Belle Status

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KEK

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Introduction

Physics Goals : Detailed study of B-meson decays

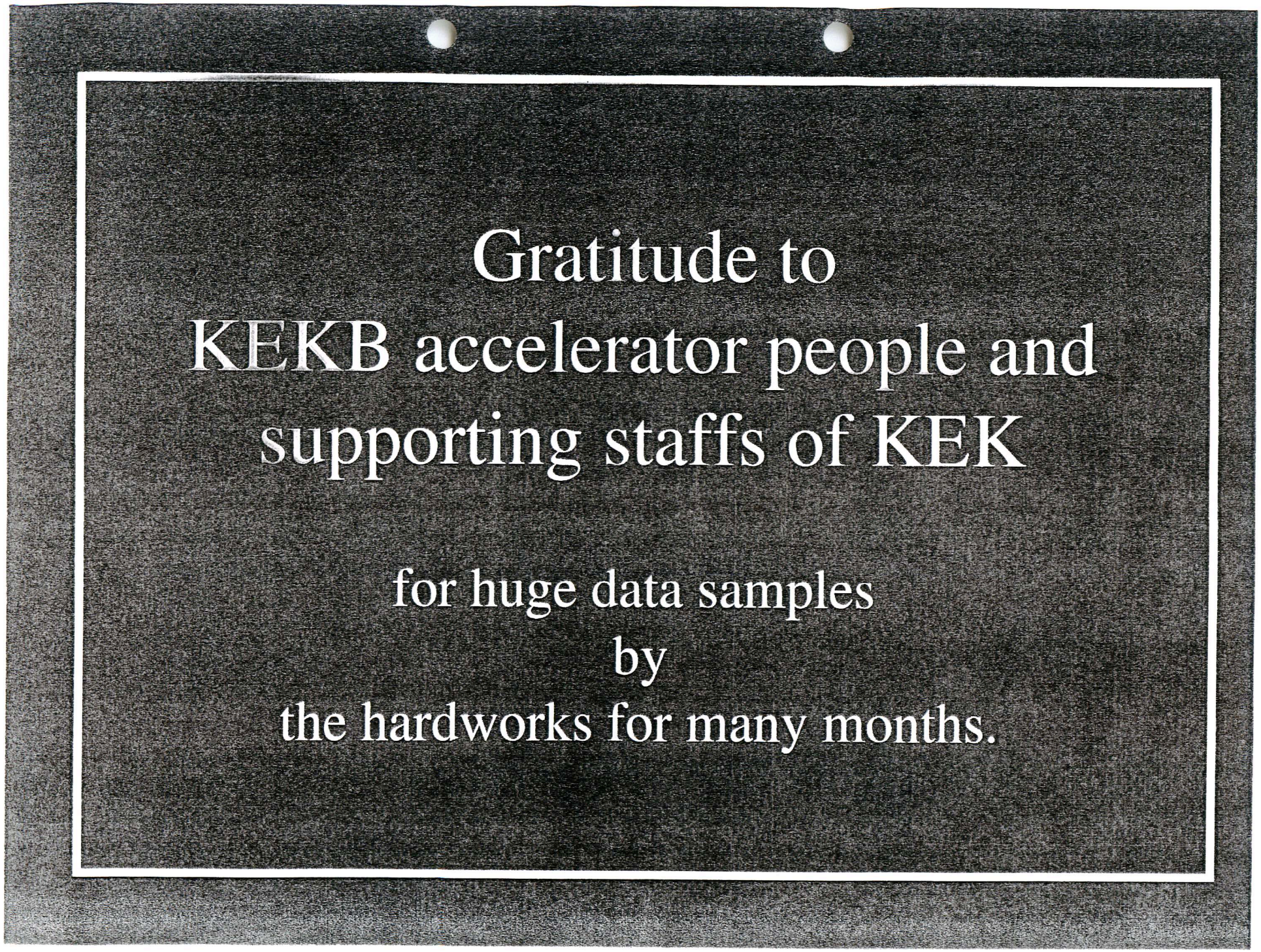
Discovery of CPV in BMD

Amount of data samples : 11 M $B\bar{B}$ <

3 3 M $q\bar{q}$ <

Sufficient for Start-up!

" However, we need much much more data."

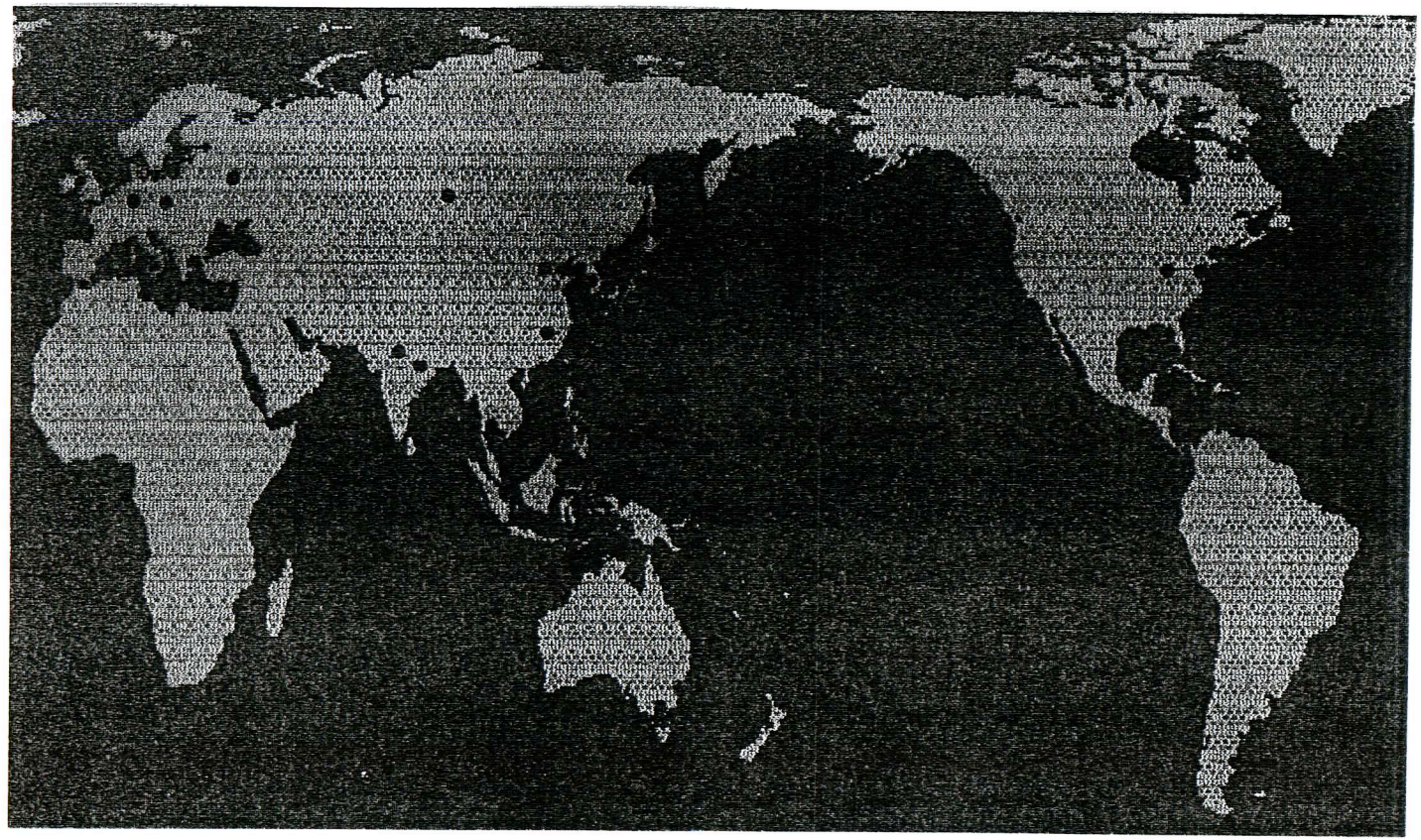

Gratitude to
KEKB accelerator people and
supporting staffs of KEK
for huge data samples
by
the hardworks for many months.

