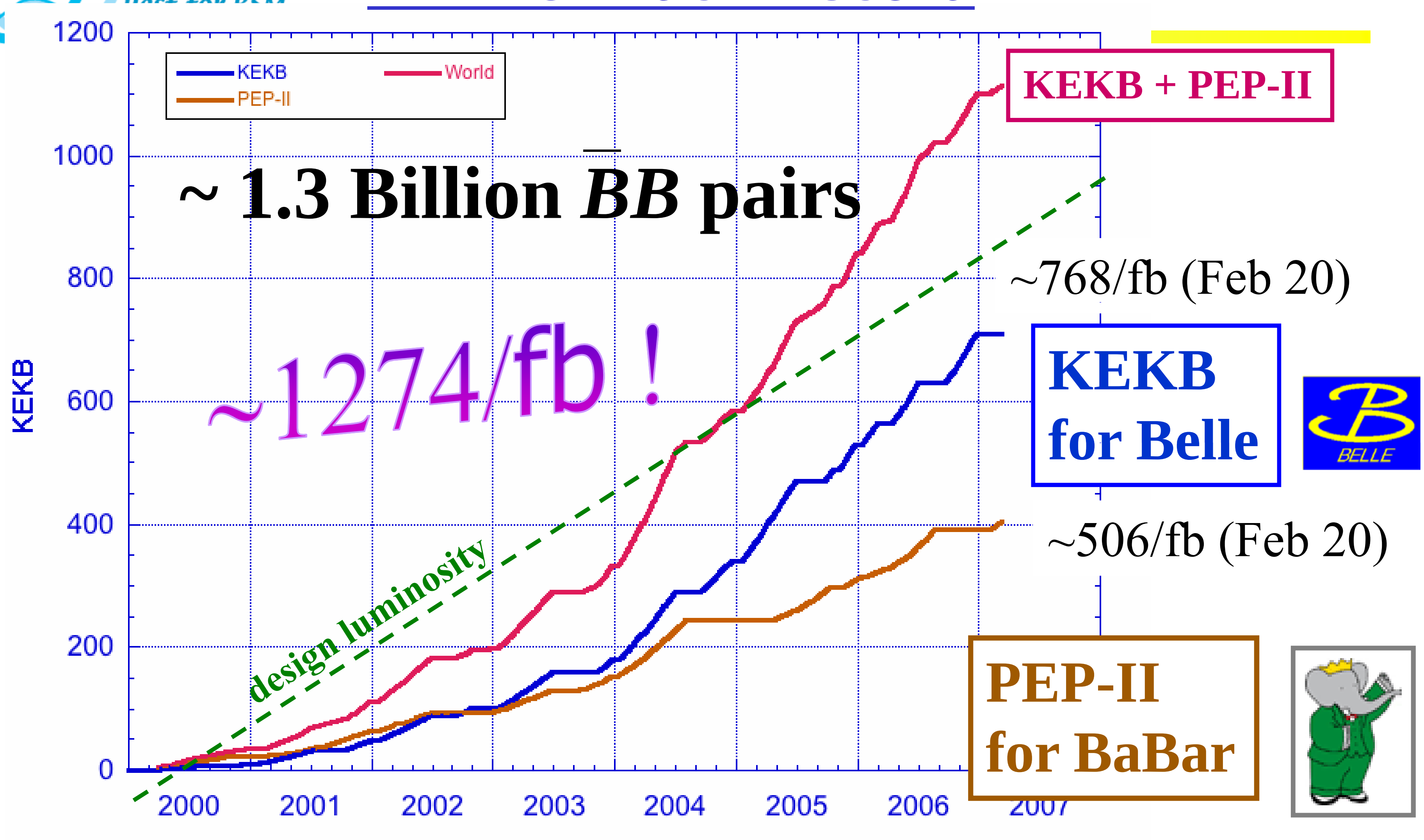
Super B factory: an important part of a broad unbiased approach to New Physics



How to do it?
→ upgrade KEKB and Belle



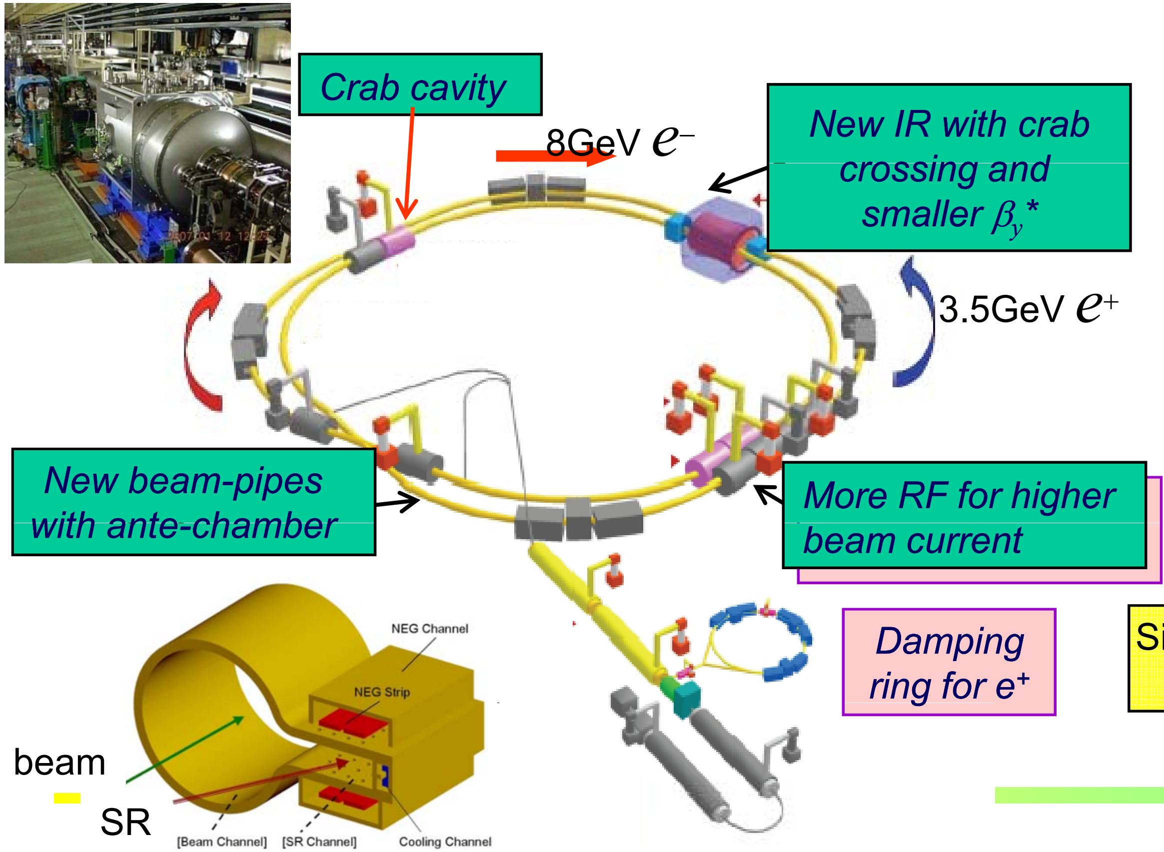
KEKB's Track Record

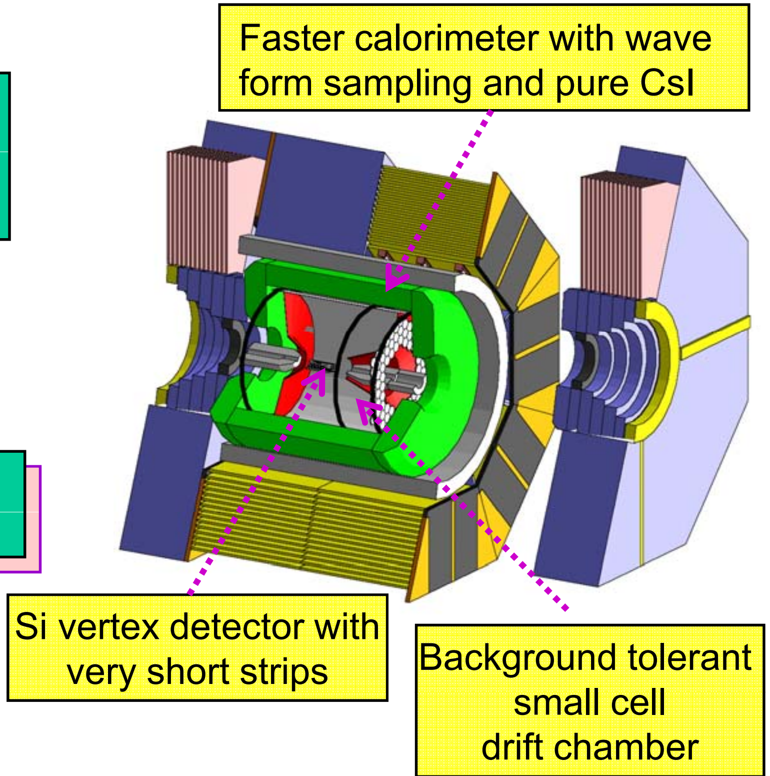


L_{peak} (KEKB) = 1.7 x 10^{34}/cm^2/sec (design 1.0)

