Belle Status and Plans

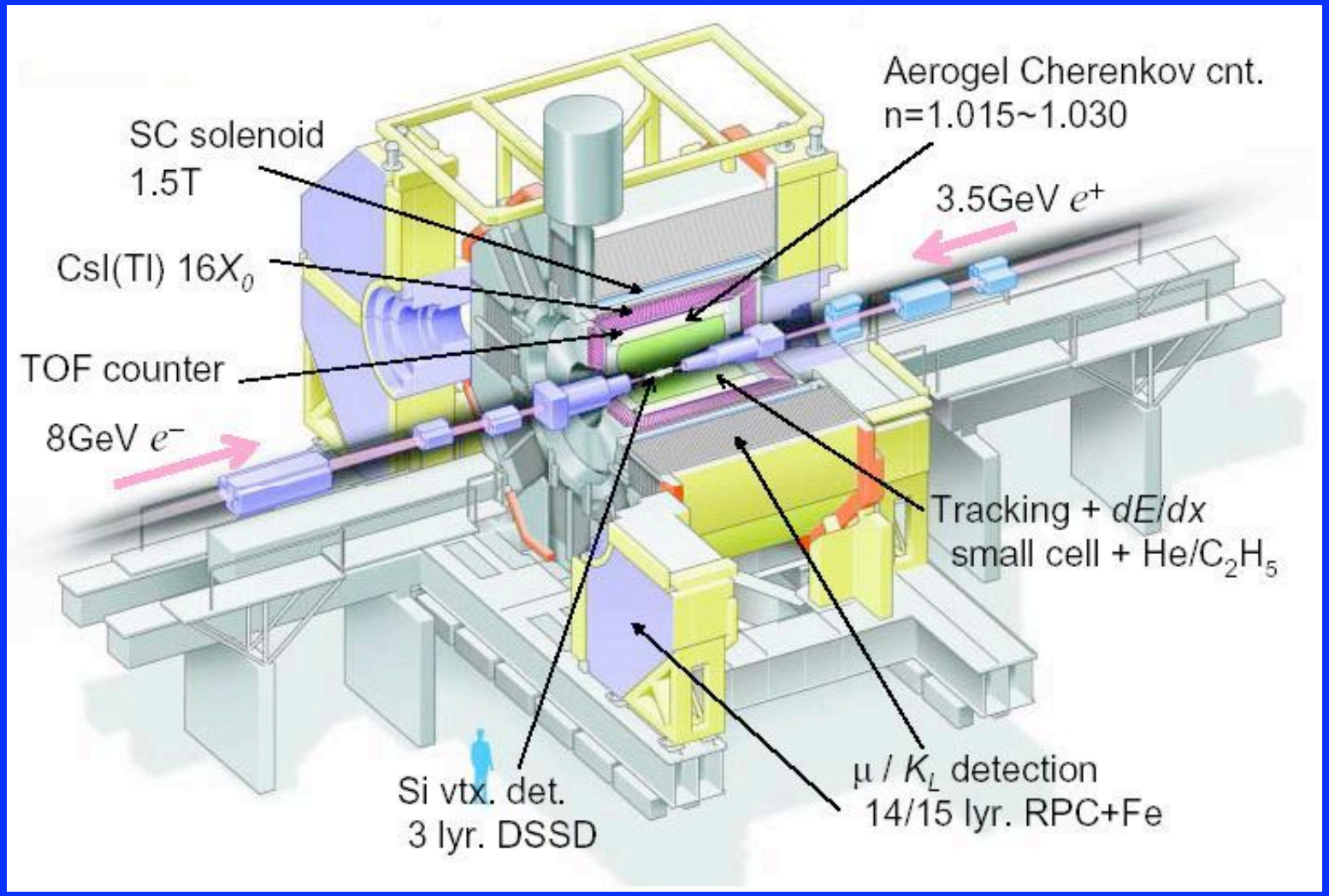
February 10, 2003

Fumihiko Takasaki, KEK

Contents

- Introduction
- Status of Physics Analysis
- Vacuum leak at IR
- Detector Upgrade
- Summary

Belle Detector



Belle Collaboration

Aomori U.
BINP
Chiba U.
Chuo U.
U. of Cincinnati
Frankfurt U.
Gyeongsang Nat'l U.
U. of Hawaii
Hiroshima Tech.
IHEP, Beijing
ITEP
Kanagawa U.
KEK
Korea U.
Krakow Inst. of Nucl. Phys.
Kyoto U.
Kyungpook National U.
U. of Lausanne
Jozef Stefan Inst.
U. of Maribor
U. of Melbourne
Nagoya U.
Nara Women's U.
National Central U.
Nat'l Kaoshiung Normal U.
Nat'l Lien-Ho Inst. of Tech.
Nat'l Taiwan U.
Nihon Dental College
Niigata U.
Osaka U.
Osaka City U.
Panjab U.
Peking U.
Princeton U.
Riken
Saga U.
USTC
Seoul National 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
Utkal U.
IHEP, Vienna
VPI
Yokkaichi U.
Yonsei U.

Status of Physics Analysis

- The Belle has already recorded < 100 million B-meson decays.

- The Belle published 55 papers and many will follow.

- The Belle sensitivity reached at the level down to Br(10^{-8}) or smaller with the 100 million B meson decays.

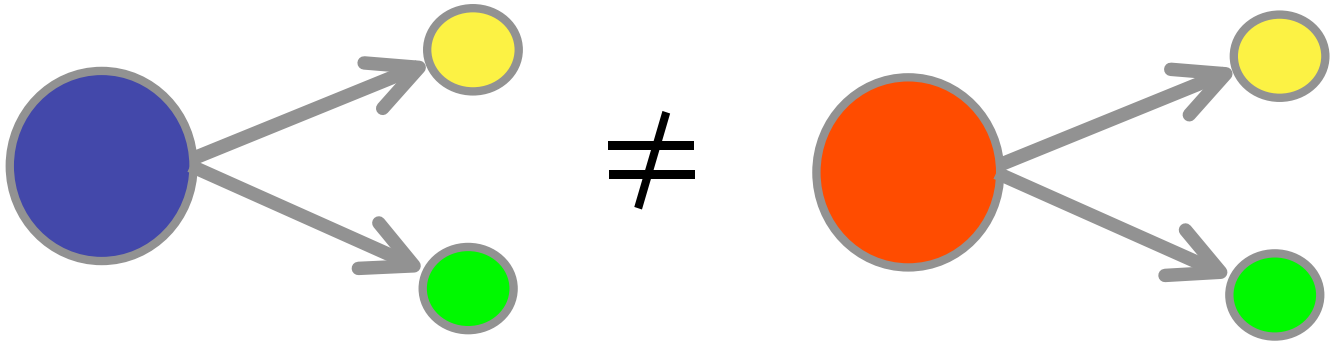
Physics Goals

One of the physics goals of the KEKB project is:

- To find evidence for CP violation in B-meson decays and
- To measure CKM parameter measurements precisely.