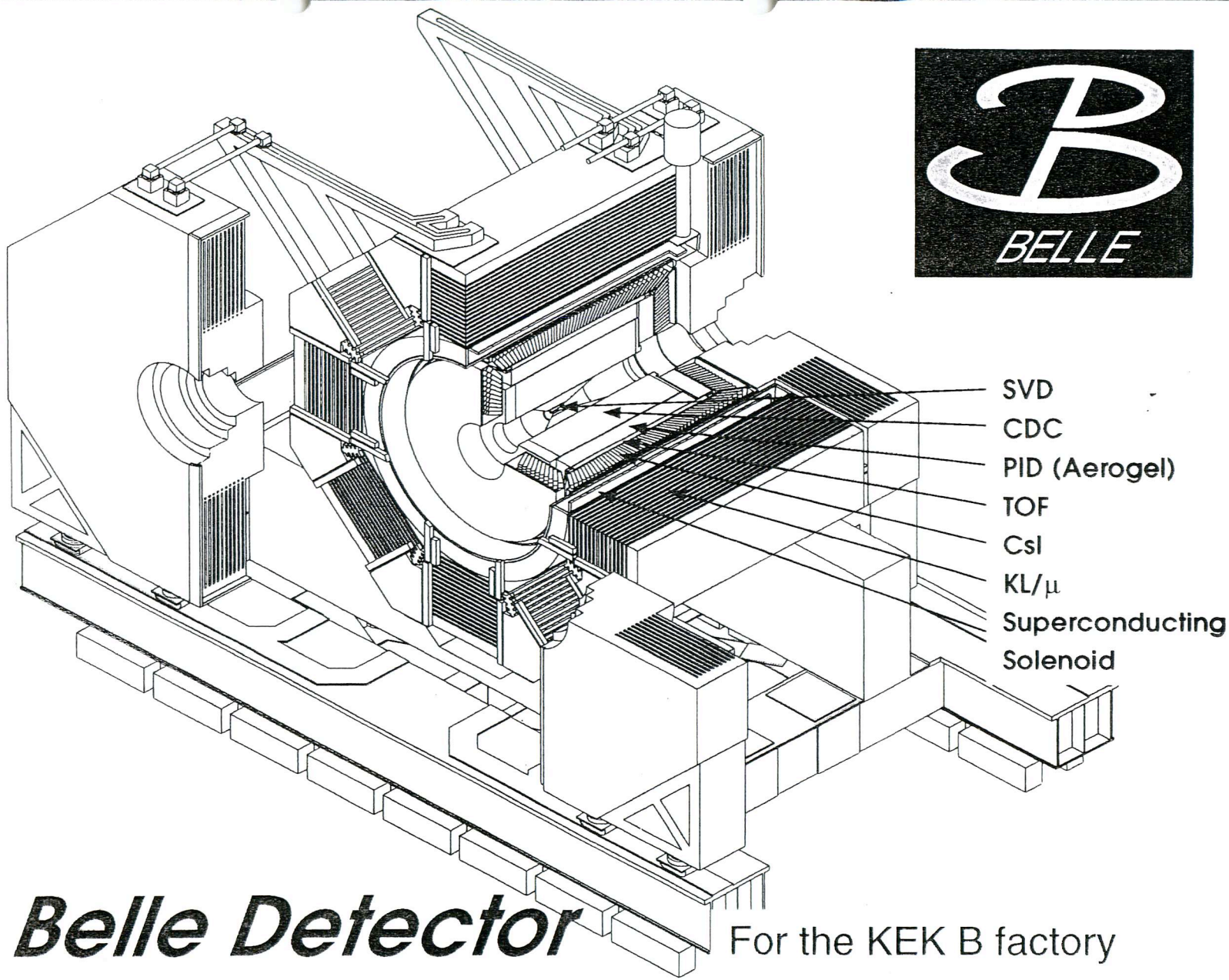
Belle Collaboration

~ 250 physicists from 52 institutions in 11 countries

Aomori University
Budker Institute of Nuclear Physics
Chiba University
Chuo University
University of Cincinnati
Frankfurt University
Gyeongsang National University
University of Hawai
Hiroshima Institute of Technology
Hiroshima College of Maritime Tech
ICRR, University of Tokyo.
IHEP, Beijing
ITEP, Moscow
Joint Crystal Collaboration Group
Kanagawa University
KEK
Korea University
Krakow Institute of Nuclear Physics
Kyoto University
University of Melbourne
Mindanao State University
Nagasaki Institute of Applied Science
Nagoya University
Nara Woman's University
National Central University
National Kaoshing University
National Lien-Ho College of Tech. and Commerce
National Taiwan University
Nihon Dental College
Niigata University
Osaka University
Osaka City University
Panjab Uiversity
Princeton University
Saga University
Seoul National University
University of Science and Tech. of China
Sugiyama Woman's College
Sungkyunkwan University
University of Sydney
Toho University
Tohoku University
Tohoku-gakuin University
University of Tokyo
Tokyo Institute of Technology
Tokyo Metropolitan University
Tokyo University of Agriculure and Technology
Toyama National College of Maritime Technology
University of Tsukuba
Utkal Univesity
Virginia Polytechnic Institute and State University
Yonsei University

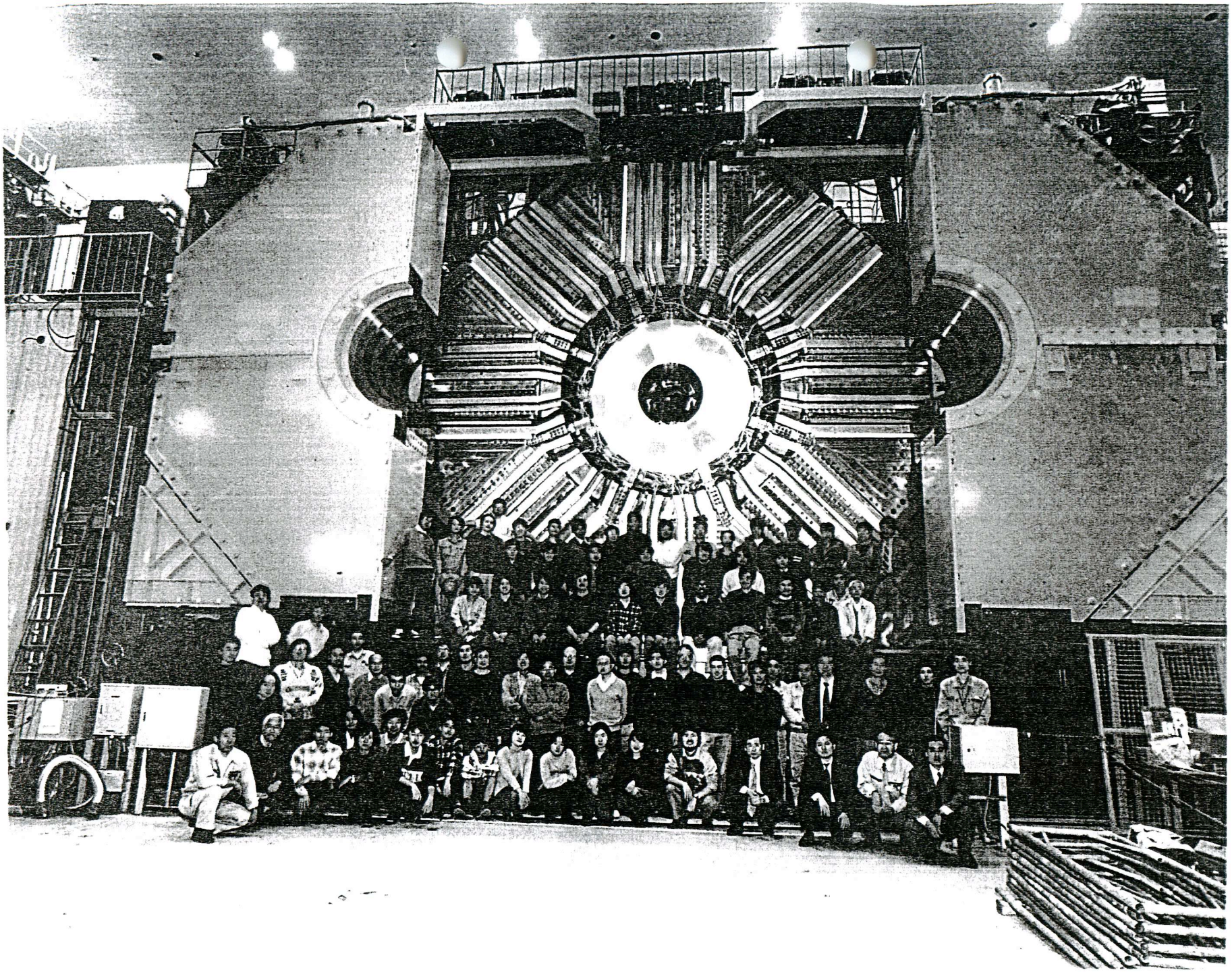
Belle Collaboration





Belle Detector

For the KEK B factory



Detector Status

Belle Detector
incl. Trigg and DAQ

is working as almost designed.
Software is in good shape.

Physics Analysis

General Remarks

Physics Topics of Interests are with very small branching ratios, 10^-4 > Br.

10 M Bbar gives us 100 events.

With the Int. luminosity 11 fb^-1, we have just reached at the sensitive regime.

Physics Topics

- CP violation ($\sin 2\phi_1$)
- Charmonium production in B decay
- Polarization in $B \to J/\psi K^*$
- B lifetime and BB mixing
- $B \to \pi\pi$ / $K\pi$ / KK
- $B \to K\pi\pi$ / $KK\pi$ / KKK
- $B \to K^*\gamma$ and $b \to s\gamma$
- $B \to K(*)\mu\mu$
- $B \to D(*)\pi$, $D(*)K(*)$
- $B \to \phi K(*)$
- $B \to \eta' K$
- $B \to \rho h$ and ωh
- Lepton inclusive rate
- V_{cb} from $D^* l\nu$ and $Dl\nu$
- V_{ub} from $\pi l\nu$ and $\rho l\nu$
- V_{ub} from $Ds\pi$
- D/Ds lifetimes
- $D\bar{D}$ mixing
- K-lepton correlation
- Charmonium production in $q\bar{q}$ events
- τ rare decays
- Search for CPV in τ decays
- $K\bar{K}$ production in $\gamma\gamma$ collisions