KEKB Upgrade Plan : Super-B Factory at KEK

- *Asymmetric energy e^+e^- collider at $E_{CM}=m(\Upsilon(4S))$ to be realized by upgrading the existing KEKB collider.*
- *Initial target:* *10×higher luminosity* ≅ 2×10^{35}/cm²/sec — after 3 year shutdown
  → 2×10^{9} $B\bar{B}$ *and* $\tau^+\tau^-$ *per yr.*
- *Final goal:* $L=8\times10^{35}$/cm²/sec *and* $\int L\,dt$ = 50 ab^{-1}



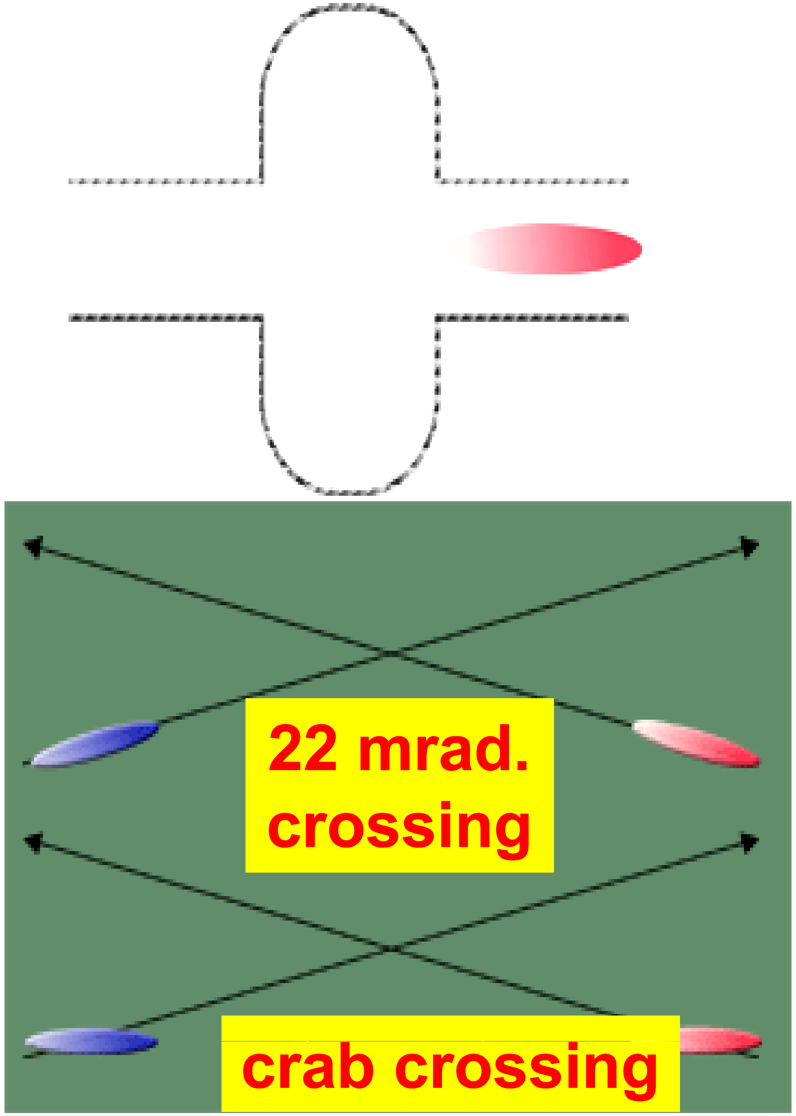


Luminosity gain and upgrade items (preliminary)

3 years shutdown (applies to: beam pipe, IR, low emittance, crab crossing)

Item	Gain	Purpose
beam pipe	x 1.5	high current, short bunch, electron cloud
IR($\beta^*_{x/y}$=20cm/3 mm)	x 1.5	small beam size at IP
low emittance(12 nm) & $\nu_x \rightarrow 0.5$	x 1.3	mitigate nonlinear effects with beam-beam
crab crossing	x 2	mitigate nonlinear effects with beam-beam
RF/infrastructure	x 3	high current
DR/e^+ source	x 1.5	low β^* injection, improve e^+ injection
charge switch	x ?	electron cloud, lower e^+ current

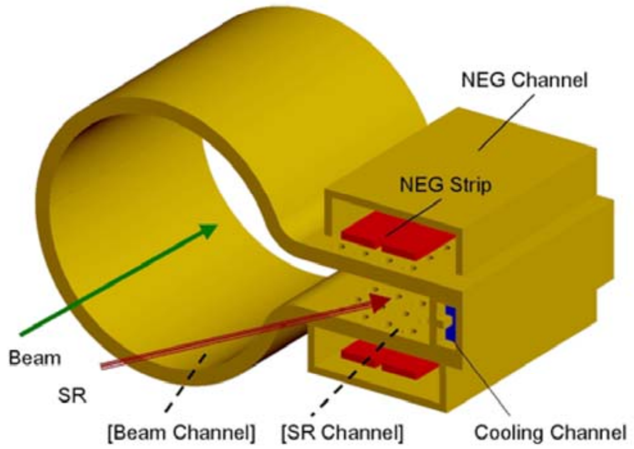
Crab cavity commissioning

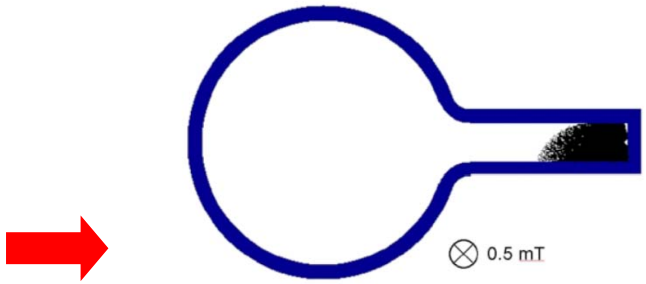


Installed in the KEKB tunnel (February 2007)

Super-KEKB (cont'd)

- Ante-chamber /solenoid for reduction of electron clouds



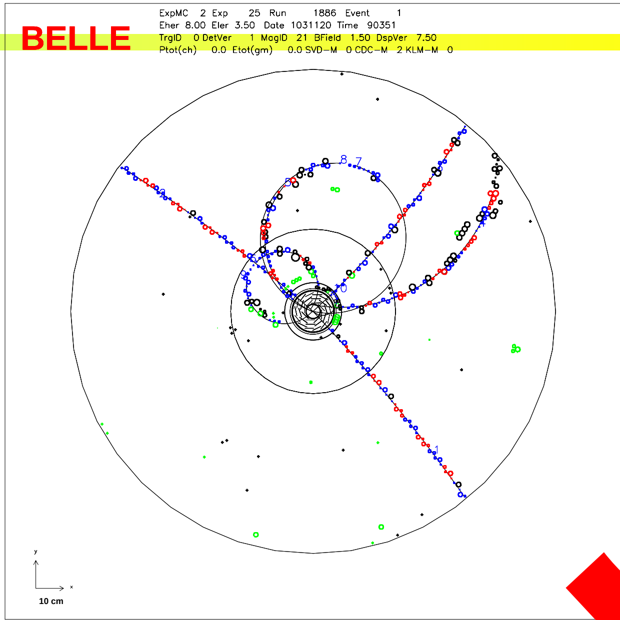


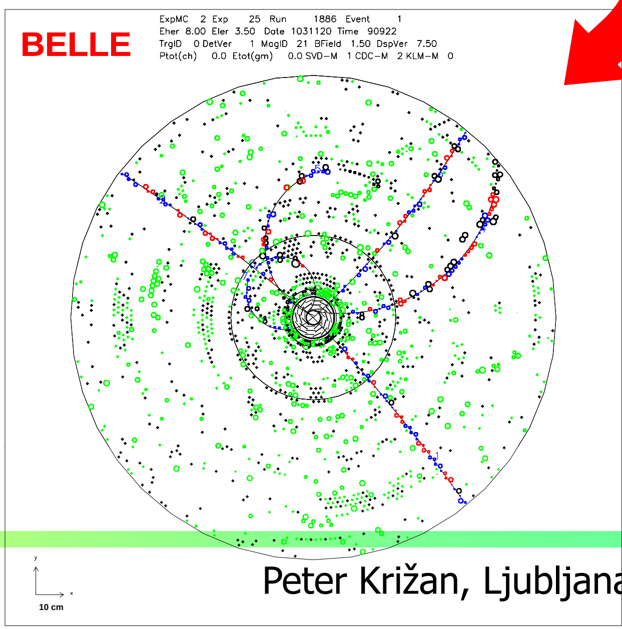
Ante-chamber
with solenoid field

Requirements for the Super B detector

Critical issues at L= 4 x 10^{35}/cm^2/sec

- **Higher background ($\times$20)**
  - radiation damage and occupancy
  - fake hits and pile-up noise in the EM
- **Higher event rate ($\times$10)**
  - higher rate trigger, DAQ and computing
- **Require special features**
  - low p μ identification $\leftarrow$ $s\mu\mu$ recon. eff.
  - hermeticity $\leftarrow$ ν “reconstruction”