Violation of CP symmetry: A special case

$$P(A \to b + c) \neq P(\bar{A} \to b + c)$$



The ϕ_i's and CKM matrix

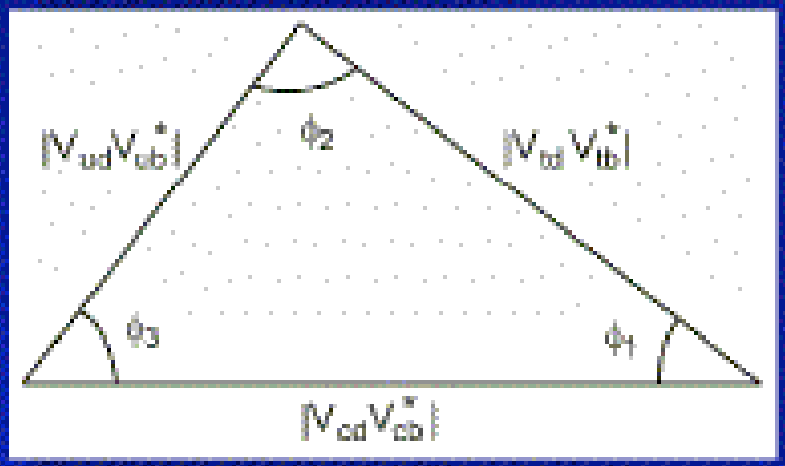
CKM quark mixing matrix

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

Unitarity

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

Unitarity triangle



$$\phi_1 \equiv \pi - \arg\left(\frac{-V_{tb}^*V_{td}}{-V_{cb}^*V_{cd}}\right)$$

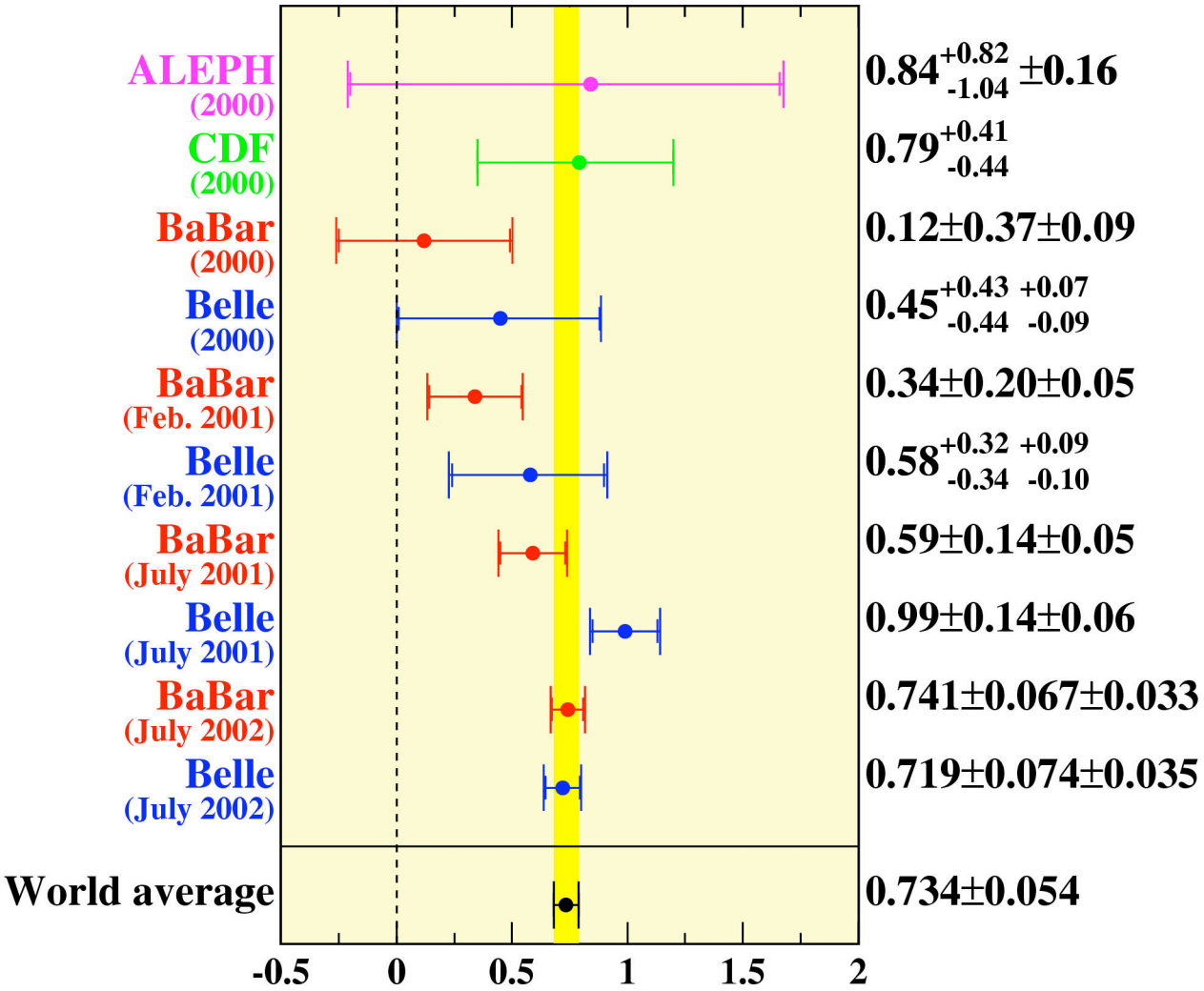
$$\phi_2 \equiv \arg\left(\frac{V_{tb}^*V_{td}}{-V_{ub}^*V_{ud}}\right)$$

Evidence for the CP symmetry V.