Observation of CPV in B-meson decays

Measurement of the CP Violation Parameter $\sin 2\phi_1$ in B^0_d Meson Decays

A. Abashian[44], K. Abe[8], K. Abe[36], I. Adachi[8], Byoung Sup Ahn[14], H. Aihara[37], M. Akatsu[19], G. Alimonti[7], K. Aoki[8], K. Asai[20], M. Asai[9], Y. Asano[42], T. Aso[41], V. Aulchenko[2], T. Aushev[12], A. M. Bakich[33], E. Banas[15], S. Behari[8], P. K. Behera[43], D. Beiline[2], A. Bondar[2], A. Bozek[15], T. E. Browder[7], B. C. K. Casey[7], P. Chang[23], Y. Chao[23], B. G. Cheon[32], S.-K. Choi[6], Y. Choi[32], Y. Doi[8], J. Dragic[17], A. Drutskoy[12], S. Eidelman[2], Y. Enari[19], R. Enomoto[8,10], C. W. Everton[17], F. Fang[7], H. Fujii[8], K. Fujimoto[19], Y. Fujita[8], C. Fukunaga[39], M. Fukushima[10], A. Garmash[2,8], A. Gordon[17], K. Gotow[44], H. Guler[7], R. Guo[21], J. Haba[8], T. Haji[37], H. Hamasaki[8], K. Hanagaki[29], F. Handa[36], K. Hara[27], T. Hara[27], T. Haruyama[8], N. C. Hastings[17], K. Hayashi[8], H. Hayashii[20], M. Hazumi[27], E. M. Heenan[17], Y. Higashi[8], Y. Higashino[19], I. Higuchi[36], T. Higuchi[37], T. Hirai[38], H. Hirano[40], M. Hirose[19], T. Hojo[27], Y. Hoshi[35], K. Hoshina[40], W.-S. Hou[23], S.-C. Hsu[23], H.-C. Huang[23], Y.-C. Huang[21], S. Ichizawa[38], Y. Igarashi[3], T. Iijima[8], H. Ikeda[8], K. Ikeda[20], K. Inami[19], Y. Inoue[26], A. Ishikawa[19], H. Ishino[38], R. Itoh[8], G. Iwai[25], M. Iwai[8], M. Iwamoto[3], H. Iwasaki[8], Y. Iwasaki[8], D. J. Jackson[27], P. Jalocha[15], H. K. Jang[31], M. Jones[7], R. Kagan[12], H. Kakuno[38], J. Kaneko[38], J. H. Kang[45], J. S. Kang[14], P. Kapusta[15], K. Kasami[8], N. Katayama[8], H. Kawai[3], H. Kawai[37], M. Kawai[8], N. Kawamura[1], T. Kawasaki[25], H. Kichimi[8], D. W. Kim[32], Heejong Kim[45], H. J. Kim[45], Hyunwoo Kim[14], S. K. Kim[31], K. Kinoshita[5], S. Kobayashi[30], S. Koike[8], S. Koishi[38], Y. Kondo[8], H. Konishi[40], K. Korotushenko[29], P. Krokovny[2], R. Kulasiri[5], S. Kumar[28], T. Kuniya[30], E. Kurihara[3], A. Kuzmin[2], Y.-J. Kwon[45], M. H. Lee[8], S. H. Lee[31], C. Leonidopoulos[29], H.-B. Li[11], R.-S. Lu[23], Y. Makida[8], A. Manabe[8], D. Marlow[29], T. Matsubara[37], T. Matsuda[8], S. Matsui[19], S. Matsumoto[4], T. Matsumoto[19], Y. Mikami[36], K. Misono[19], K. Miyabayashi[20], H. Miyake[27], H. Miyata[25], L. C. Moffitt[17], A. Mohapatra[43], G. R. Moloney[17], G. F. Moorhead[17], N. Morgan[44], S. Mori[42], T. Mori[4], A. Murakami[30], T. Nagamine[36], Y. Nagasaka[18], Y. Nagashima[27], T. Nakadaira[37], T. Nakamura[38], E. Nakano[26], M. Nakao[8], H. Nakazawa[4], J. W. Nam[32], S. Narita[36], Z. Natkaniec[15], K. Neichi[35], S. Nishida[16], O. Nitoh[40], S. Noguchi[20], T. Nozaki[8], S. Ogawa[34], T. Ohshima[19], Y. Ohshima[38], T. Okabe[19], T. Okazaki[20], S. Okuno[13], S. L. Olsen[7], W. Ostrowicz[15], H. Ozaki[8], P. Pakhlov[12], H. Palka[15], C. S. Park[31], C. W. Park[14], H. Park[14], L. S. Peak[33], M. Peters[7], L. E. Piilonen[44], E. Prebys[29], J. L. Rodriguez[7], N. Root[2], M. Rozanska[15], K. Rybicki[15], J. Ryuko[27], H. Sagawa[8], S. Saitoh[3], Y. Sakai[8], H. Sakamoto[16], H. Sakaue[26], M. Satapathy[43], N. Sato[8], A. Satpathy[8,5], S. Schrenk[5], S. Semenov[12], Y. Settai[4], M. E. Sevior[17], H. Shibuya[34], B. Shwartz[2], A. Sidorov[2], V. Sidorov[2], S. Stanič[42], A. Sugi[19], A. Sugiyama[19], K. Sumisawa[27], T. Sumiyoshi[8], J. Suzuki[8], J.-I. Suzuki[8], K. Suzuki[3], S. Suzuki[19], S. Y. Suzuki[8], S. K. Swain[7], H. Tajima[37], T. Takahashi[26], F. Takasaki[8], M. Takita[27], K. Tamai[8], N. Tamura[25], J. Tanaka[37], M. Tanaka[8], Y. Tanaka[18], G. N. Taylor[17], Y. Teramoto[26], M. Tomoto[19], T. Tomura[37], S. N. Tovey[17], K. Trabelsi[7], T. Tsuboyama[8], Y. Tsujita[42], T. Tsukamoto[8], T. Tsukamoto[30], S. Uehara[8], K. Ueno[23], N. Ujiie[8], Y. Unno[3], S. Uno[8], Y. Ushiroda[16], Y. Usov[2], S. E. Vahsen[29], G. Varner[7], K. E. Varvell[33], C. C. Wang[23], C. H. Wang[22], M.-Z. Wang[23], T. J. Wang[11], Y. Watanabe[38], E. Won[31], B. D. Yabsley[8], Y. Yamada[8], M. Yamaga[36], A. Yamaguchi[36], H. Yamaguchi[8], H. Yamamoto[7], T. Yamanaka[27], H. Yamaoka[8], Y. Yamaoka[8], Y. Yamashita[24], M. Yamauchi[8], S. Yanaka[38], M. Yokoyama[37], K. Yoshida[19], Y. Yusa[36], H. Yuta[1], C. C. Zhang[11], H. W. Zhao[8], Y. Zheng[7], V. Zhilich[2], and D. Žontar[42]

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[2] *Budker Institute of Nuclear Physics, Novosibirsk*
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[5] *University of Cincinnati, Cincinnati, OH*
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[14] *Korea University, Seoul*
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[24] Nihon Dental College, Niigata
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[26] Osaka City University, Osaka
[27] Osaka University, Osaka
[28] Panjab University, Chandigarh
[29] Princeton University, Princeton NJ
[30] Saga University, Saga
[31] Seoul National University, Seoul
[32] Sungkyunkwan University, Suwon
[33] University of Sydney, Sydney NSW
[34] Toho University, Funabashi
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[43] Utkal University, Bhubaneswer
[44] Virginia Polytechnic Institute and State University, Blacksburg VA
[45] Yonsei University, Seoul

(February 9, 2001)

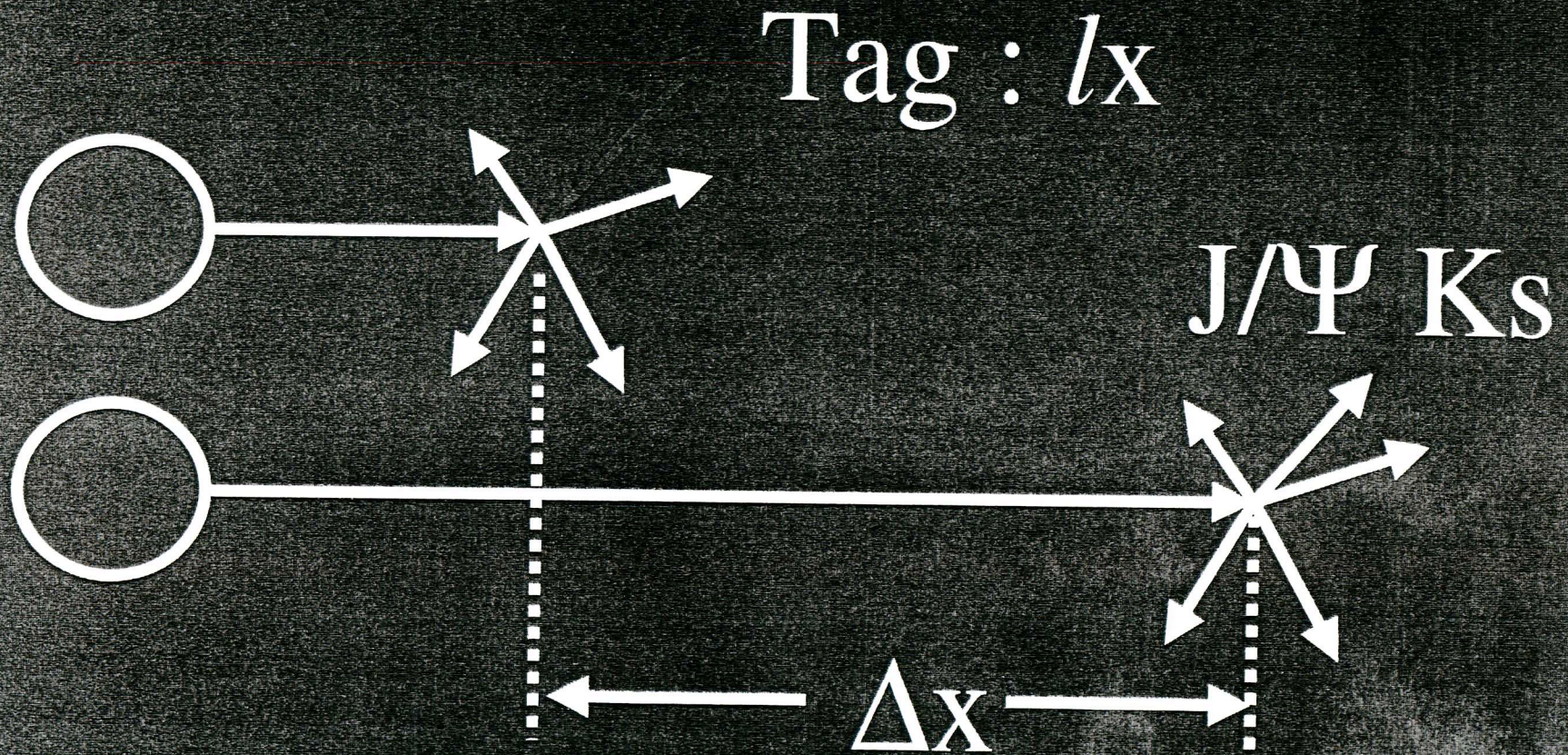
We present a measurement of the Standard Model CP violation parameter $\sin 2\phi_1$ based on a 10.5 fb^{-1} data sample collected at the $\Upsilon(4S)$ resonance with the Belle detector at the KEKB asymmetric e^+e^- collider. One neutral B meson is reconstructed in the $J/\psi K_S$, $\psi(2S)K_S$, $\chi_{c1}K_S$, $\eta_c K_S$, $J/\psi K_L$ or $J/\psi\pi^0$ CP-eigenstate decay channel and the flavor of the accompanying B meson is identified from its charged particle decay products. From the asymmetry in the distribution of the time interval between the two B-meson decay points, we determine $\sin 2\phi_1 = 0.58^{+0.32}_{-0.34}(\mathrm{stat})^{+0.09}_{-0.10}(\mathrm{syst})$.

