Prospects for upgrades of KEKB and Belle

Belle and beyond: physics, collider, detector

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University of Cincinnati
Belle Collaboration
Belle (1999-present)

- RICH physics in the Upsilon region

**Headliners**
- CKM, including \( \sin 2\varphi_1 \), constraints on \( \varphi_2, \varphi_3 \)
- new charmonia, charmonium-like states in continuum, ISR, \( D_{sJ} \), \( B \) decays
- \( D^0 \) mixing
- probes of New Physics

+ many more measurements on
  \( B, \text{charm, tau, 2-photon, } \Upsilon(4S), \Upsilon(10860), B_s, \Upsilon(3S), \Upsilon(1S), ... \)

**Addressing**
- CP, CKM, QCD, HQ spectroscopy, LFV, NP, Dark Matter, ...
Belle (1999-present)

- RICH physics in the Upsilon region

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- CKM, including $\sin 2\varphi_1$, constraints on $\varphi_2, \varphi_3$
- new charmonia, charmonium-like states in continuum, ISR, $D_{sJ}$, $B$ decays
- $D^0$ mixing
- probes of New Physics
  
+ many more measurements on $B$, charm, tau, 2-photon, $\Upsilon(4S), \Upsilon(10860), B_s, \Upsilon(3S), \Upsilon(1S), \ldots$

Addressing
- $CP$, CKM, QCD, HQ spectroscopy, LFV, NP, Dark Matter, \ldots

265 journal articles published/submitted

http://belle.kek.jp/bdocs/b_journal.html
Why continue in flavor physics?

- **CKM**: highly constrained pattern of CC couplings w CP violation manifested in diverse processes in B decay
  -> many measurements, (over)constrain CKM
- statistics limited on $\rho^0\rho^0(\varphi_2)$, Dalitz analyses ($\varphi_3$), $b\rightarrow d\gamma$, $\tau\rightarrow\mu\gamma$, ...
- SM extensions likely to have new sources of CPV & flavor couplings
  -> precision CKM as window to New Physics
- in 1.4 ab$^{-1}$ at Belle+Babar: hints of New Physics?
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  pro’s vis-a-vis LHCb: $\gamma$, $K_L$ detection; hermeticity -> neutrinos
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- CP asymmetry in b-$\rightarrow$s penguin -> non-SM contributions
- Lepton universality B-$\rightarrow$ $\tau$\nu, B-$\rightarrow$D(*) $\tau$\nu
- Right-handed currents CP asymmetry of B-$\rightarrow${s}$\gamma$
- Inclusive b-$\rightarrow$s$\gamma$, b-$\rightarrow$d$\gamma$, B-$\rightarrow$ s$^+l^-$
- CP asymmetry in D mixing -> NP
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- Inclusive b-$\rightarrow s \gamma$, b-$\rightarrow d \gamma$, B-$\rightarrow s l^+ l^-$
- CP asymmetry in D mixing $\rightarrow$ NP
  - ... + many B-factory measurements are not yet systematics limited
CP asymmetry in $B \rightarrow s\bar{s}s$: $\sin 2\varphi_1$ in SM

for $B \rightarrow J/\psi K_s$

tree (real $V_{ij}$) $\propto V_{cb}^* V_{cs}$

\[ B \left\{ \begin{array}{c} \bar{d} \\
\end{array} \right\} \rightarrow \begin{array}{c} \bar{c} \\
w \end{array} \rightarrow \begin{array}{c} c \\
J/\psi \end{array} \left\{ \begin{array}{c} \bar{d} \\
d \end{array} \right\} \rightarrow \begin{array}{c} s \\
K_s \end{array} \]

mixing+tree $\propto V_{tb}^* V_{td}^2 V_{cb} V_{cs}^*$

\[ \left\{ \begin{array}{c} \bar{c} \\
w \end{array} \right\} \rightarrow \begin{array}{c} t \\
\bar{b} \rightarrow w \rightarrow \begin{array}{c} b \\
J/\psi \end{array} \left\{ \begin{array}{c} \bar{d} \\
d \end{array} \right\} \rightarrow \begin{array}{c} s \\
K_s \end{array} \]
**CP asymmetry in B→ss\bar{s}: sin2\varphi_1 in SM**