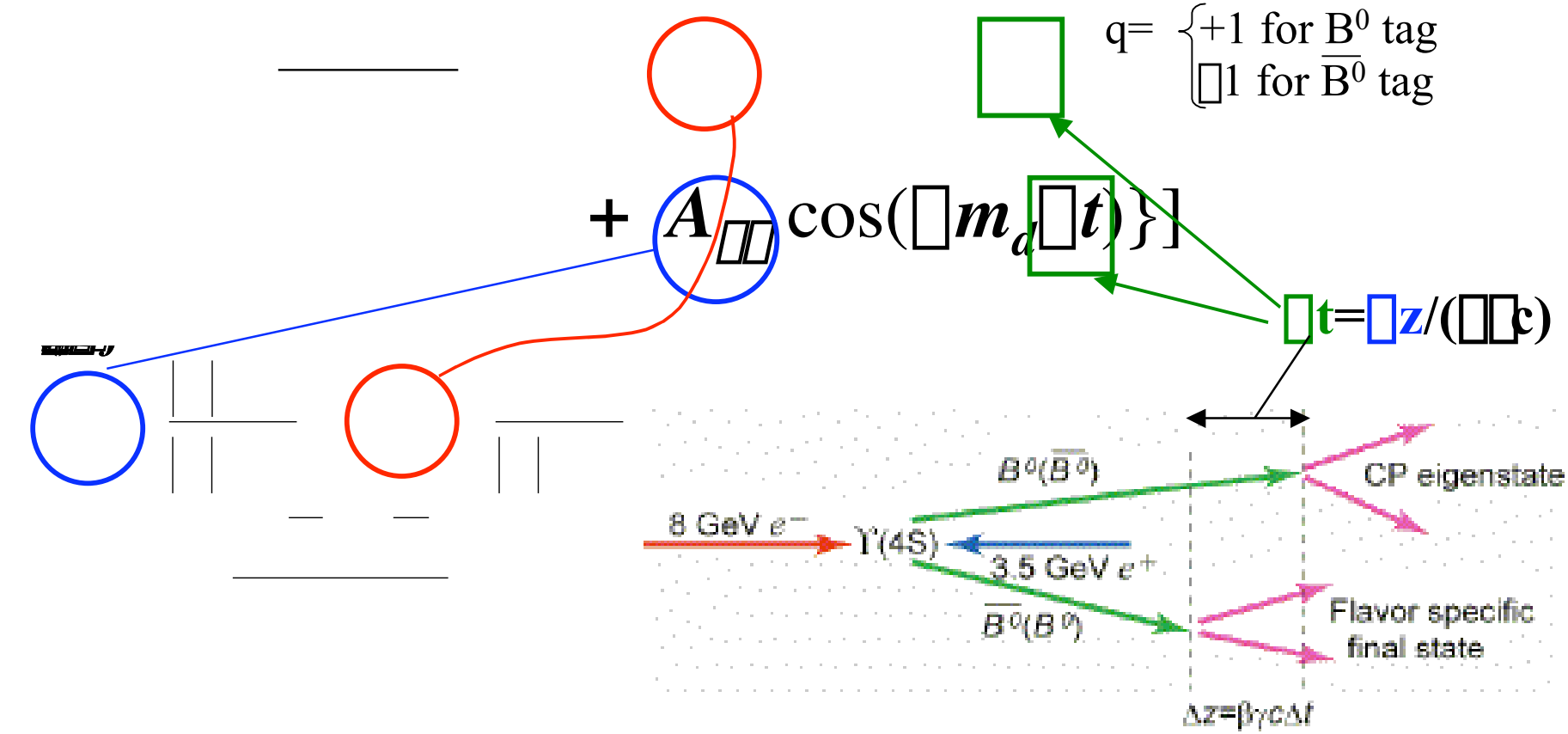
- In the year 2001, we discovered the CPV in the B-meson decays modes, B □ J/□ K.

- In the year 2002, we found an evidence for the CPV in a new mode, B □ □□.