PACS numbers:11.30.Er,12.15.Hh,13.25.Hw

$$A(t) \equiv \frac{\Gamma(B_d \to f_{cp}) - \Gamma(\overline{B}_d \to f_{cp})}{\Gamma(B_d \to f_{cp}) + \Gamma(\overline{B}_d \to f_{cp})}$$

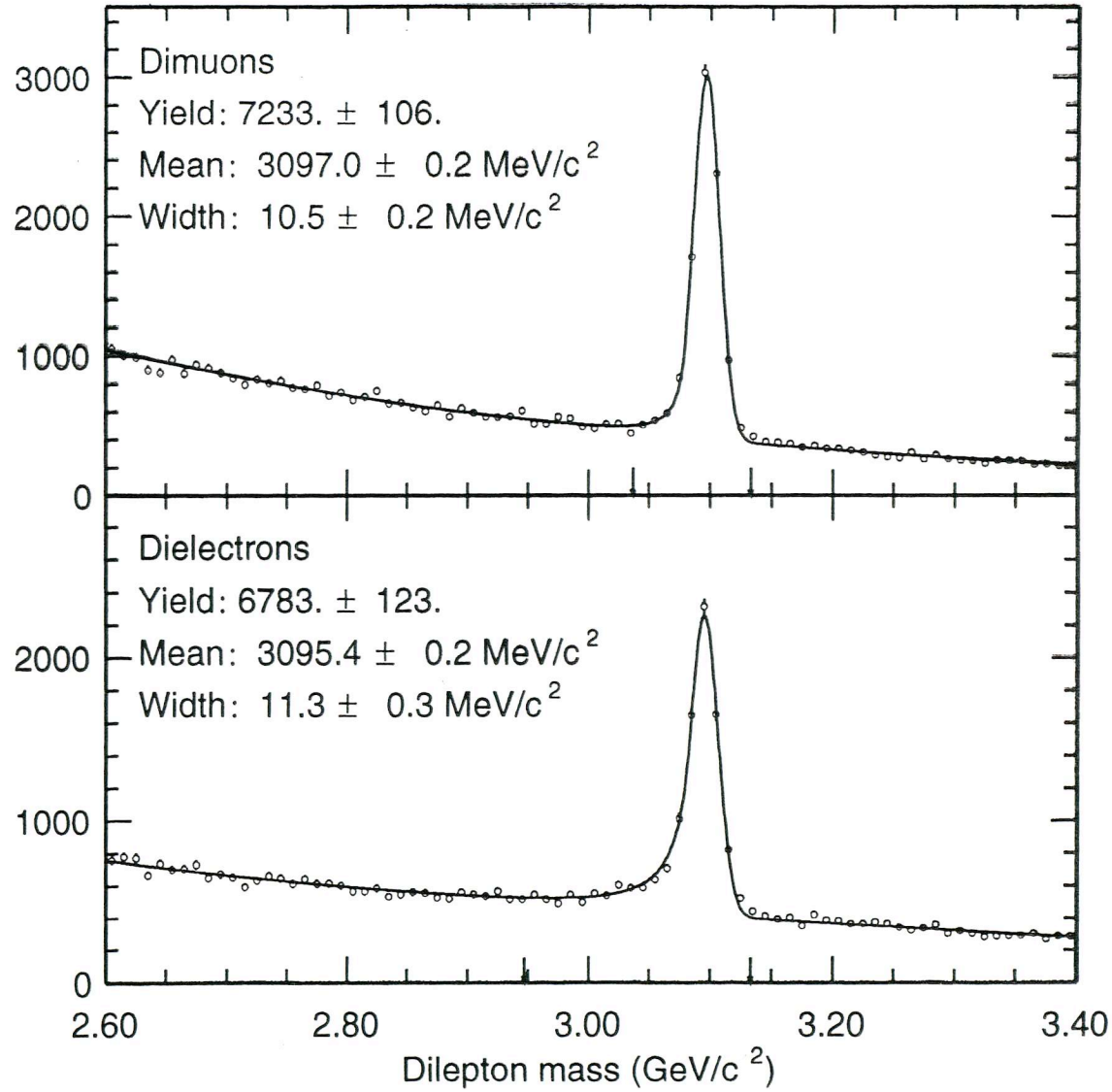
$$= \xi_f \sin 2\phi_1 \sin \Delta m_d \, t$$

B中間子と反B中間子の崩壊確率の違いの観測

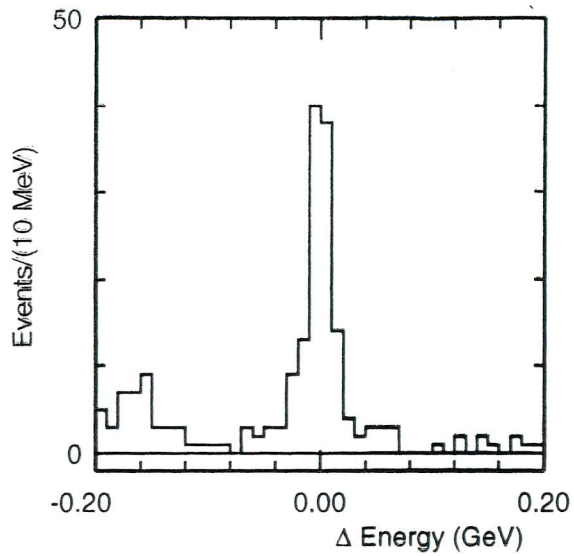


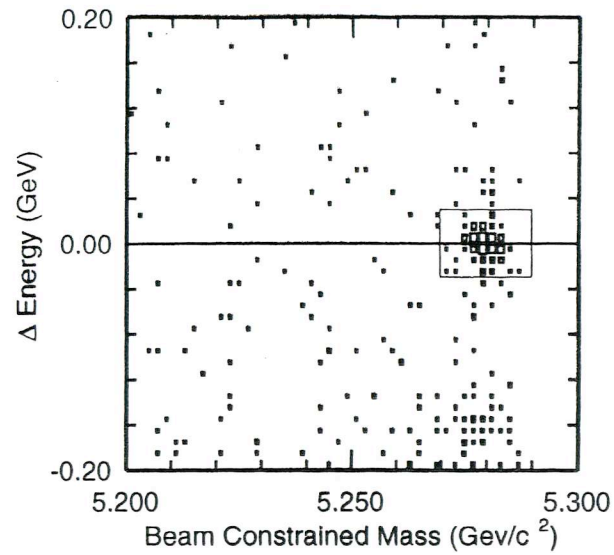
J/ψ Reconstruction

- $\int L\,dt = 10.5\ fb^{-1}$
- Both leptons were required to satisfy the lepton cuts.
- Added the four momenta of any photons within 0.05 radians of the initial electron direction to the electron four momenta.



$B \rightarrow J/\psi\ Ks$ Reconstruction

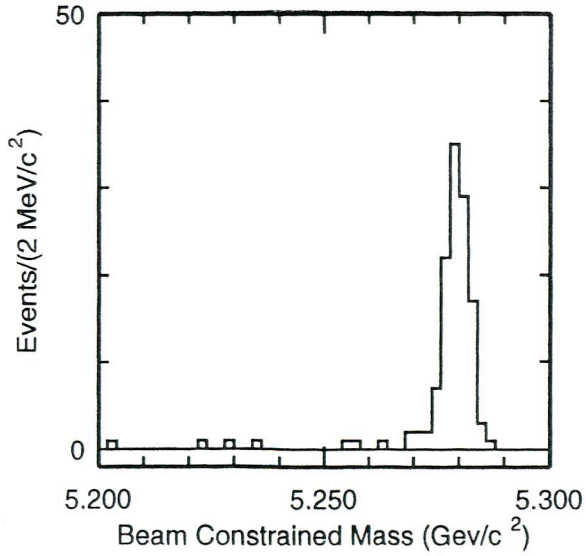




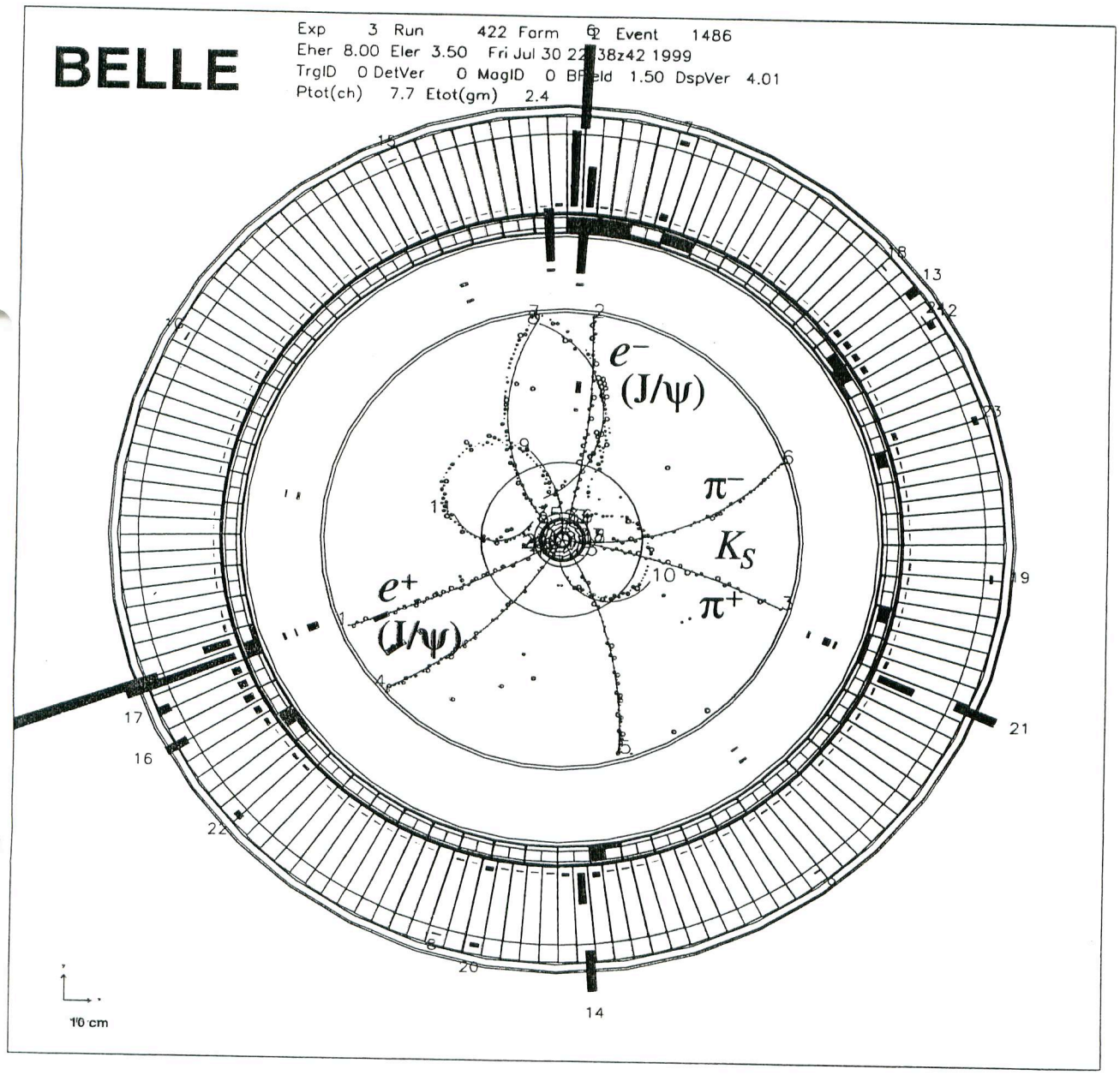
"Beam constrained mass"

$$\equiv \sqrt{E_{beam}^2 - p(J/\psi\ Ks)^2}$$

(= 5.28GeV for true events)