for B→J/\psi K_s

\text{tree (real } V_{ij}) \propto V^*_{cb}V_{cs}

\text{mixing+tree } \propto V^*_{tb}V^*_{td}V_{cb}V_{cs}

\text{well-measured}
CP asymmetry in $B \to s\bar{s}\bar{s}$: $\sin 2\varphi_1$ in SM

for $B \to J/\psi K_s$

- **Tree (real $V_{ij}$)**: $\propto V_{cb}^* V_{cs}$

- **Mixing+Tree**: $\propto V_{tb}^* V_{td}^2 V_{cb} V_{cs}^*$

Both processes involve identical hadronic processes and yield the same $|A|$. The diagrams illustrate the processes with $b \to c$ transitions, with weak interactions mediated by the $W$ boson.
CP asymmetry in B→ss̅s: sin2φ₁ in SM

for B → J/ψ Kₛ

tree (real Vᵢⱼ) \propto V_{cb}^* V_{cs}

mixing + tree \propto V_{tb}^* V_{td} V_{cb}^* V_{cs}

identical hadronic processes \rightarrow same \vert A \vert

Phase of mixing (V_{tb}^* V_{td}^2) = 2φ₁, V_{cb}^* V_{cs} real \rightarrow asym \sim \sin 2φ₁
CP asymmetry in $B \rightarrow s\bar{s}s$: $\sin 2\varphi_1$ in SM

for $B \rightarrow J/\psi K_s$

- tree (real $V_{ij}$) $\propto V_{cb}^* V_{cs}$
- mixing+tree $\propto V_{tb}^* V_{td}^2 V_{cb} V_{cs}$

well-measured

identical hadronic processes $\rightarrow$ same $|A|$

Phase of mixing ($V_{tb}^* V_{td}^2$) = $2\varphi_1$, $V_{cb}^* V_{cs}$ real $\rightarrow$ asym $\sim \sin 2\varphi_1$

for $b \rightarrow s\bar{s}s$

- similarly, penguin & mixing+penguin
  - due to loop cancellation, large $m_t$ $\rightarrow$ $\propto V_{tb}^* V_{ts}$
  - real $\rightarrow$ asym $\sim \sin 2\varphi_1$

K. Kinoshita BEACH 2008
**CP asymmetry in B \rightarrow s\bar{s}s: \sin2\varphi_1 in SM**

for **B \rightarrow J/\psi K_s**

- **tree (real \(V_{ij}\))** \(\propto V_{cb}^*V_{cs}\)
  
  \[
  B \rightarrow W^+ b \rightarrow J/\psi K_s
  \]

- **mixing+tree** \(\propto V_{tb}^*V_{td}^2V_{cb}V_{cs}^*\)
  
  \[
  \begin{array}{c}
  \bar{d} \rightarrow W^+ i \rightarrow J/\psi K_s \\
  b \rightarrow W^+ d \rightarrow J/\psi K_s
  \end{array}
  \]

  - **well-measured**
  - **identical hadronic processes \(\rightarrow\) same \(|A|\)**

  - **Phase of mixing** \((V_{tb}^*V_{td}^2)=2\varphi_1, V_{cb}^*V_{cs}\) **real \(\rightarrow\) asym \(\sim\) \(\sin 2\varphi_1\)**

for **b \rightarrow s\bar{s}s**

- **similarly, penguin & mixing+penguin**
  - **due to loop cancellation, large \(m_t\) \(\rightarrow\) \(\propto V_{tb}^*V_{ts}\)**
  - **real \(\rightarrow\) asym \(\sim\) \(\sin 2\varphi_1\)**

- **NP w complex phase** \(\varphi_{\text{new}}\) \(\rightarrow\) **asym \(\sim\) \(\sin (2\varphi_1 \pm 2\varphi_{\text{new}})\)**
Average "\( \sin 2\varphi_1 \)" from \( b \to s \) penguins

Naïve World Average

\[ \sin 2\varphi_1 (b \to s q\bar{q}) = 0.56 \pm 0.05 \]
Average "sin2\(\varphi_1\)" from \(b\to s\) penguins

Naïve World Average

\[
\sin(2\beta_{\text{eff}}) = \sin(2\phi_1_{\text{eff}}) = 0.56 \pm 0.05
\]

Compare to c\(\bar{c}\)s:

\[
\sin(2\varphi_1(b\to c\bar{c}s)) = 0.680 \pm 0.025
\]
Average “sin2φ₁” from \( b \rightarrow s penguins \)

\[
\text{Naïve World Average} \\
\sin 2\varphi_1 (b \rightarrow sq\bar{q}) = 0.56 \pm 0.05
\]