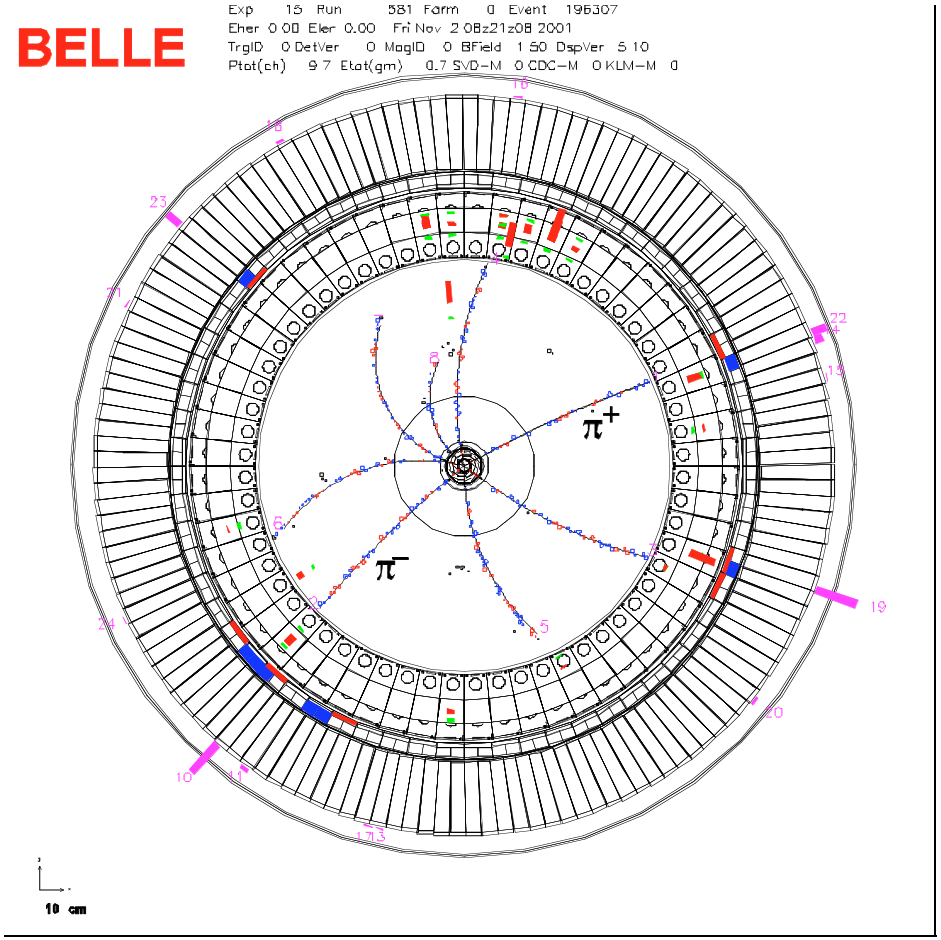
sin2β_1 history

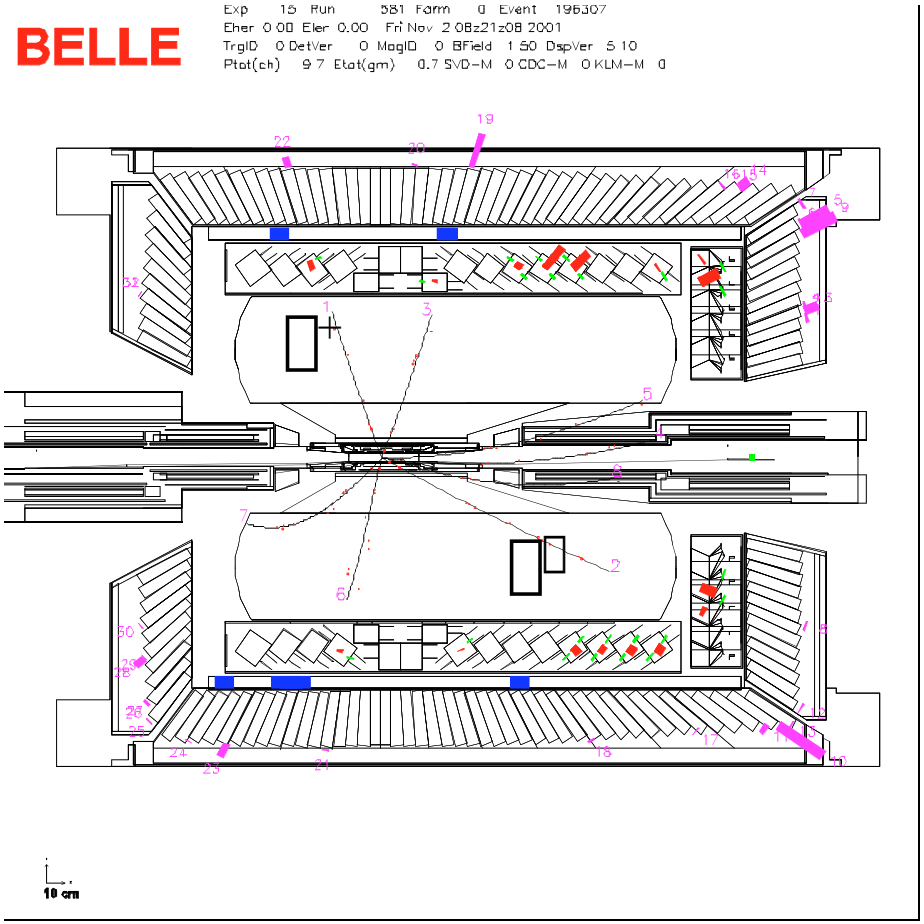


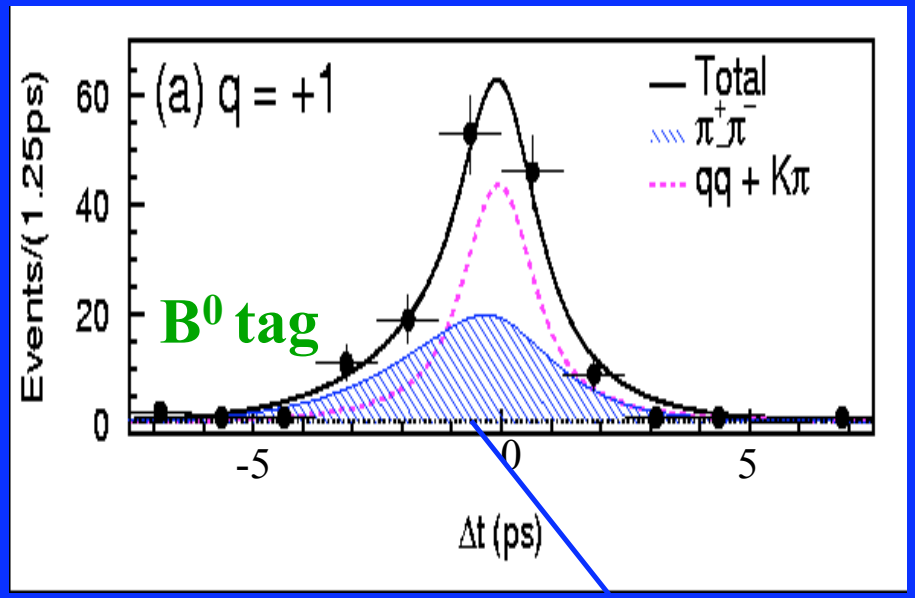
Time-dependent CP asymmetries in $B^0 \to \pi^+\pi^-$ -- the best way to access the CKM angle ϕ_2