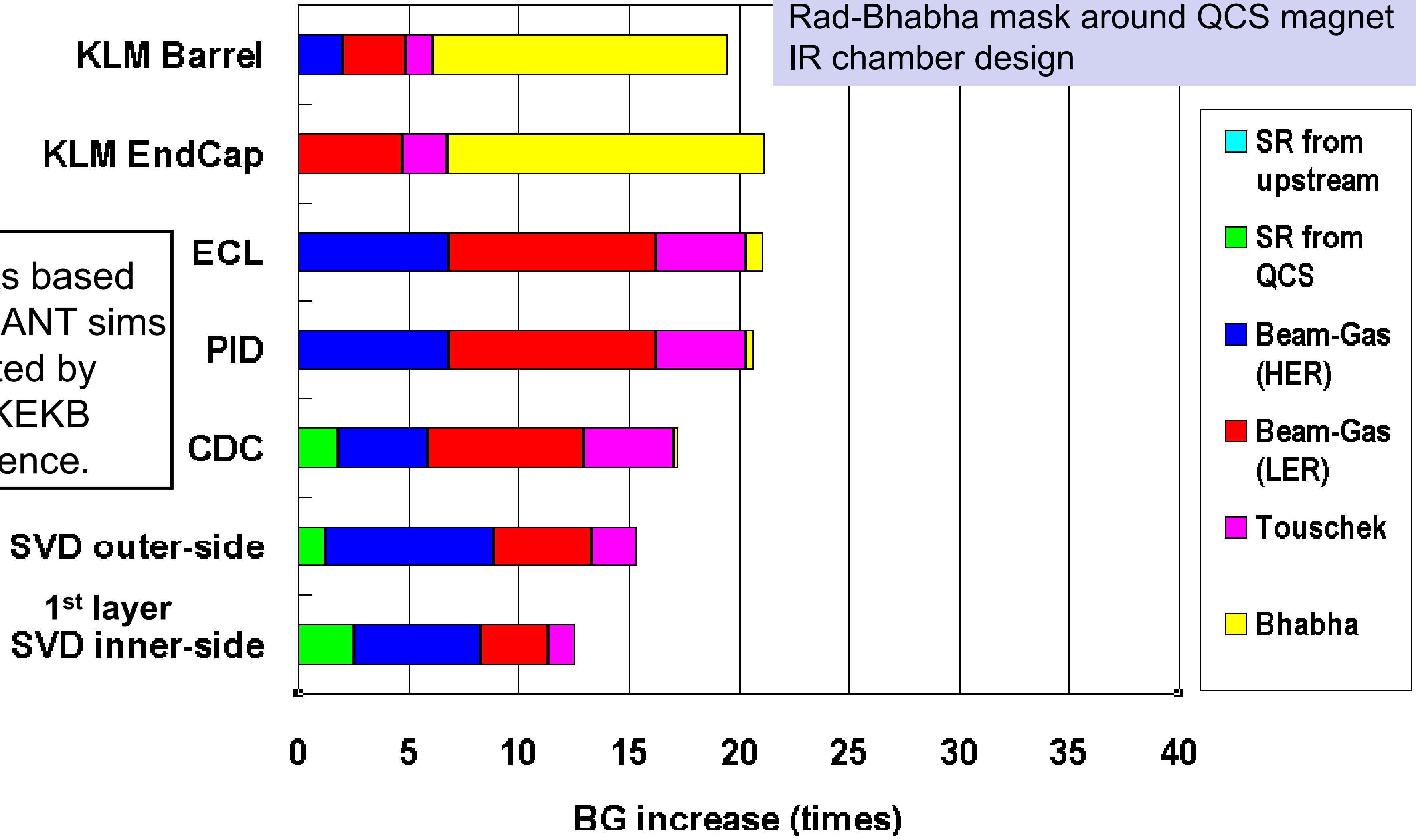
Possible solution:

- Replace inner layers of the vertex detector with a silicon striplet or pixel detector.
- Replace inner part of the central tracker with a silicon strip detector.
- Better particle identification device
- Replace endcap calorimeter by pure CsI.
- Faster readout electronics and computing system.

Beam Background (after 1st optimization)

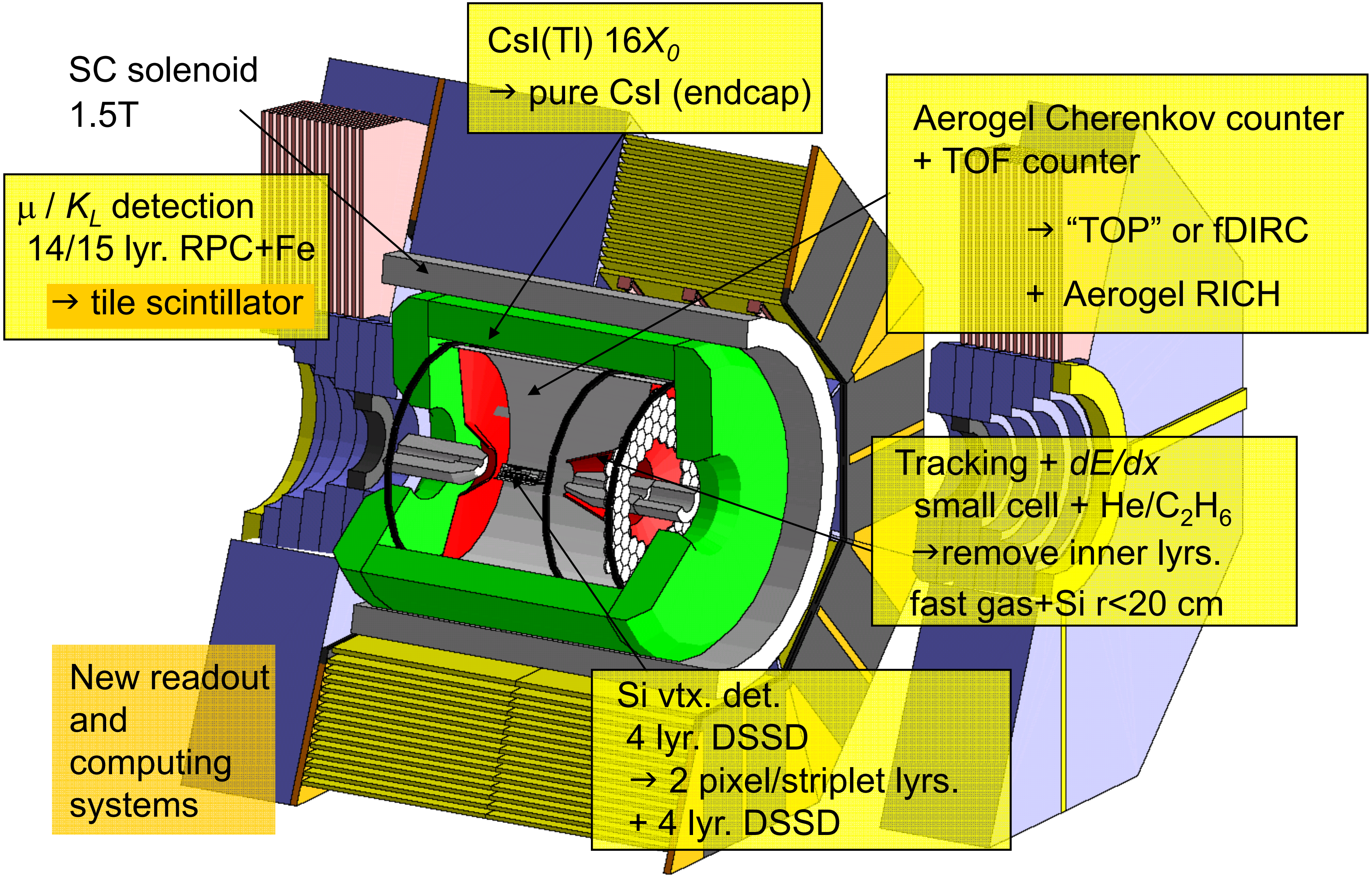
Rad-Bhabha mask around QCS magnet
IR chamber design