Compare to \( c\bar{c}s \):
\[
\sin 2\varphi_1 (b \rightarrow c\bar{c}s) = 0.680 \pm 0.025
\]

\[CL = 0.03 (2.2\sigma)\]
- statistics?
- experimental systematics?
- theory corrections?
- new physics?
CP asymmetry in $b \rightarrow s$: SuperKEKB sensitivity

$B \rightarrow \phi K^0, \eta' K^0, KsKsKs$ projection for SuperKEKB

SM prediction

some of recent QCDF estimates $\sin 2\beta_{eff} - \sin 2\beta$

$\Delta S$ Uncertainty

Integrated luminosity (ab$^{-1}$)

New Physics
(SUSY GUT, Warped Extra Dimension, String-inspired MSSM, ...)

Belle (July 2006, 492 fb$^{-1}$)

SuperKEKB (50 ab$^{-1}$)
$B^+ \rightarrow \tau^+ \nu_\tau$: constraints on charged Higgs

$$\mathcal{B}(B \rightarrow \tau \nu) = \mathcal{B}(B \rightarrow \tau \nu)_{SM} \times r_H$$

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

{WS Hou, PRD 48, 2342 (1993)}
B^{+} \to \tau^{+} \nu_{\tau} : \text{constraints on charged Higgs}

\[ B(B \to \tau \nu) = B(B \to \tau \nu)_{\text{SM}} \times r_{H} \]

\[ r_{H} = \left(1 - \frac{m_{B}^{2}}{m_{H}^{2}} \tan^{2} \beta \right)^{2} \]

(Belle) 0.41 ab^{-1}

\[ B(B \to \tau \nu) = (1.8 \pm 0.5 \pm 0.5) \times 10^{-4} \]

PRL 97, 251802 (2006)

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$B^+ \rightarrow \tau^+ \nu_\tau$: constraints on charged Higgs

$$B(B \rightarrow \tau \nu) = B(B \rightarrow \tau \nu)_{SM} \times r_H$$

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(Belle) 0.41 ab$^{-1}$

$B(B \rightarrow \tau \nu) = (1.8 \pm 0.5 \pm 0.5) \times 10^{-4}$

PRL 97, 251802 (2006)

(extrapolation) 50 ab$^{-1}$

{WS Hou, PRD 48, 2342 (1993)}
Lepton universality: $B \rightarrow \mu\nu$

**SM:**

$B(B \rightarrow \tau\nu) = 1.6 \times 10^{-4}$

$B(B \rightarrow \mu\nu) = 7.1 \times 10^{-7}$

$B(B \rightarrow e\nu) = 1.7 \times 10^{-11}$
Lepton universality: $B \rightarrow \mu \nu$

SM:
$B(B \rightarrow \tau \nu) = 1.6 \times 10^{-4}$
$\boxed{B(B \rightarrow \mu \nu) = 7.1 \times 10^{-7}}$
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expect observation within few ab$^{-1}$
Lepton universality: $B \rightarrow \mu \nu$

SM:
- $B(B \rightarrow \tau \nu) = 1.6 \times 10^{-4}$
- $\boxed{B(B \rightarrow \mu \nu) = 7.1 \times 10^{-7}}$
- $B(B \rightarrow e \nu) = 1.7 \times 10^{-11}$

expect observation within few ab$^{-1}$

$B \rightarrow \tau \nu$
$B \rightarrow \mu \nu$

deviations from SM sensitive to NP
B → D(∗) \tau \nu

- Lepton universality via semileptonic decays

\[ m_b \tan \beta + m_c \cot \beta \]

\[ H^+/W^+ \]

\[ m_\tau \tan \beta \]

\[ \nu_\tau \]

\[ B(B^0 \rightarrow D^* \tau \nu) = (2.0 \pm 0.4 \pm 0.4)\% \]

[PRL 99, 191807 (2007)]

- Ratio (\tau/\mu) is sensitive to charged Higgs (similar to B → \tau \nu)
$B \rightarrow D^{(*)} \tau \nu$