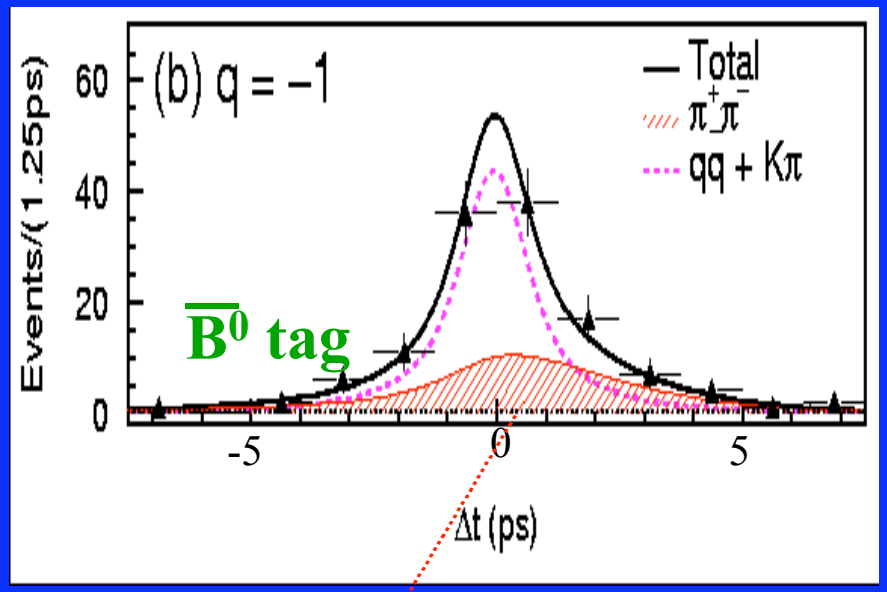


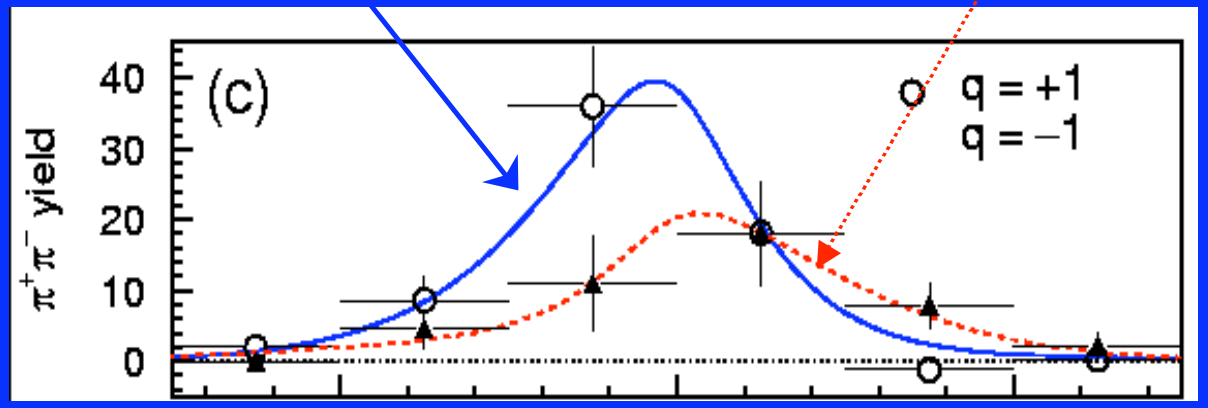
B^0 □ □+□- example


BELLE
Exp 15 Run 581 Form 0 Event 196307
Eher 0.00 Eler 0.00 Fri Nov 2 08:21:08 2001
TrgID 0 DetVer 0 MagID 0 BField 1.50 DspVer 5.10
Ptot(ch) 9.7 Etot(gm) 0.7 SVD-M 0 CDC-M 0 KLM-M 0
π+
π−
10 cm


BELLE
Exp 15 Run 581 Form 0 Event 196307
Eher 0.00 Eler 0.00 Fri Nov 2 08:21:08 2001
TrgID 0 DetVer 0 MagID 0 BField 1.50 DspVer 5.10
Ptot(ch) 9.7 Etot(gm) 0.7 SVD-M 0 CDC-M 0 KLM-M 0
10 cm



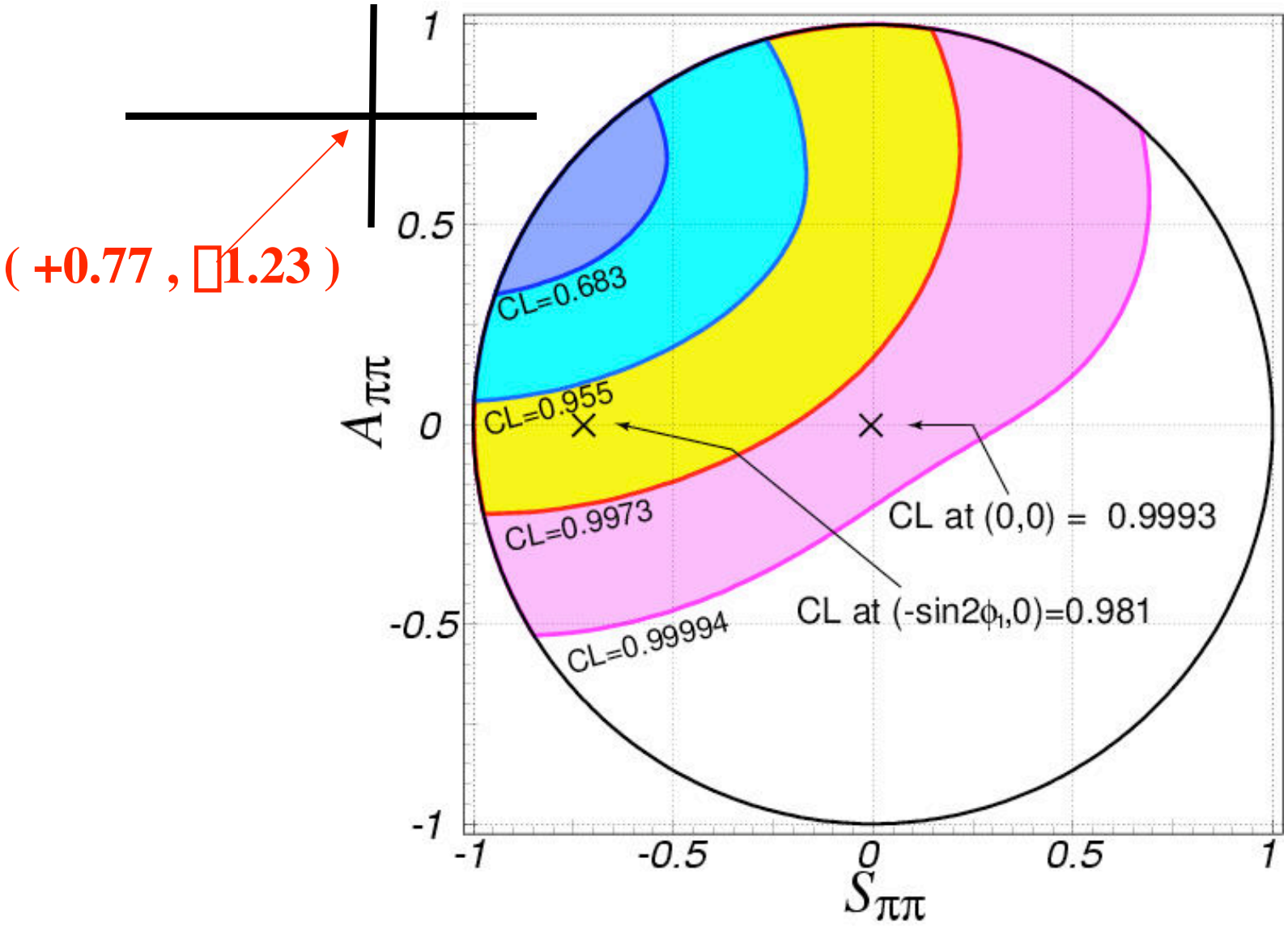




Large *CP* Violation is seen !

$A_{\square\square} = +0.77 \pm 0.27(\text{stat}) \pm 0.08(\text{syst})$

$S_{\square\square} = \square 1.23 \pm 0.41(\text{stat}) \; {}^{+0.08}_{\square 0.07} \; (\text{syst})$



Evidence for CP violation in $B^0 \to \pi^+\pi^-$!