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



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

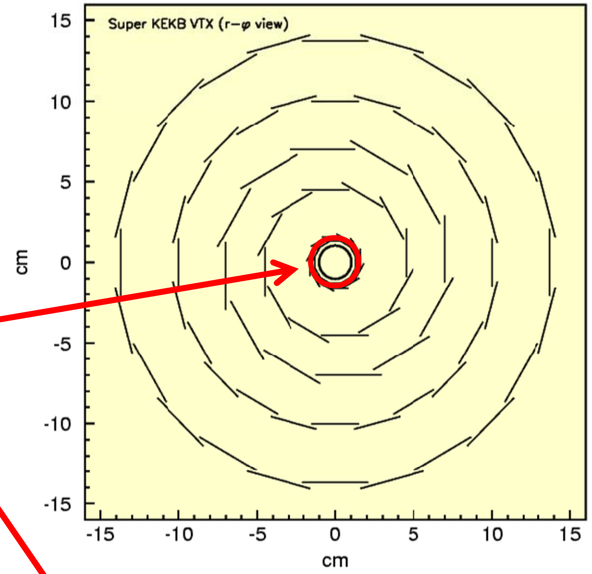
Belle Upgrade for Super-B



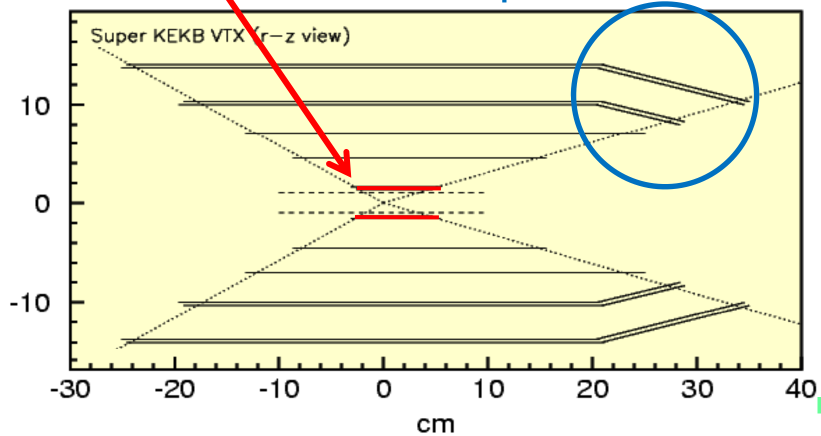
SVD Upgrade

- Readout chip: VA1TA→ APV25
  - Reduction of occupancy coming from beam background.
  - Pipeline readout to reduce dead time.
- Sensors of the innermost layer:

  Normal double sided Si detector (DSSD) → Pixel sensors
- Configuration: 4 layers →6 layers (outer radius = 8cm→14cm)
  - More robust tracking
  - Higher Ks vertex reconstruction efficiency
- Inner radius: 1.5cm → 1.0cm
  - Better vertex resolution. Not on day 1.

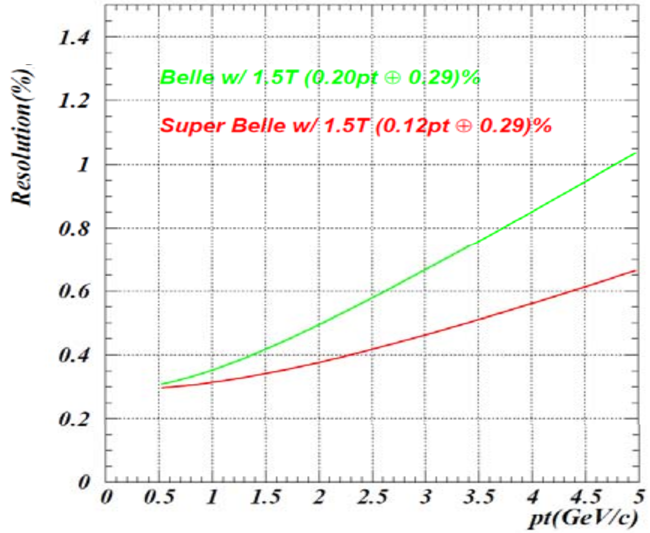


Slant layer to keep the acceptance



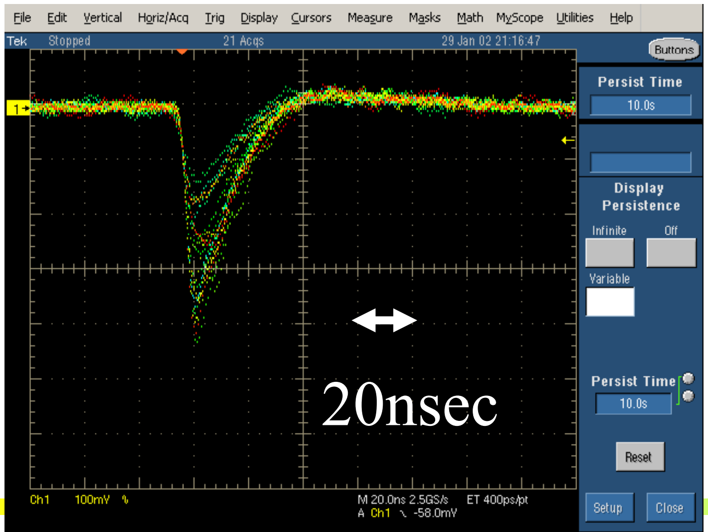
CDC Upgrade

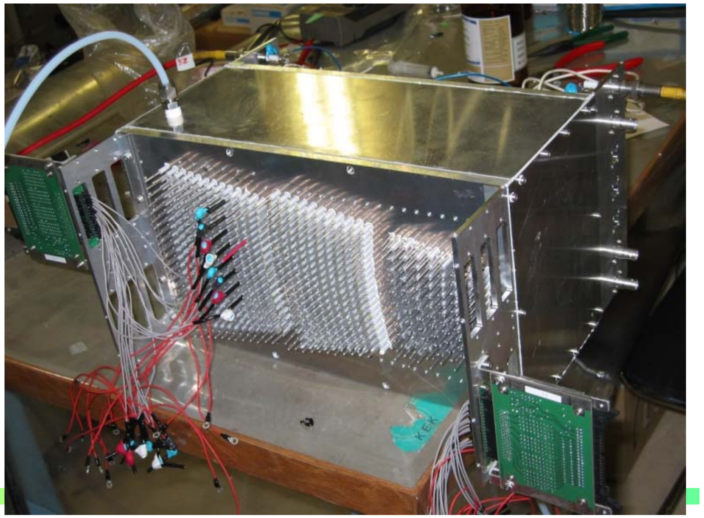
- Larger outer radius: 752mm →978mm
  - Longer lever arm → better Pt reso.
  - More samplings → better dE/dx reso.



- Smaller cell size:

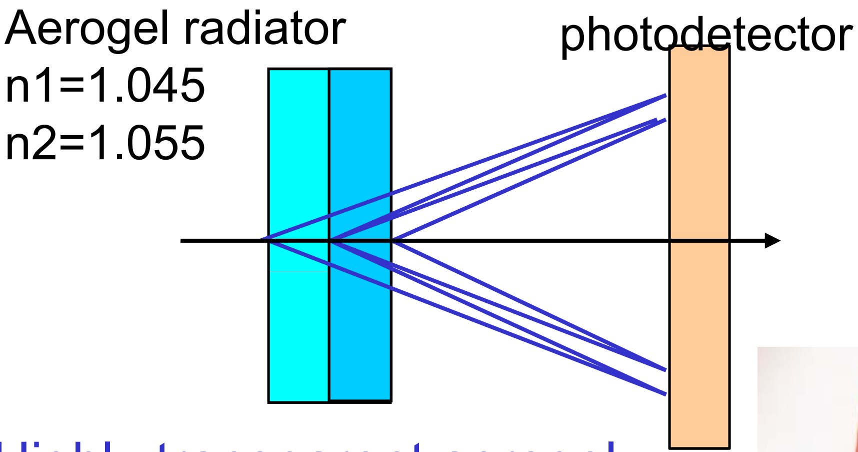
  12mm, 64cells → 8mm, 160cells
  - Improved background tolerance
- New ASD with fast shaping



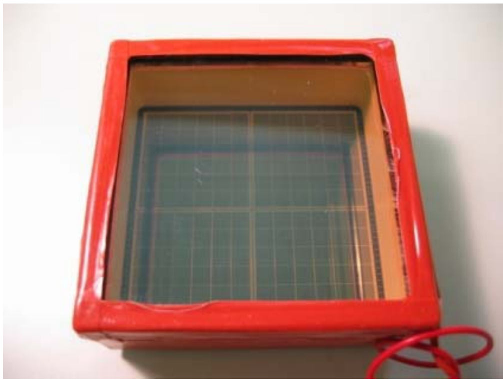


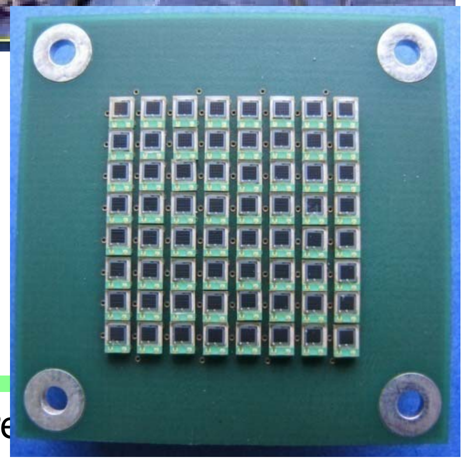
Aerogel RICH

- Proximity focusing RICH with multiple aerogel radiator with different indices.