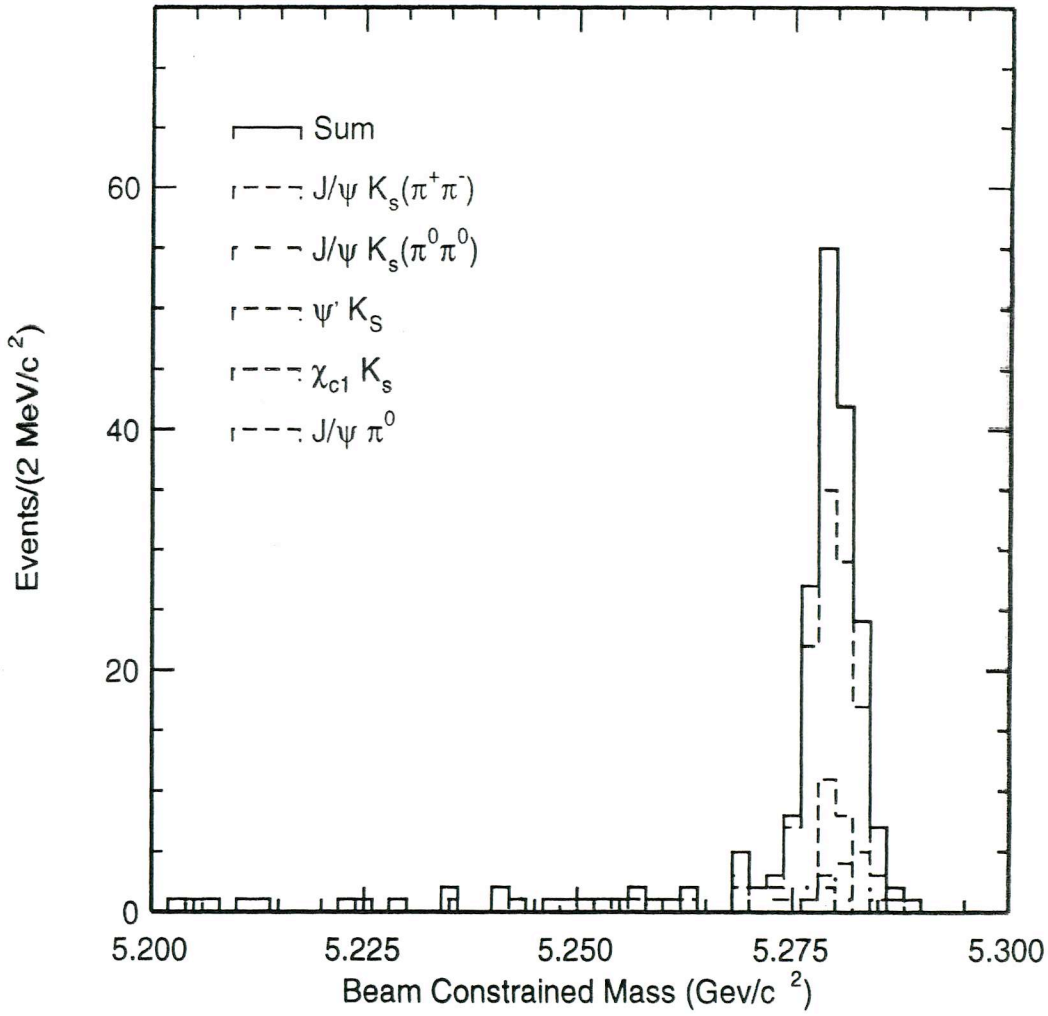


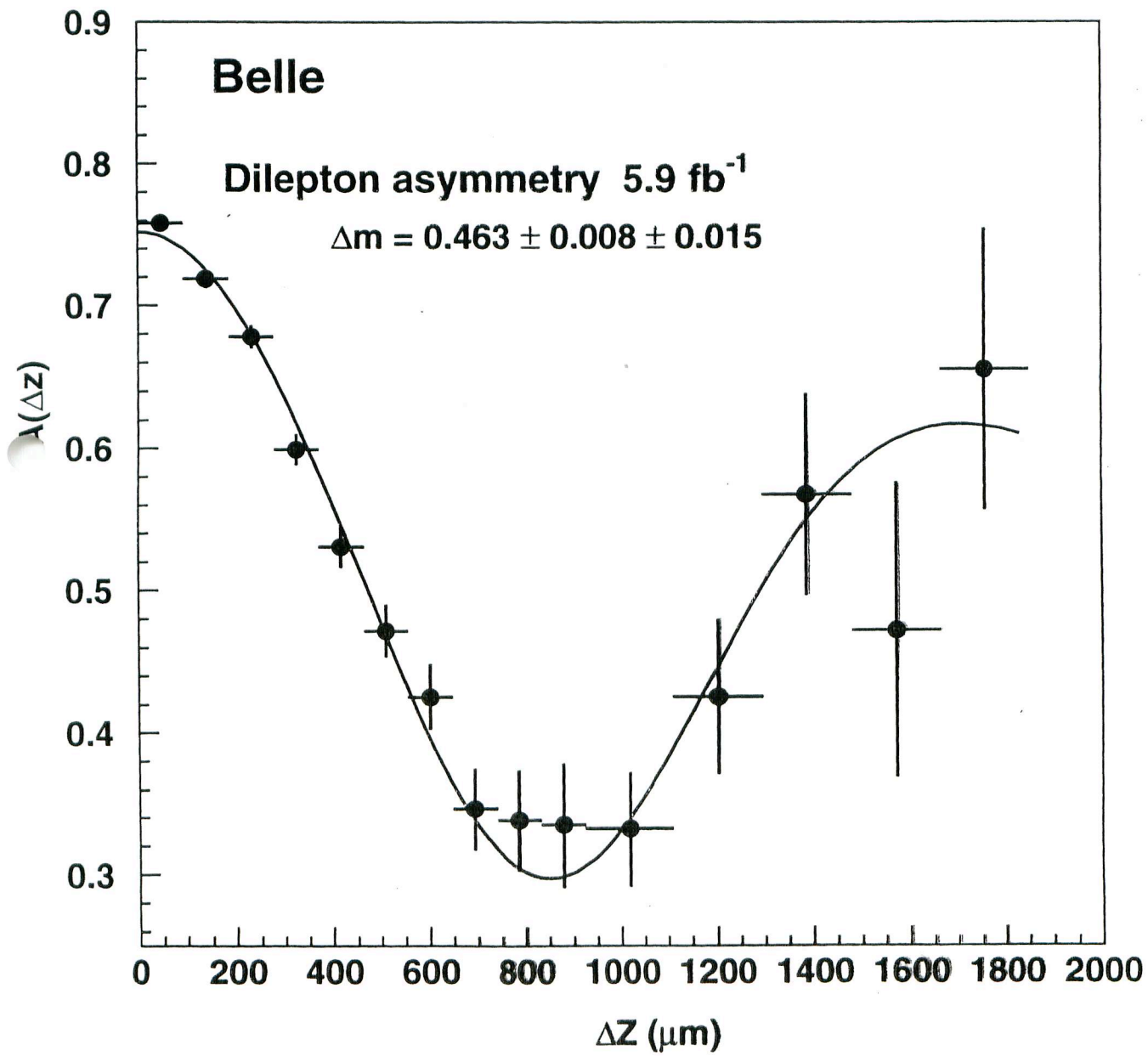
$B^0 \rightarrow J/\psi\ Ks$ candidate

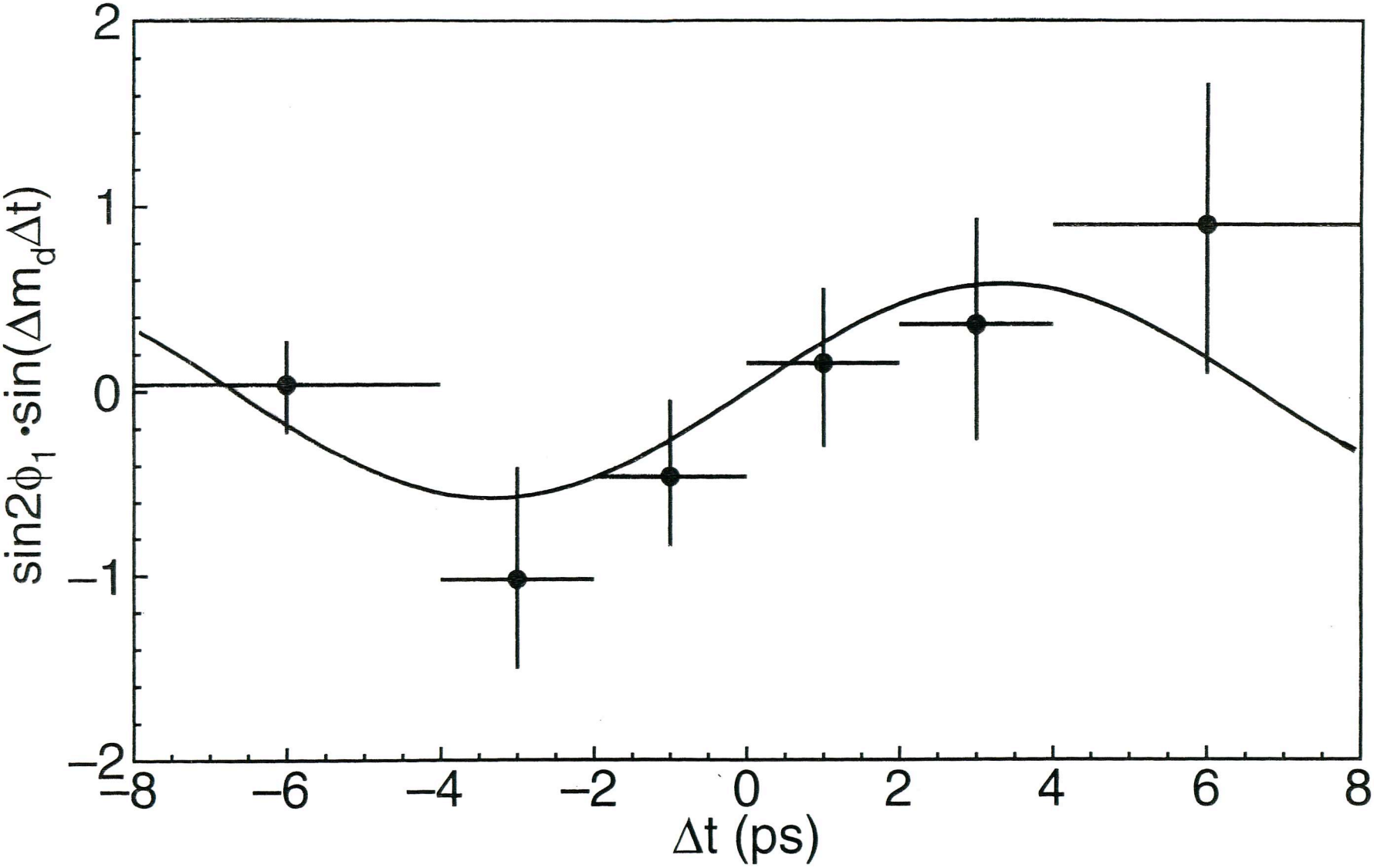


Summary of CP eigenstates

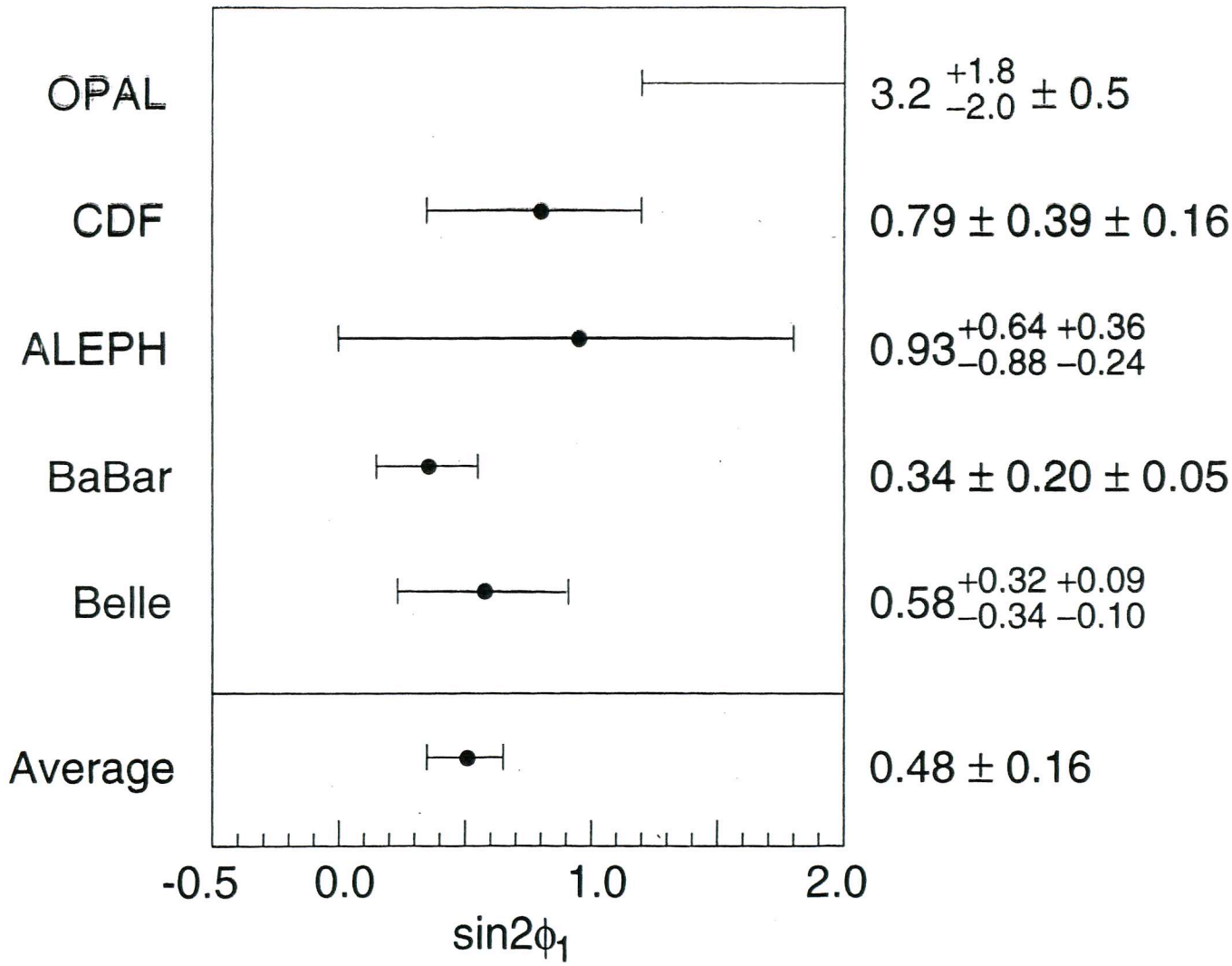
mode	Cnd.	Bkg
$B^0 \to J/\psi\, K_S$		
$K_S \to \pi^+\pi^-$	123	1.7
$K_S \to \pi^0\pi^0$	19	1.9
$B^0 \to \psi'\, K_S$		
$\psi' \to l^+ l^-$	13	0.2
$\psi' \to J/\psi\pi^+\pi^-$	11	0.0
$B^0 \to \chi_{c1}\, K_S$	3	0.0
$B^0 \to J/\psi\pi^0$	10	0.3
$B^0 \to \eta_c\, K_S$	15	2.6
Total	194	6.7