***CP* conservation ruled out at the**

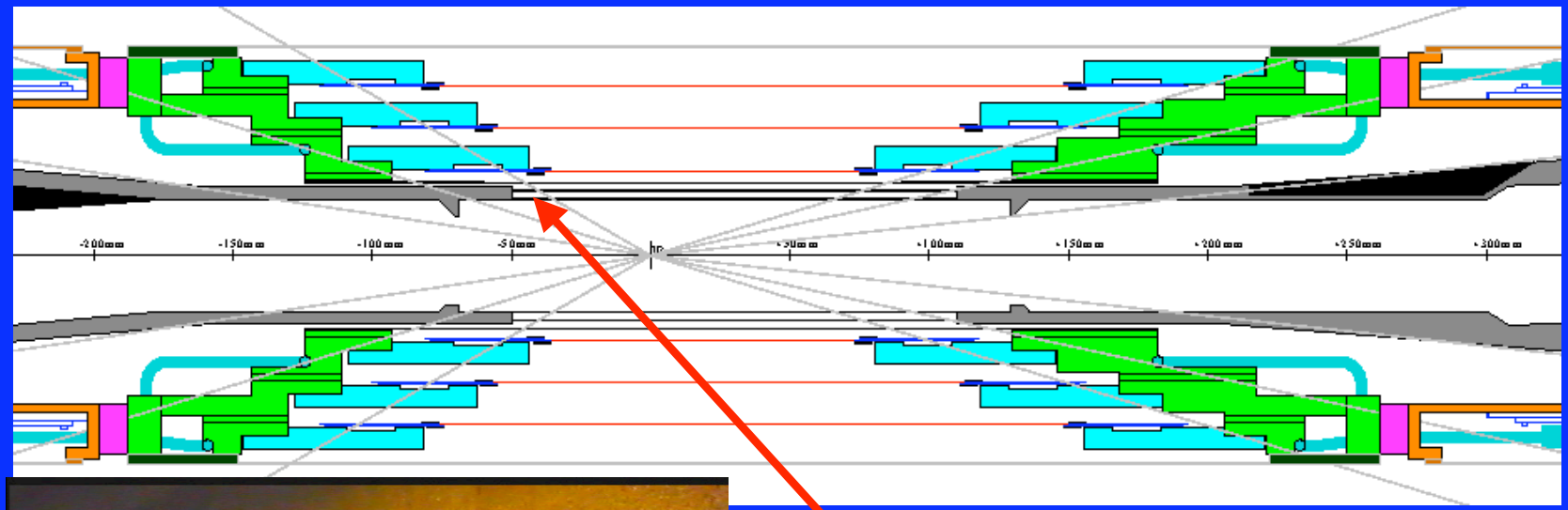
99.93% CL (3.4σ)

First constraints on the CKM angle α_2 !

$$78^o < \alpha_2 < 152^o \quad \text{(95.5\% CL)}$$

[for $0.15 < |P/T| < 0.45$ and $\alpha_1 = 23.5^o (\sin 2\alpha_1 = 0.73)$]

Pin-hole in IR Be-Chamber



leak point

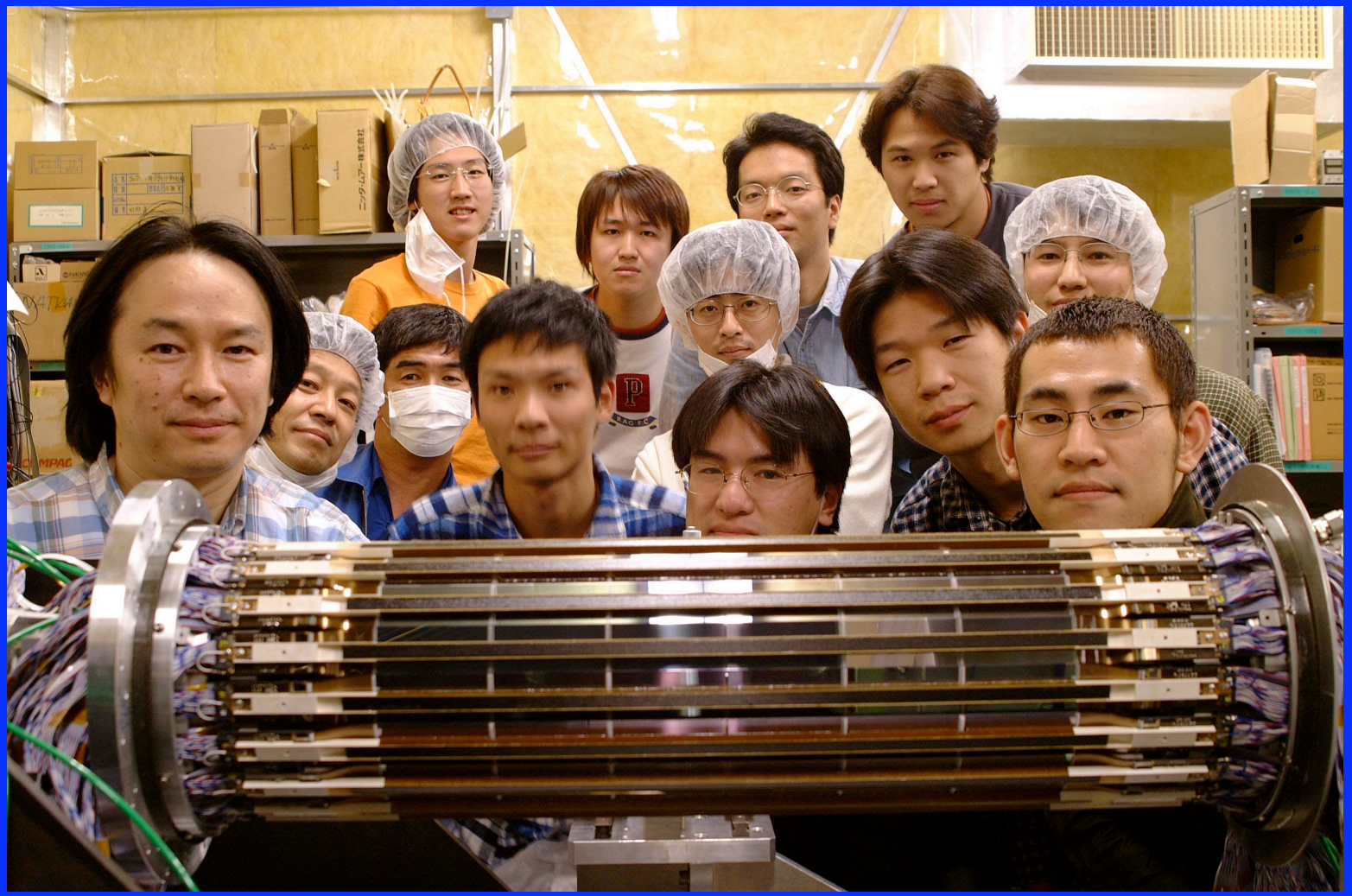
Bubble !!!!