Multi-pixel photodetector to measure single photon positions in B=1.5T
→ HAPD/MCP-PMT/G-APD

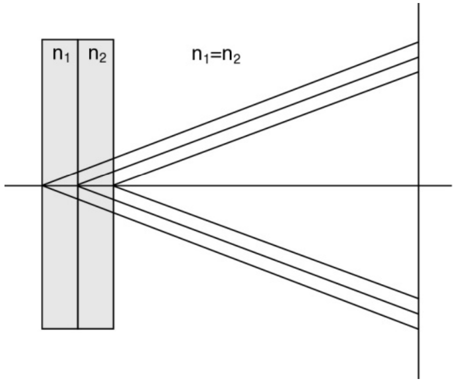


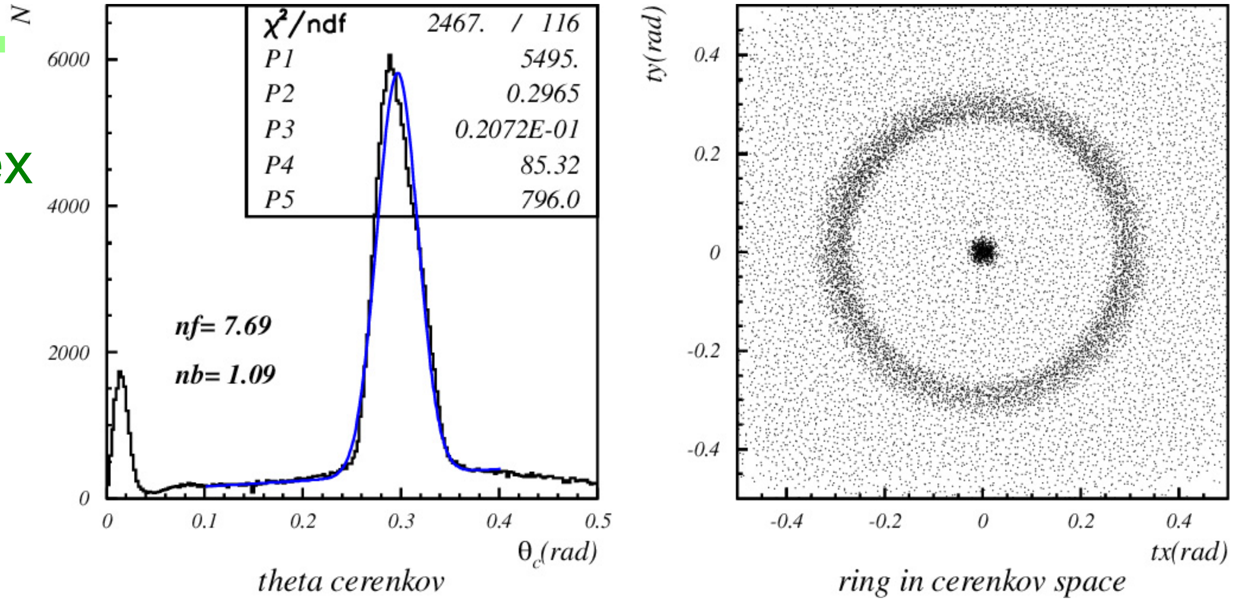


Highly transparent aerogel :
Λ_t > 40mm (λ=400nm)

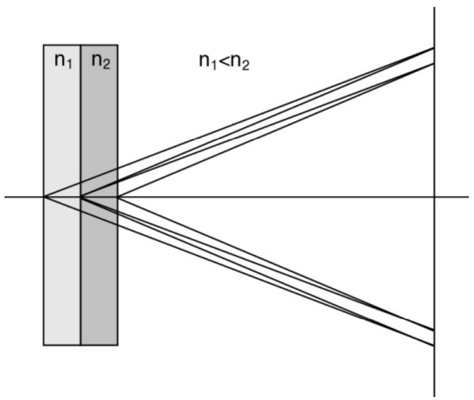
Aerogel RICH – test results

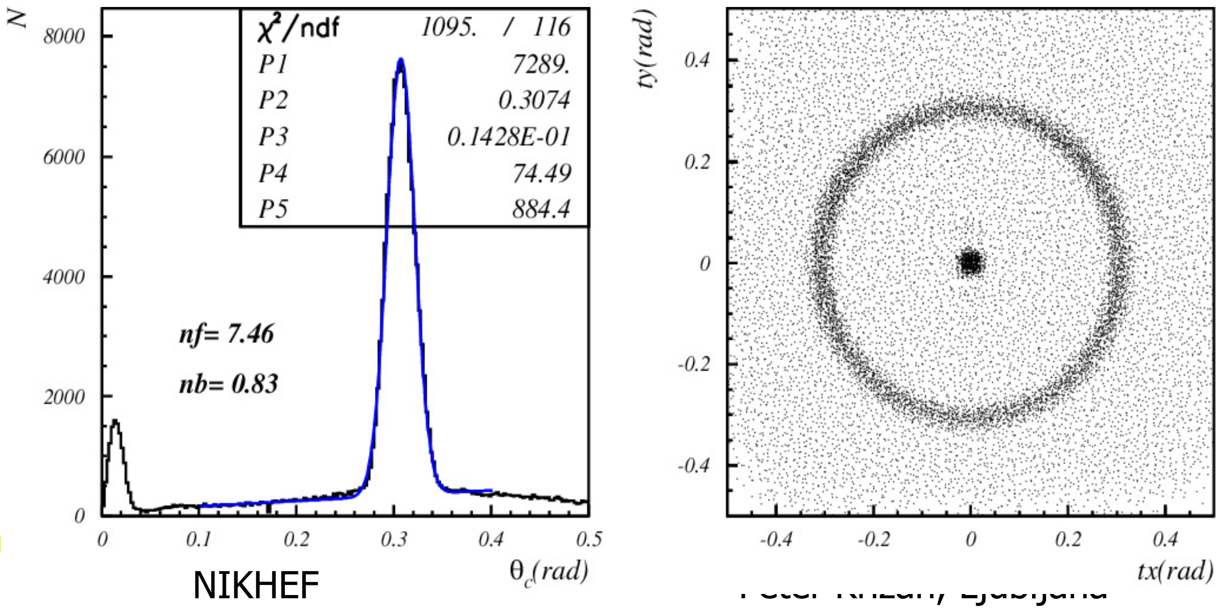
4cm aerogel single index





2+2cm aerogel





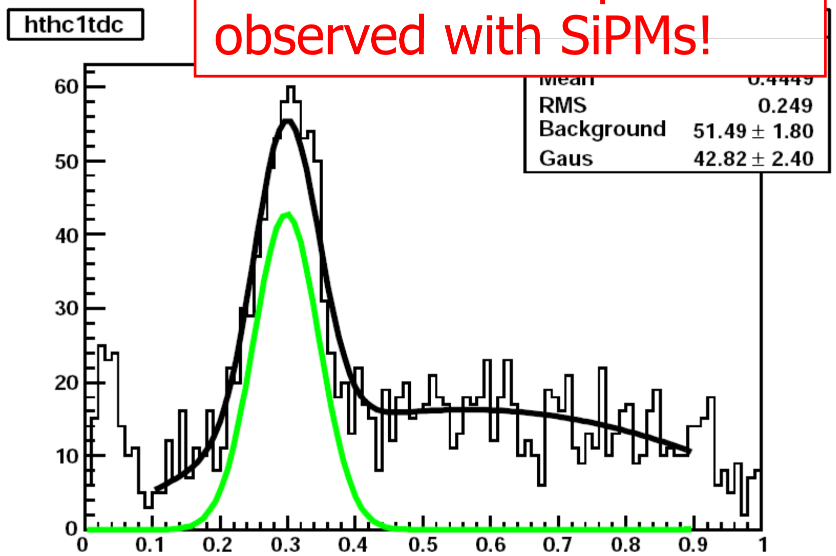
SiPMs for Aerogel RICH

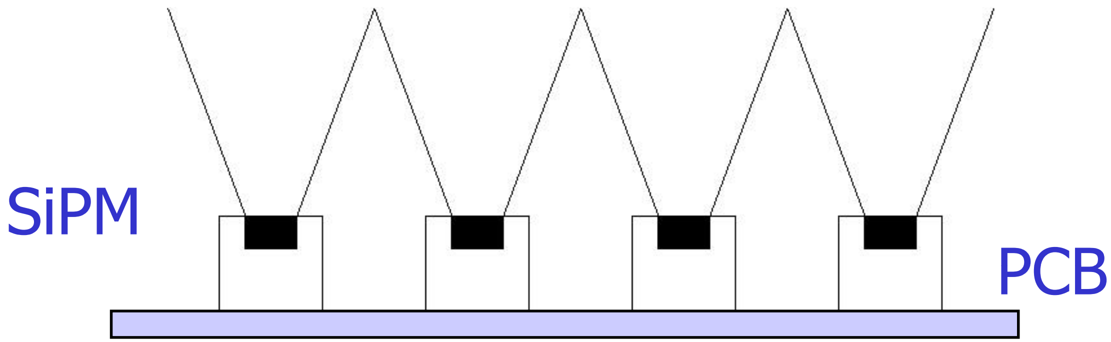
Main challenge: R+D of a photon detector for operation in high magnetic fields (1.5T)