- Lepton universality via semileptonic decays
  
  \[ m_b \tan \beta + m_c \cot \beta \]

  \[ H^+/W^+ \]

  \[ m_\tau \tan \beta \]

  \[ \nu_\tau \]

  \[ \tau^+ \]

  \[ B(B^0 \rightarrow D^{*-} \tau \nu) = (2.0\pm0.4\pm0.4)\% \]

  [PRL 99, 191807 (2007)]

- Ratio ($\tau/\mu$) is sensitive to charged Higgs (similar to $B \rightarrow \tau \nu$)

$B \rightarrow \tau X$ decays probe NP in different ways:
  
  - $B \rightarrow \tau \nu$: H-b-u vertex
  - $B \rightarrow D \tau \nu$: H-b-c vertex
Sizable CP asymmetry expected in $B^0 \rightarrow X_s \gamma$ if NP includes right-handed current
D mixing/CP violation

For 75 ab\(^{-1}\)

\[ x = 0.8 \quad \text{>4\(\sigma\) significance on } x \]

\[ y = 0.8 \quad \text{>5\(\sigma\) significance on } y \]

\[ |q/p| = 0.9 \quad \text{~4\(\sigma\) significance on } 1-|q/p| \]
**KEKB Upgrade plan**

- **e+ 4.1 A**
- **e- 9.4 A**

**SuperKEKB**

- Crab cavities
- New beam pipe & bellows
- More RF sources
- More RF cavities
- Energy exchange C-band
- Damping ring
- Positron source

- 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.

\[
L = \frac{\gamma_\pm}{2e_r e} \left( 1 + \frac{\sigma_y^*}{\sigma_x^*} \right) \left( \frac{I_\pm}{\beta_y^*} \right) \left( \frac{R_L}{R_y} \right)
\]
KEKB Upgrade plan

- upgrade existing KEKB collider

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

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$L = \frac{\gamma_{\pm}}{2e\gamma_{e}} \left( 1 + \frac{\sigma_{y}^{\pm}}{\sigma_{x}^{\pm}} \right) \left( \frac{I_{\pm}}{\frac{\beta_{y}^{\pm}}{\beta_{y}^{\pm}}} \frac{R_{L}}{R_{y}} \right)$

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

- upgrade existing KEKB collider
- Final goal: $L = 8 \times 10^{35} / \text{cm}^2 / \text{sec}$ and $\int L \, dt = 50 \text{ ab}^{-1}$

\[ L = \frac{\gamma \varepsilon}{2e r_e} \left( 1 + \frac{\sigma_y^2}{\sigma_x^2} \right) \left( \frac{I_\text{pp}}{I_\text{pp}} \frac{\varepsilon^2}{\beta_y^2} \right) \left( \frac{R_L}{R_y} \right) \]
KEKB Upgrade plan

- upgrade existing KEKB collider
- Final goal: $L = 8 \times 10^{35} / \text{cm}^2 / \text{sec}$ and $\int L \, dt = 50 \, \text{ab}^{-1}$

SuperKEKB

- Crab cavities will be installed and tested with beam in 2006.
- The superconducting cavities will be upgraded to absorb more higher-order mode power up to 50 kW.

- More RF sources
- More RF cavities
- Energy exchange C-band

Positron source

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

- $L = \frac{\gamma \varepsilon}{2e \varepsilon} \left(1 + \frac{\sigma_y^2}{\sigma_x^2}\right) \left(1 + \frac{R_L}{R_y}\right)$

“adiabatic” - test/install in existing machine
KEKB track record (although past performance does not guarantee future results...)

~ 1.4 billion $B\bar{B}$ pairs

KEKB/Belle

PEP-II/BaBar

KEKB + PEP-II

~842/fb (6/08)

~553/fb
KEKB track record (although past performance does not guarantee future results...)

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KEKB/Belle

PEP-II/BaBar

~553/fb

$\mathcal{L}_{\text{peak}} = 1.7 \times 10^{34} \text{cm}^2\text{sec} \quad \text{(design=1.0)}$

design luminosity
Super KEKB

Luminosity Projection (preliminary)

Operation time: 200 days/year

Integrate luminosity (ab⁻¹)

KEK roadmap

Target for roadmap

Peak luminosity (cm⁻²s⁻¹)

Damping Ring

RF upgrade

3 years shutdown

Target for roadmap

Year

2010

2015

2020

2025

Peak current (A)
Crab cavities: as of June 08, $L_{\text{max}} = 1.61 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$