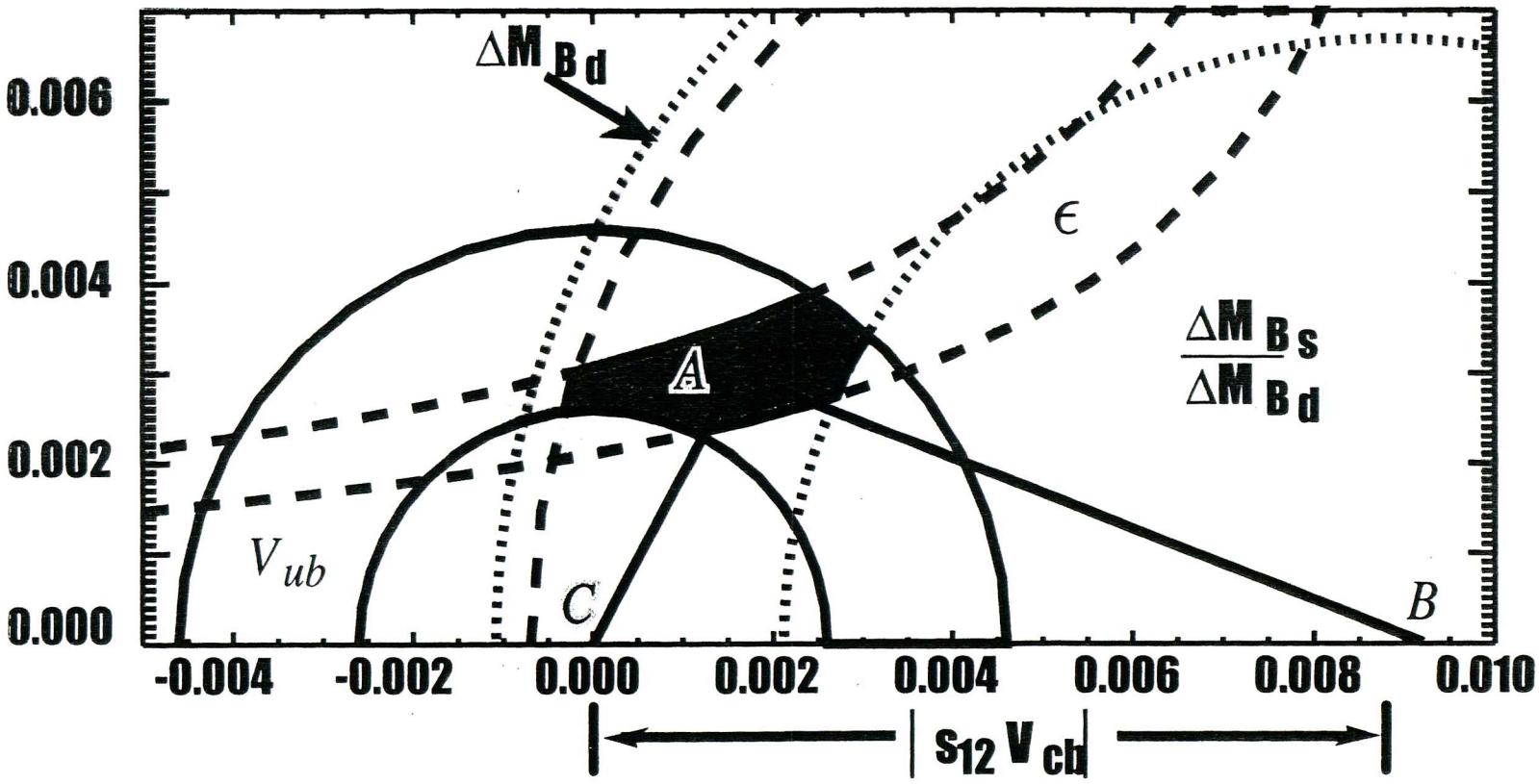


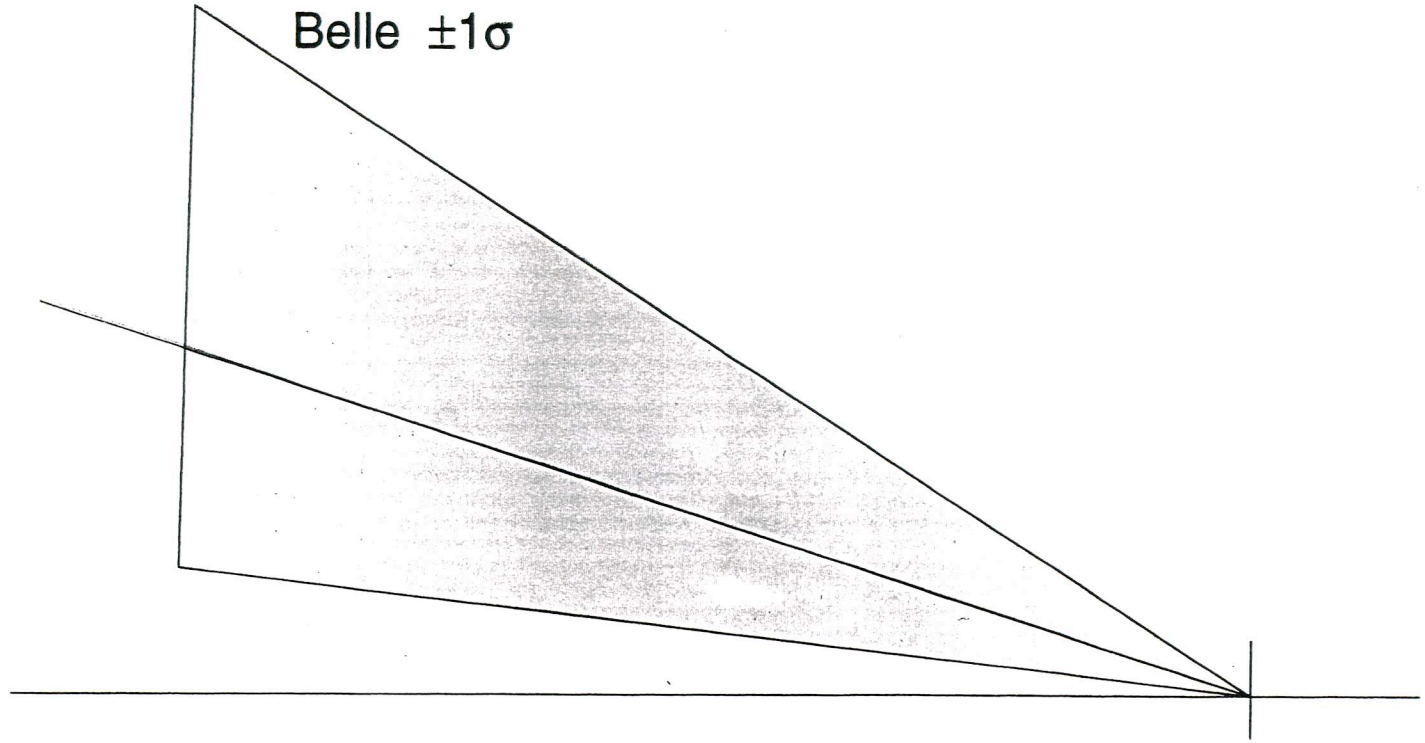

Belle
Dilepton asymmetry 5.9 fb-1
Δm = 0.463 ± 0.008 ± 0.015
A(Δz)
ΔZ (μm)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0
200
400
600
800
1000
1200
1400
1600
1800
2000


2
1
0
−1
−2
−8
−6
−4
−2
0
2
4
6
8
sin2φ1 •sin(Δmd Δt)
Δt (ps)

$\sin 2\phi_1$ Summary

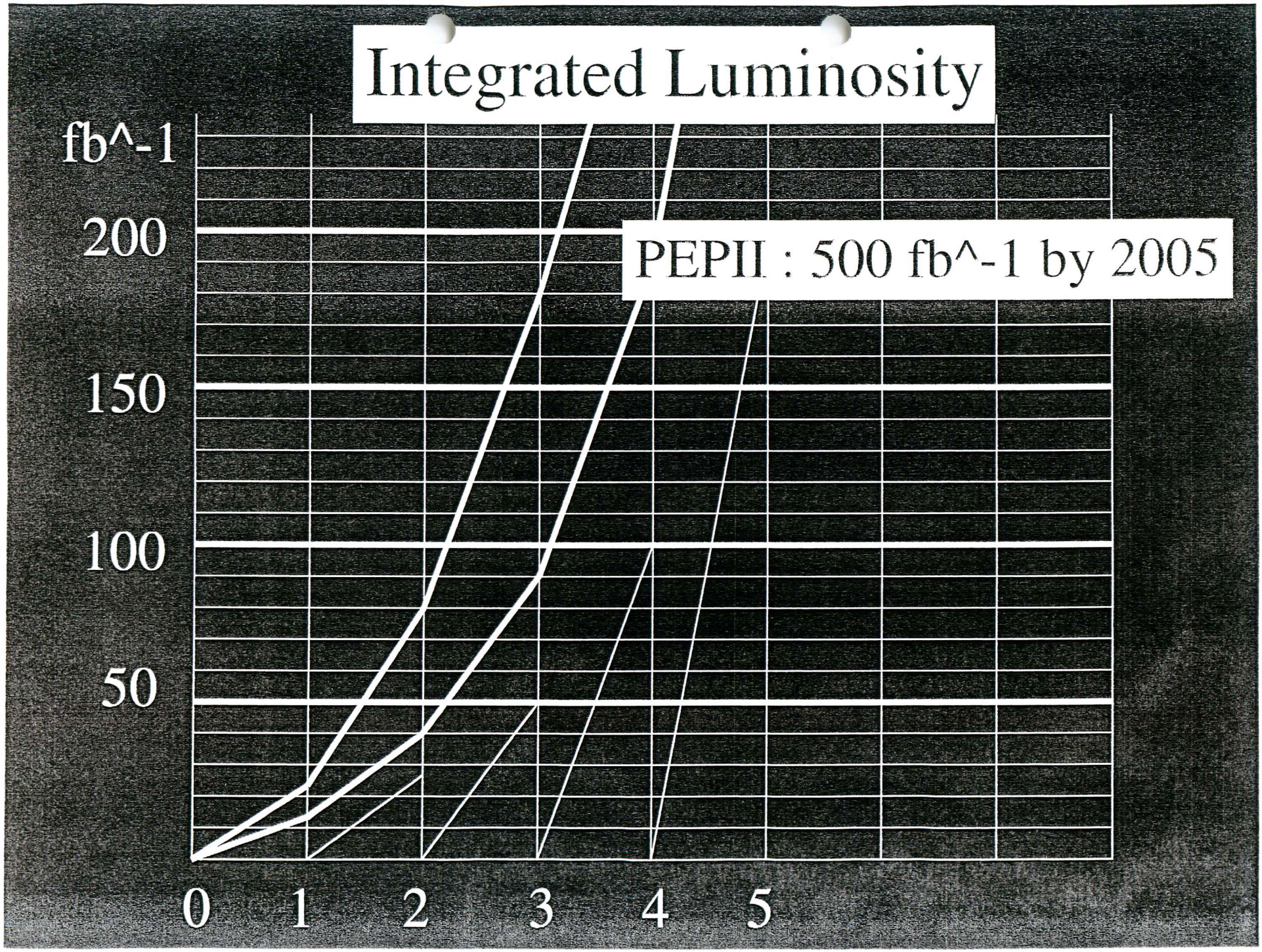


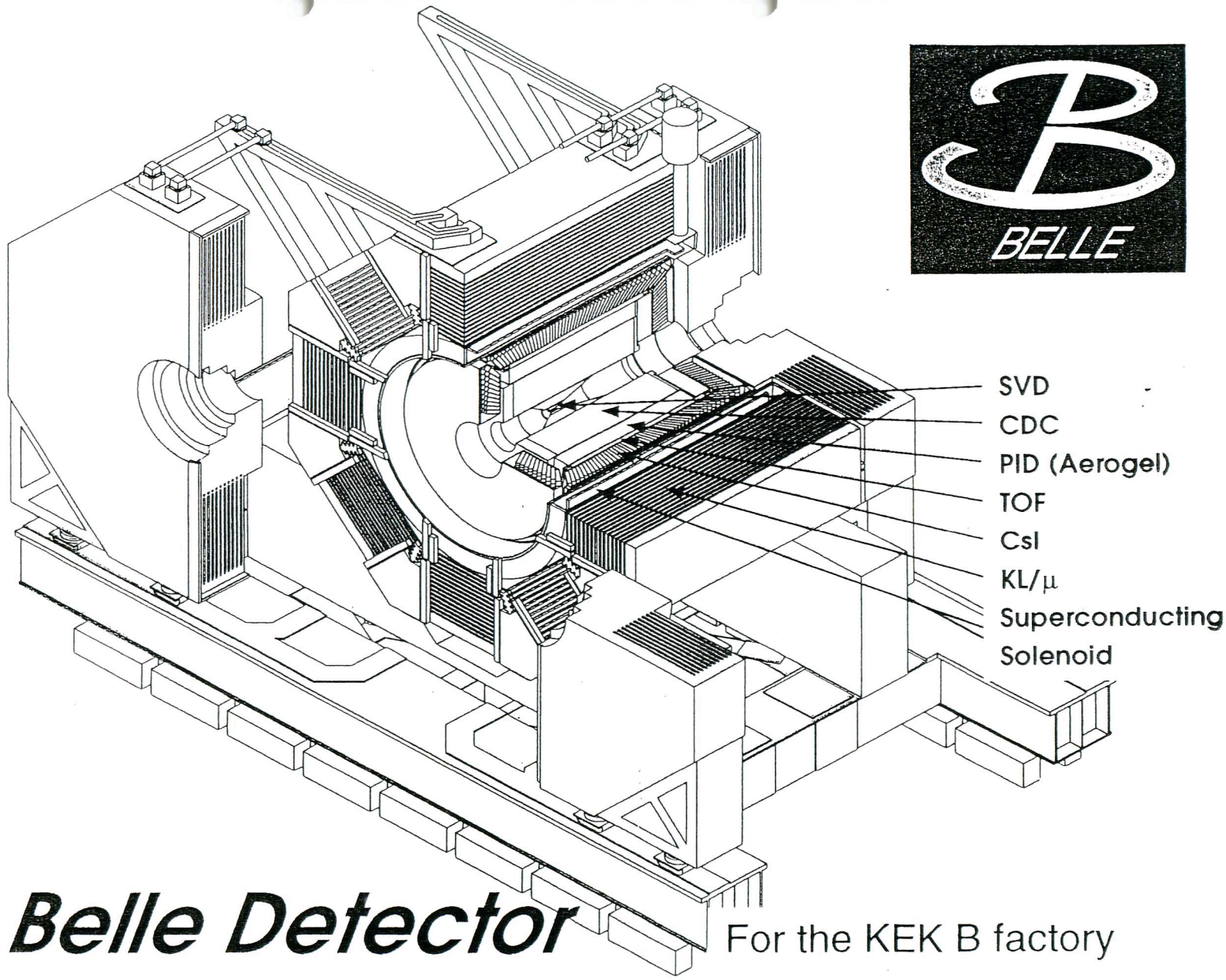

0.006
0.004
0.002
0.000
ΔM Bd
ϵ
ΔM Bs / ΔM Bd
A
V ub
C
B
-0.004
-0.002
0.000
0.002
0.004
0.006
0.008
0.010
| s12 V cb |