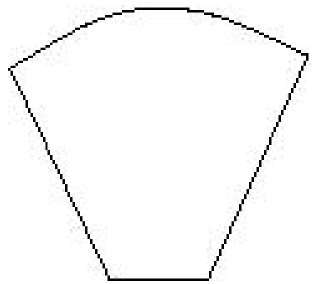
Candidates:

- MCP PMT: excellent timing, could be also used as a TOF counter
- SiPMs: easy to handle, but never before used for single photon detection (high dark count rate with single photon pulse height) → use a narrow time window and light concentrators

First Cherenkov photons observed with SiPMs!



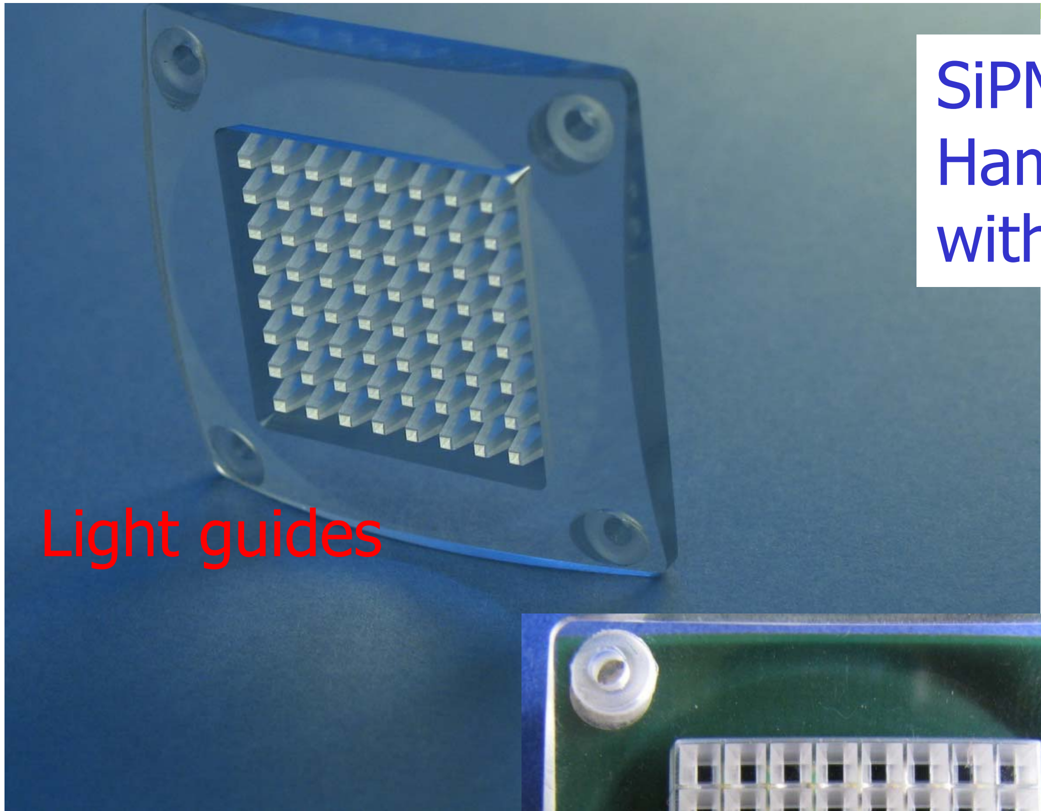




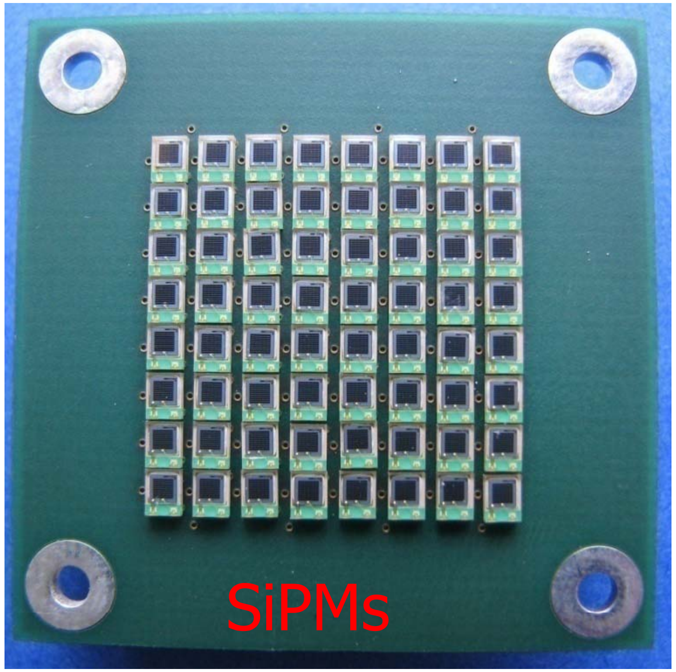
or combine a lens and mirror walls

Detector module for beam tests at KEK

SiPMs: array of 8x8 SMD mount Hamamatsu S10362-11-100P with 0.3mm protective layer

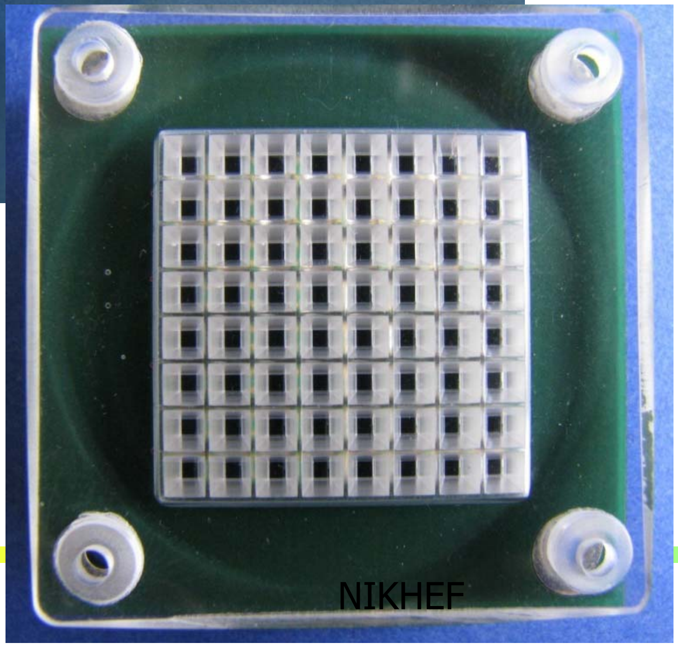


Light guides



SiPMs

2cm



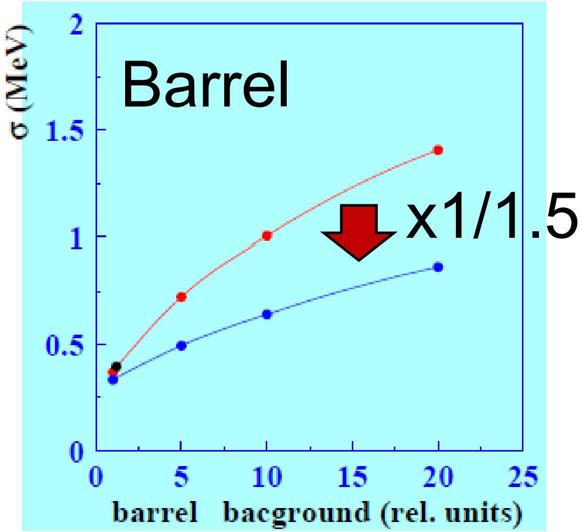
SiPMs + light guides

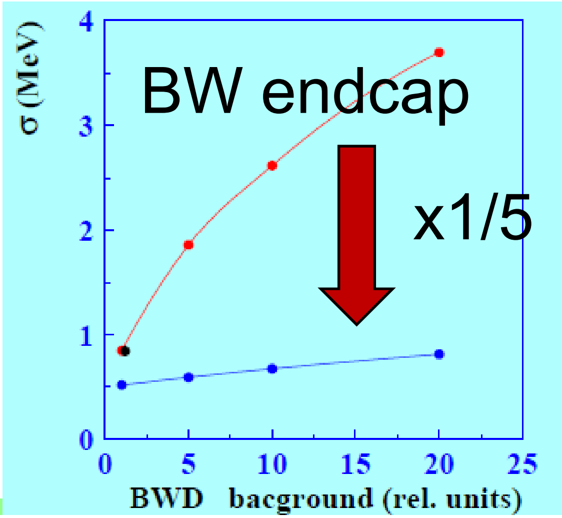
ECL Upgrade

- Increase of dark currents due to neutron flux
- Fake clusters & pile-up noise

- Barrel:
  0.5μs shaping + 2MHz w.f. sampling.
- Endcap:
  pure CsI + photopentods
  30ns shaping + 43MHz w.f. sampling