* A number of measurements indicate effective head-on collision.
* The vertical tune shift became higher than 0.088. Before crab, it was 0.055.
* The specific luminosity / bunch was improved more than the geometrical gain.
* Need more time to achieve the goal (X2 specific luminosity).
Super KEKB: detector requirements and strategy

Background projection (preliminary)

- SVD
- CDC
- PID
- ECL
- KLM (FWD)

Begin with 7~10x ~5x in the first few years 20x at full spec
Super KEKB: detector requirements and strategy

Background projection (preliminary)

Issues
- Radiation damage
- Occupancy
- Fake hits, pile-up
- Event rate

 Begins with 7~10x
 ~5x in the first few years
 20x at full spec
(the detector temporarily known as) sBelle

[upgrade Belle to operate w 20X background, 50X event rate]
(the detector temporarily known as) sBelle

[upgrade Belle to operate with 20X background, 50X event rate]

Si vertex detector with high background tolerance
((1) faster readout then (2) pixels)
(the detector temporarily known as) sBelle

[upgrade Belle to operate w 20X background, 50X event rate]

Background tolerant super small cell tracking detector

Si vertex detector with high background tolerance ((1)faster readout then (2)pixels)
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[upgrade Belle to operate w 20X background, 50X event rate]

New particle identifier with precise Cherenkov device:
(i)TOP or fDIRC.
Endcap: Aerogel RICH

Background tolerant super small cell tracking detector

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[upgrade Belle to operate w 20X background, 50X event rate]

- Faster calorimeter with waveform sampling and pure CsI (endcap)
- New particle identifier with precise Cherenkov device: (i)TOP or fDIRC. Endcap: Aerogel RICH
- Background tolerant super small cell tracking detector
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- KL/μ detection with scintillator and next generation photon sensors
- Background tolerant super small cell tracking detector
- Si vertex detector with high background tolerance ((1)faster readout then (2)pixels)
(the detector temporarily known as) sBelle

[upgrade Belle to operate w 20X background, 50X event rate]

Faster calorimeter with waveform sampling and pure CsI (endcap)

New particle identifier with precise Cherenkov device:
(i)TOP or fDIRC.
Endcap: Aerogel RICH

KL/µ detection with scintillator and next generation photon sensors

New dead time free pipelined readout and high speed computing systems

Background tolerant super small cell tracking detector

Si vertex detector with high background tolerance
((1)faster readout then (2)pixels)
Current concepts

**Silicon inner tracker**
- improve vertexing -> thin innermost 2 layers, reduce inner radius
- improve $K_S$ acceptance -> increase outer radius
- background/occupancy -> triplets, pixels, pipelined readout

<table>
<thead>
<tr>
<th></th>
<th>Belle</th>
<th>sBelle (t=0)</th>
<th>sBelle (t&gt;&gt;0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detector type</td>
<td>4 X DSSD</td>
<td>4X DSSD + 2 X DSSD (short strips)</td>
<td>2 X pixel + 4 X DSSD</td>
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<tr>
<td>Inner radius</td>
<td>15 mm</td>
<td>15 mm</td>
<td>10 mm</td>
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<tr>
<td>Outer radius</td>
<td>70 mm</td>
<td>120 mm</td>
<td>120 mm</td>
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<tr>
<td>DSSD readout</td>
<td>Hold/readout</td>
<td>pipelined</td>
<td>pipelined</td>
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<tr>
<td>Readout time</td>
<td>800 ns</td>
<td>50 ns</td>
<td>50 ns</td>
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</tbody>
</table>
Current concepts

Drift chamber
- improve momentum resolution -> increase outer radius
- improve dE/dx -> longer radial path
- background/occupancy -> smaller cells

<table>
<thead>
<tr>
<th></th>
<th>Belle</th>
<th>sBelle ($t&gt;0)$</th>
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<tbody>
<tr>
<td>Inner radius</td>
<td>77 mm</td>
<td>160 mm</td>
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<tr>
<td>Outer radius</td>
<td>880 mm</td>
<td>1140 mm</td>
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<tr>
<td>Inner layer cell size</td>
<td>12 mm</td>
<td>8 mm</td>
</tr>
<tr>
<td># sense wires</td>
<td>8400</td>
<td>15140</td>
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</tbody>
</table>
Current concepts