Detector Upgrade

1) A new silicon detector has
a 4-layer structure to be arranged around
a new IR beam pipe
with the radius of 1.5 cm.

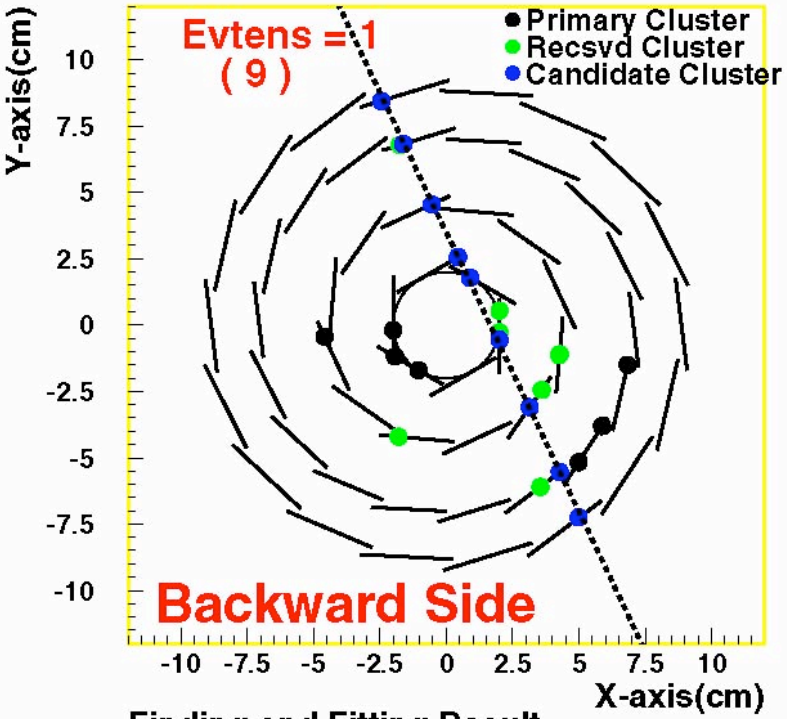
2) The replacement of the inner part of CDC
is also scheduled.

Installation is scheduled in this summer.



2002/12/28 06.37

2D Track Finding(used N-Cluster)



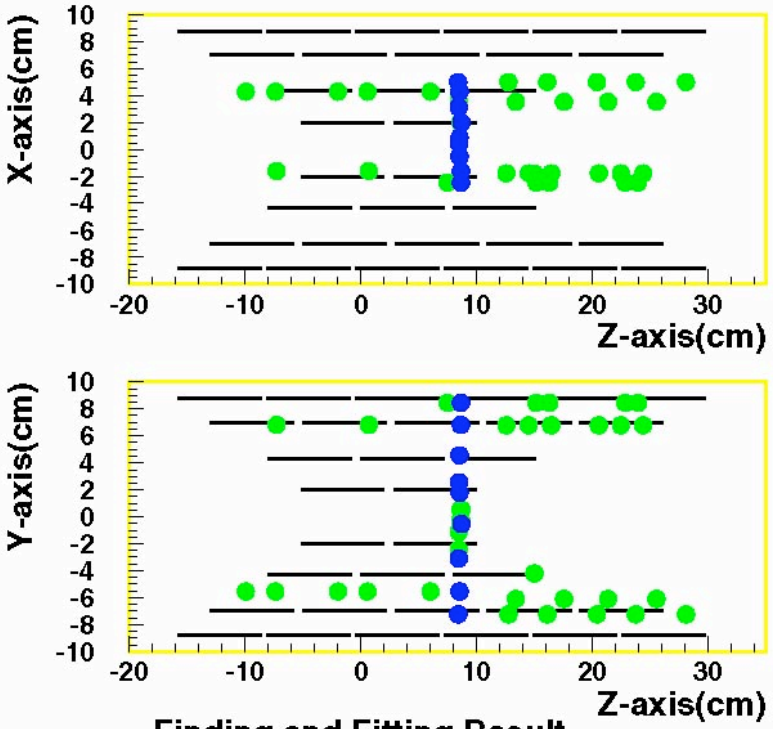
Finding and Fitting Result

Number of Cluster = 9

Directon = (-0.428881,0.903323,0.00834067)

2D LINE Y = -2.10623X + 3.49476

3D Track Finding(PN-Cluster)