Pure CsI & photopentods

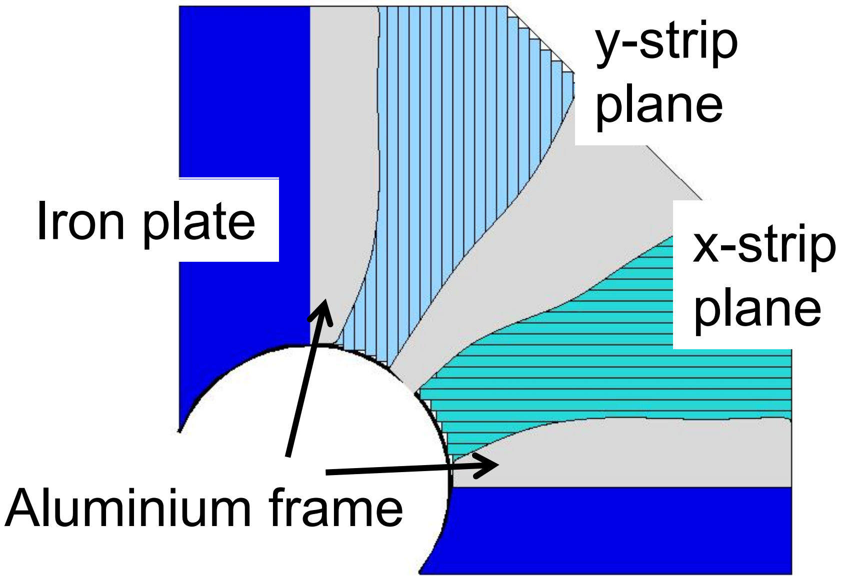


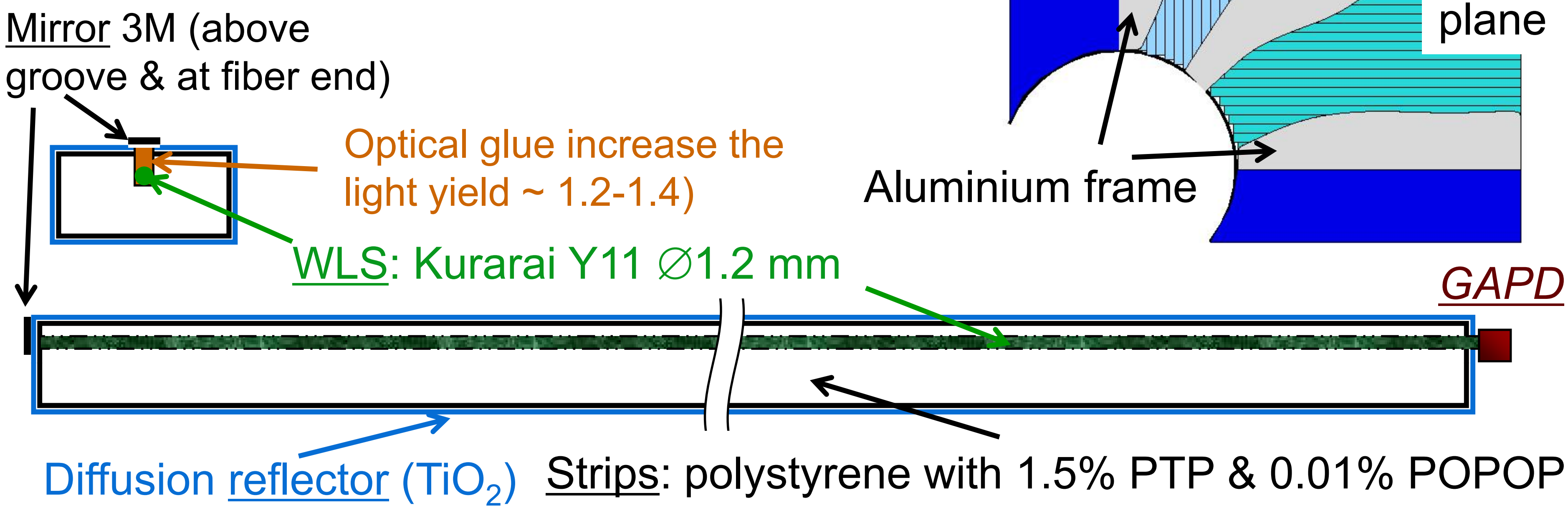


KLM upgrade

Scintillator-based KLM (endcap)

- Two independent (x and y) layers in one superlayer made of orthogonal strips with WLS read out
- Photo-detector = avalanche photodiode in Geiger mode (SiPM)
- ~120 strips in one 90º sector (max L=280cm, w=25mm)
- ~30000 read out channels
- Geometrical acceptance > 99%