Particle ID
- improve $K/\pi$ for $b\rightarrow s$ vs $b\rightarrow d$, etc.
- add endcap PID
- reduce material in front of calorimeter

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<tr>
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<th>sBelle ($t&gt;0$)</th>
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<tbody>
<tr>
<td>Barrel</td>
<td>Aerogel TOF</td>
<td>Cerenkov time-of-propagation (TOP) [imaging TOP] [focusing DIRC]</td>
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<tr>
<td>Endcap</td>
<td>none</td>
<td>Aerogel RICH</td>
</tr>
</tbody>
</table>
**Current concepts**

**Electromagnetic calorimeter**
- reduce background without loss of resolution

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<tr>
<th></th>
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<th>sBelle (t&gt;0)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Barrel</strong></td>
<td>CsI (TI)</td>
<td>CsI(Tl) + waveform sampling/fitting</td>
</tr>
<tr>
<td><strong>Endcap</strong></td>
<td>CsI(Tl)</td>
<td>Pure CsI</td>
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<tr>
<td><strong>Rise time</strong></td>
<td>1000 ns</td>
<td>30 ns</td>
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<tr>
<td><strong>Photodetector</strong></td>
<td>Si photodiode</td>
<td>PMT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ waveform sampling/fitting</td>
</tr>
</tbody>
</table>
**Current concepts**

**$K_L$/muon detector**
- reduce background in endcap

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<tr>
<td>Barrel</td>
<td>Glass RPC, streamer mode</td>
<td>Same RPC (avalanche mode?)</td>
</tr>
<tr>
<td>Endcap</td>
<td>Glass RPC, streamer mode</td>
<td>Plastic scintillator x-y strips</td>
</tr>
<tr>
<td>Year</td>
<td>J-PARC</td>
<td>KEKB</td>
</tr>
<tr>
<td>------</td>
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</tr>
<tr>
<td>2006</td>
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<tr>
<td>2008</td>
<td>construction</td>
<td>experiment + upgrade</td>
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<td>2010</td>
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<td>2012</td>
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- **Detector R&D**
- **ERL**
- **C-ERL R&D**
- **ILC**
- **ILC R&D**

*Very Preliminary*

Host and Site: Yet to be decided
- Official 20 p. report released Jan 4, 2008 by director A. Suzuki & KEK mgmt
- Affirmed by Roadmap Review Committee (March)
Placement of KEKB upgrade on roadmap is significant
Placement of KEKB upgrade on roadmap is **significant**

- 3-year KEKB upgrade (’09–’11) with constant annual budget (KEKB operations → construction)
- Staging RF cavities etc, initial $L \sim 2 \times 10^{35}$ cm$^{-2}$s$^{-1}$
- Funding: KEK management in discussions w agency (MEXT)

- Official 20 p. report released Jan 4, 2008 by director A. Suzuki & KEK mgmt
- Affirmed by Roadmap Review Committee (March)
International group for sBelle

- New experimental group being formed (not an extension of present Belle collaboration): name TBD
- New participants are welcome, will have equal opportunities to work on detector construction and physics

Interim Steering Committee:
Hiroaki Aihara (Tokyo/IPMU), Alex Bondar (BINP), Tom Browder (Hawaii), Paoti Chang (NTU), Toru Iijima (Nagoya), Peter Krizan (Chair, Ljubljana), Thomas Muller (Karlsruhe), Henryk Palka (Crakow), Christoph Schwanda (Vienna), Martin Sevior (Melbourne), Eunil Won (Korea), Changzheng Yuan (IHEP, China), Yutaka Ushiroda, Yoshi Sakai (KEK), Masa Yamauchi (KEK)
Summary

- B-factories 1999-2009, >1.4x10^9 B pairs:
  established CKM as source of CP asymmetry in weak interaction
  multiple measurements on CKM with increasing precision:
    \( \varphi_1, \varphi_2, \varphi_3, |V_{ub}|, \)
    -> probe New Physics:
  discoveries: D mixing, new hadronic states
  studies of tau
  a few unresolved effects: K\(\pi\) CP asymmetry, imperfect CKM fit

- \(~10^2X\) luminosity will probe significantly into >1 TeV mass scale
  precision CKM, CP, lepton universality, LFV

- KEKB upgrade for \(L=2-8 \times 10^{35}\) included in KEKB Roadmap
- KEKB/Belle upgrade plans well underway
  new international collaboration forming