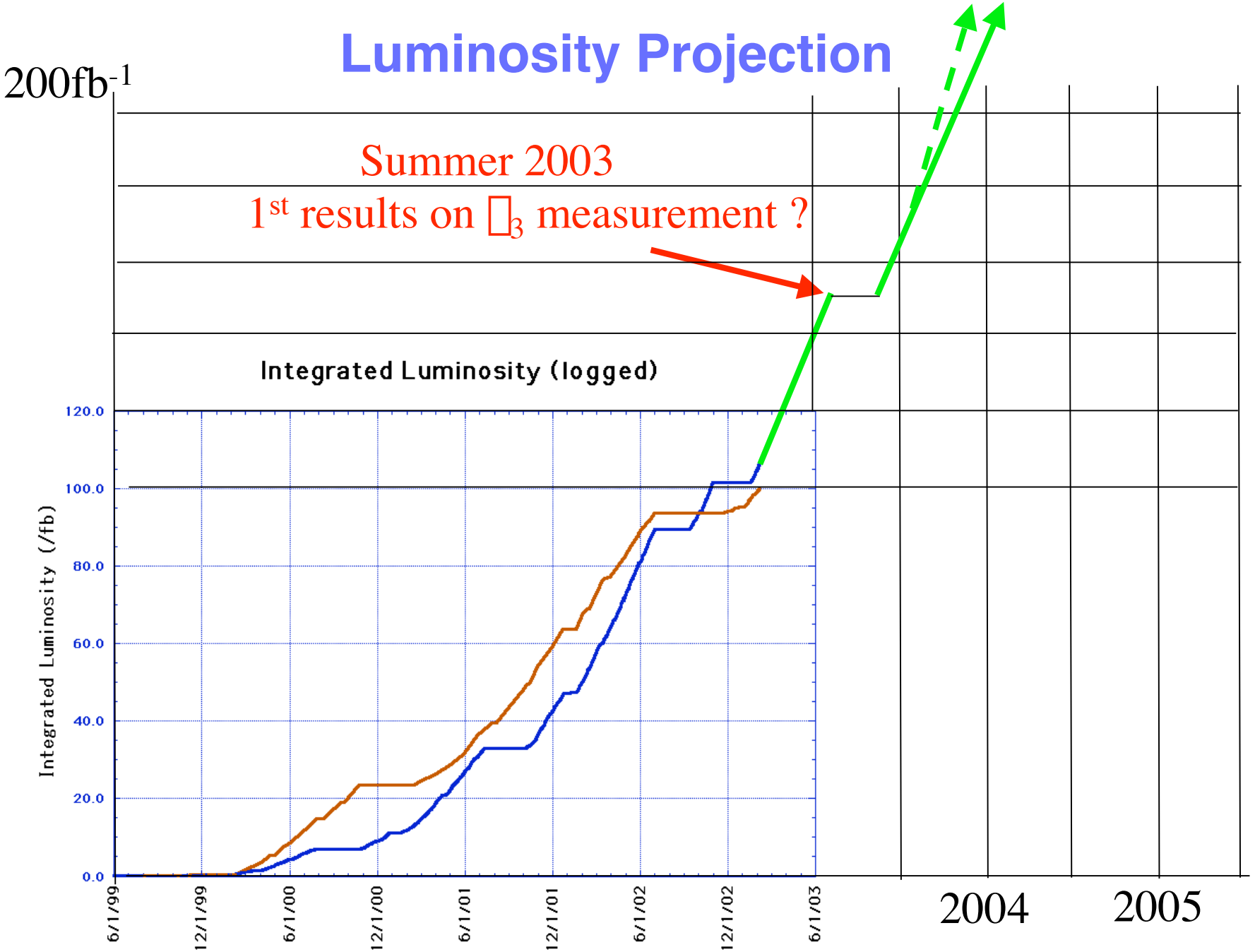


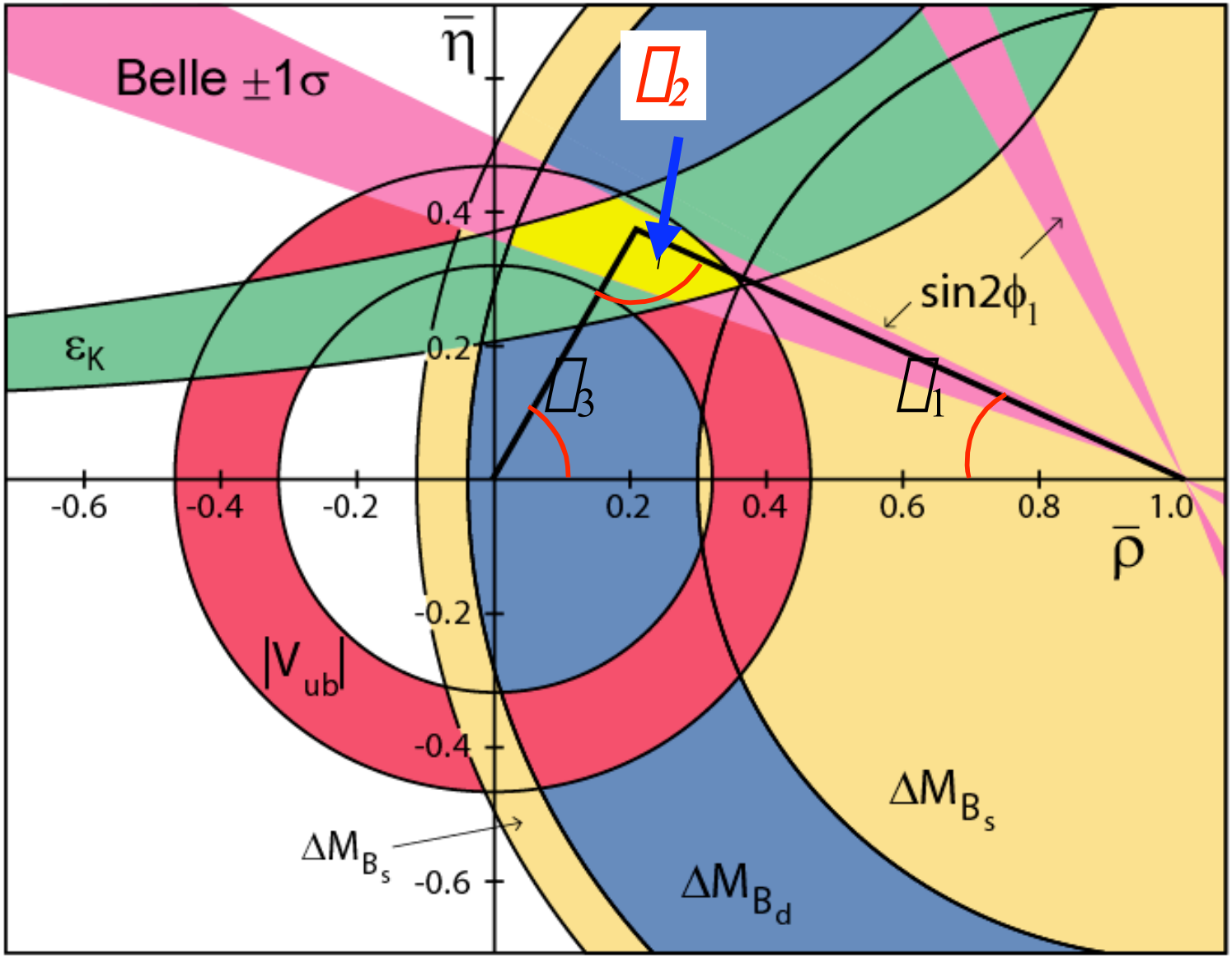
Finding and Fitting Result

2D LINE X = -51.4205Z + 442.583

2D LINE Y = 108.303Z + -928.686

Luminosity Projection




Belle ±1σ
$\bar{\eta}$
α_2
0.4
0.2
-0.2
-0.4
-0.6
ε_K
α_3
α_1
sin2ϕ_1
-0.6
-0.4
-0.2
0.2
0.4
0.6
0.8
1.0
$\bar{\rho}$
$|V_{ub}|$
ΔM_{B_s}
ΔM_{B_s}
ΔM_{B_d}

Summary

- The KEKB/belle is demonstrating that it is one of the most competitive projects these days.

- With the 100 times more data, we can find evidence for the New Objects, such as SUSY particles and Charged Higgs.

- We would like to ask you to give us good advice for the substantial upgrade of the luminosity,

to the $10^{35} <$ regime.

Gratitude

- We express our gratitude to the KEKB accel. people for a wonderful performance of the KEKB accelerator.

- We also thank the KEKB review team for the careful and timely advice to the operation of the KEKB accelerator.