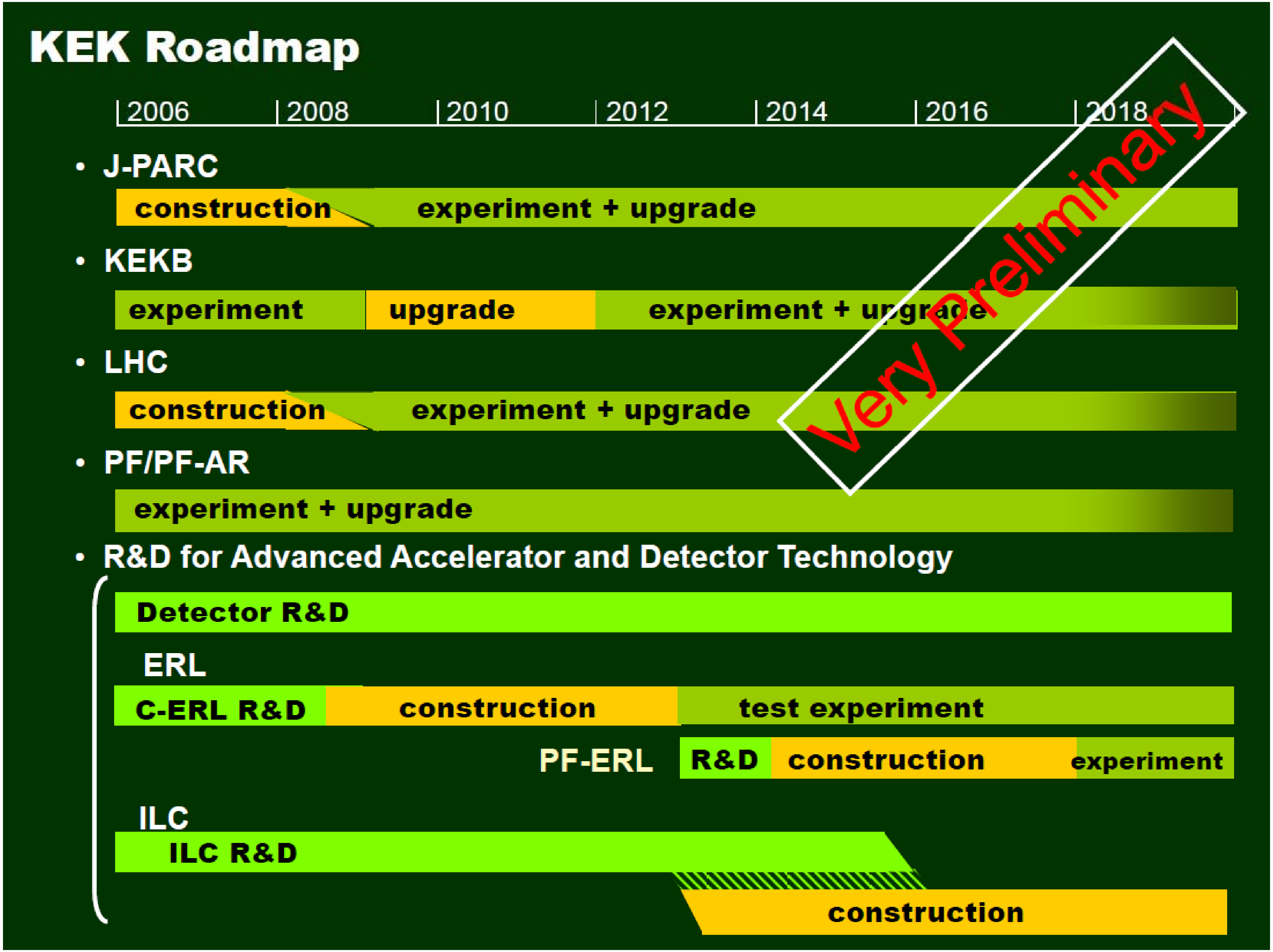




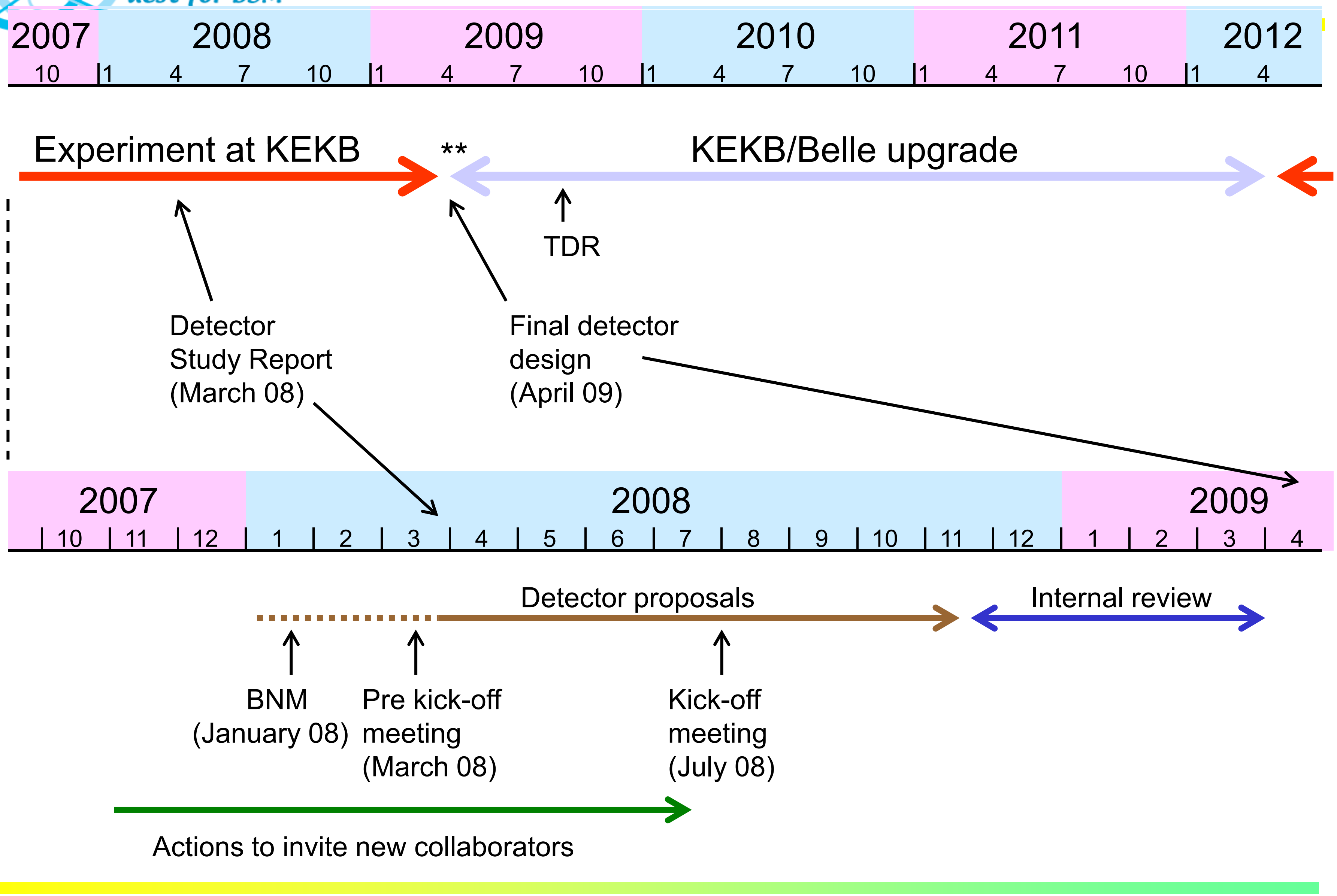
KEK's 5 year Roadmap

- Official 20 page report released on January 4, 2008 by director A. Suzuki and KEK management
- KEKB's upgrade to 2×10^{35} /cm^2/sec in 3+x years is *the central element in particle physics.* (Funding limited: Final goal is 8×10^{35} and an integrated luminosity of 50 ab^{-1})
  - Will be finalized after recommendations by the Roadmap Review Committee
    - Membership: Young Kee Kim, John Ellis, Rolf Heuer, Andrew Hutton, Jon Rosner, H. Takeda and reviewers from other fields

Super-Belle (and Super KEKB) is an open international project that covers the next two orders of magnitudes at the luminosity frontier. A special opportunity for high impact international collaboration


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

Tight Schedule for the Super KEKB Collaboration



** Possible 6-month shift to the right

Summary

- B factories have proven to be an excellent tool for flavour physics
- Reliable long term operation, constant improvement of the performance.
- Major upgrade in 2009-12 → Super B factory, L x10 → x40
- Essentially a new project, all components have to be replaced, plans exist (LoI), nothing is frozen...
- Expect a new, exciting era of discoveries, complementary to LHC
- Do not miss the chance to be part of it...

Additional slides

Model-indep. check of NP

- A_{cp} ($K\pi$) sum rule

M. Gronau, PLB 627, 82 (2005);

D. Atwood & A. Soni, Phys. Rev. D 58, 036005(1998).

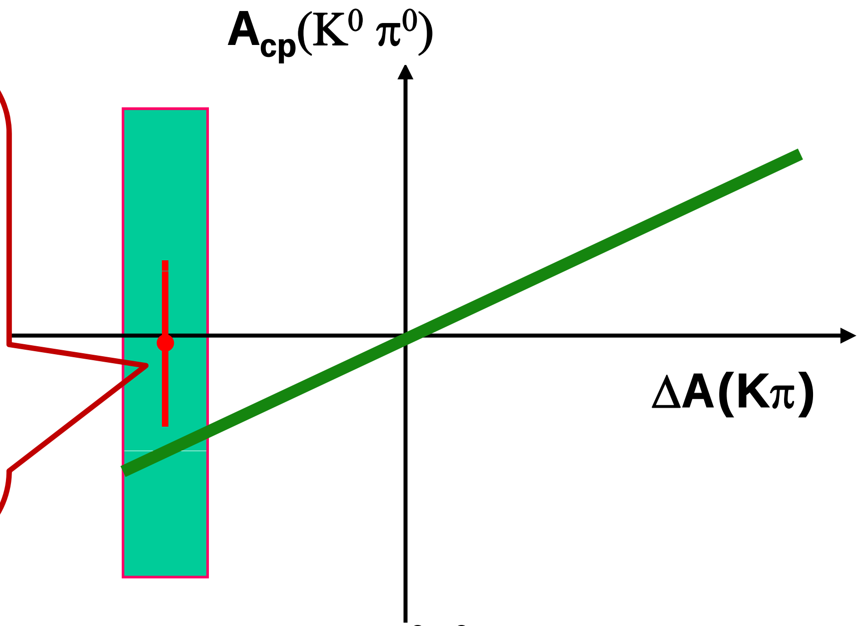
$$\mathcal{A}_{CP}(K^+\pi^-) + \mathcal{A}_{CP}(K^0\pi^+)\frac{\mathcal{B}(K^0\pi^+)}{\mathcal{B}(K^+\pi^-)}\frac{\tau_0}{\tau_+} = \mathcal{A}_{CP}(K^+\pi^0)\frac{2\mathcal{B}(K^+\pi^0)}{\mathcal{B}(K^+\pi^-)}\frac{\tau_0}{\tau_+} + \mathcal{A}_{CP}(K^0\pi^0)\frac{2\mathcal{B}(K^0\pi^0)}{\mathcal{B}(K^+\pi^-)}$$

$B^0 \to K^0 \pi^0$ New

$A = -0.13 \pm 0.13 \pm 0.03$

$A = +0.14 \pm 0.13 \pm 0.06$

HFAG AVG: -0.01 ± 0.10



Sum rule predicts $A_{cp}(K^0\pi^0)$ = -0.151±0.043