Belle ±1σ

Belle Upgrade

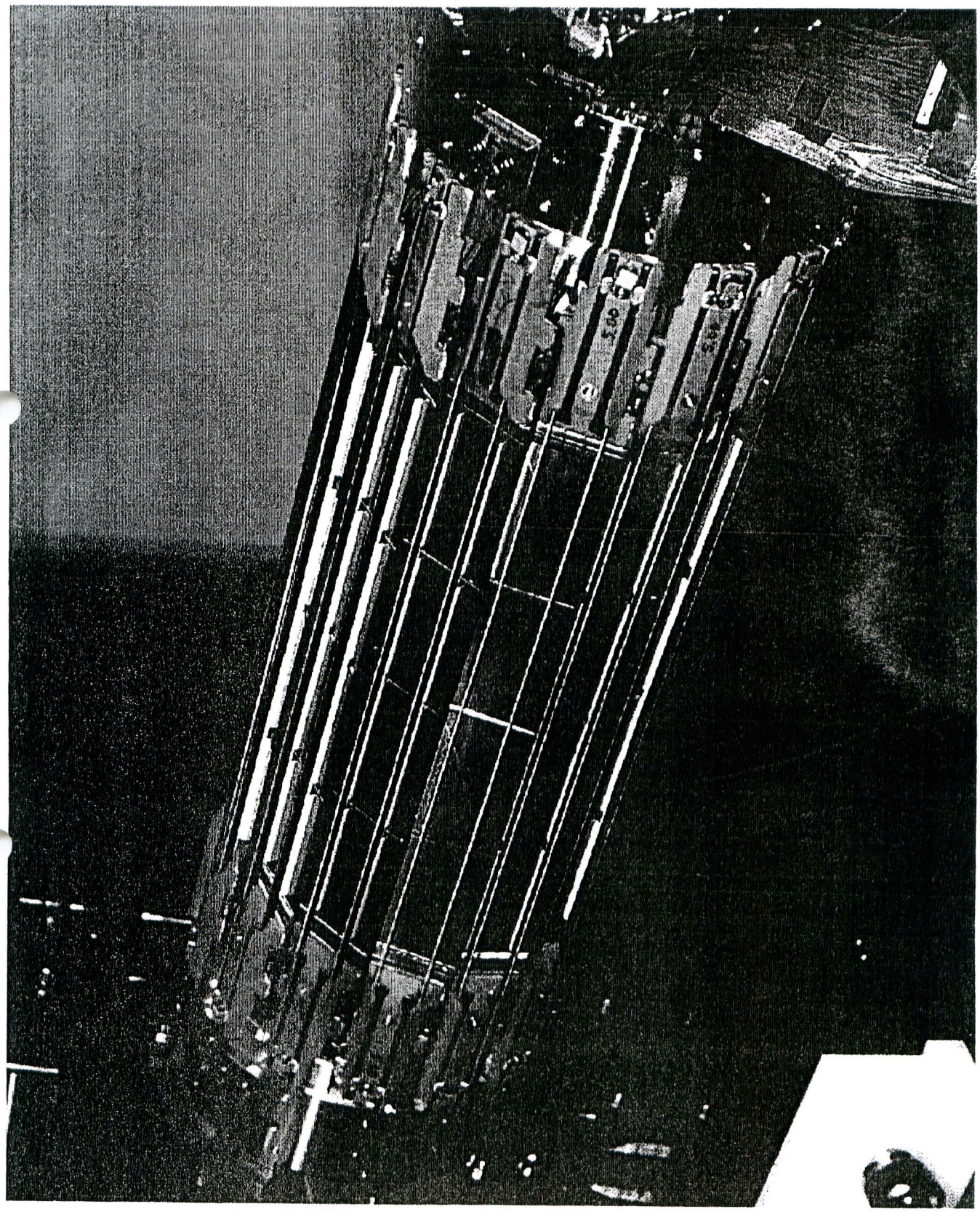
- More rad-resistive SVD
- Better vertex resolution
- Better angle coverage
- Better tracking efficiency
- Cope with higher trigger rate

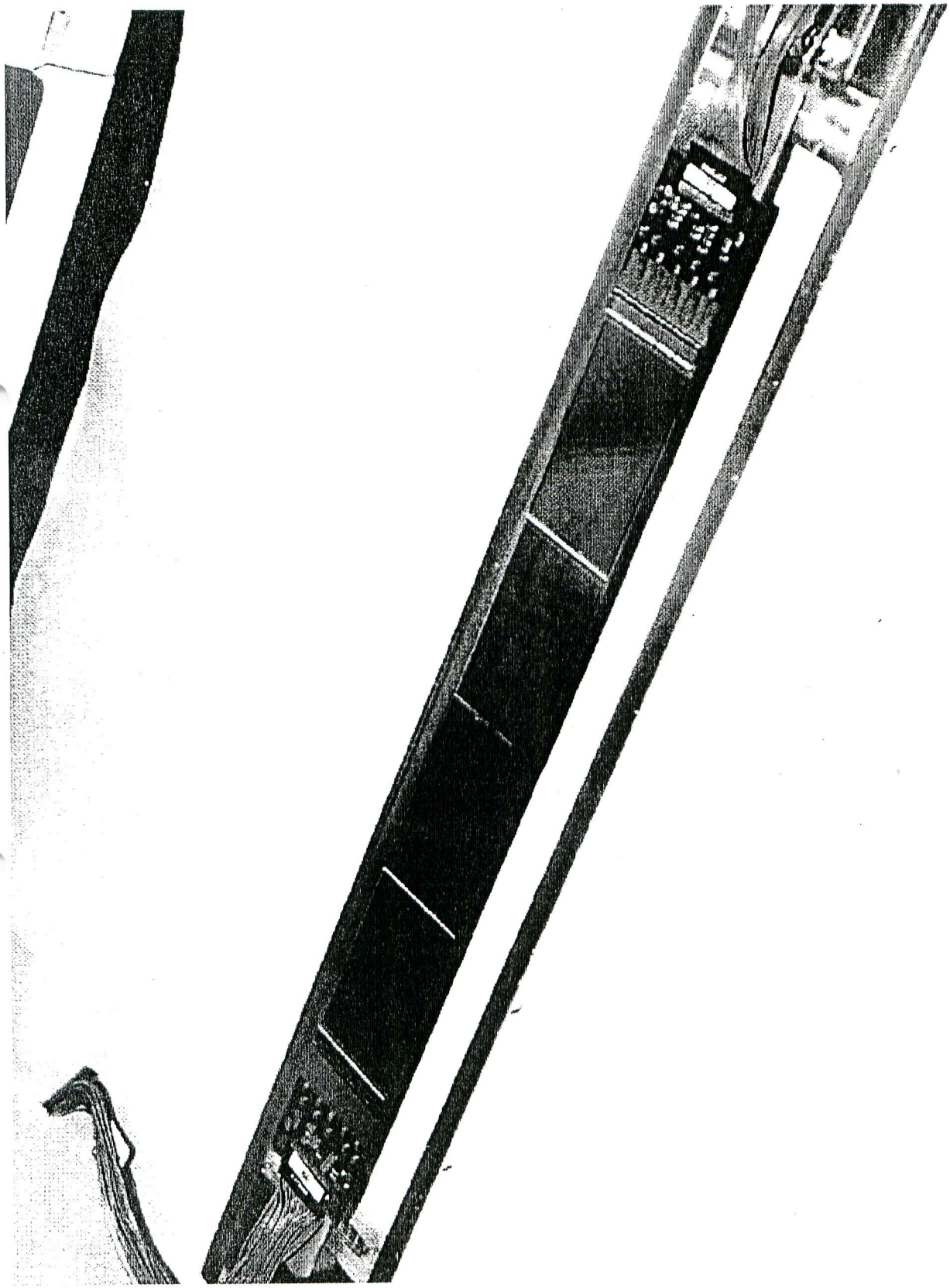

Integrated Luminosity
fb^-1
200
150
100
50
0
1
2
3
4
5
PEPII : 500 fb^-1 by 2005

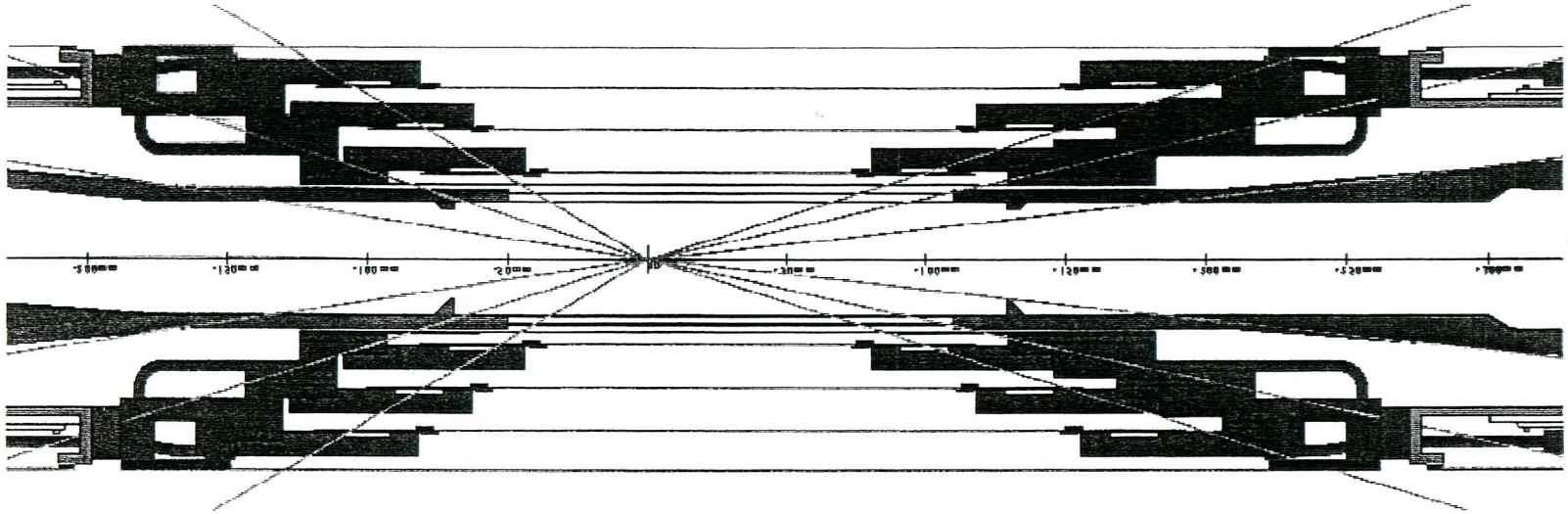


Belle Detector

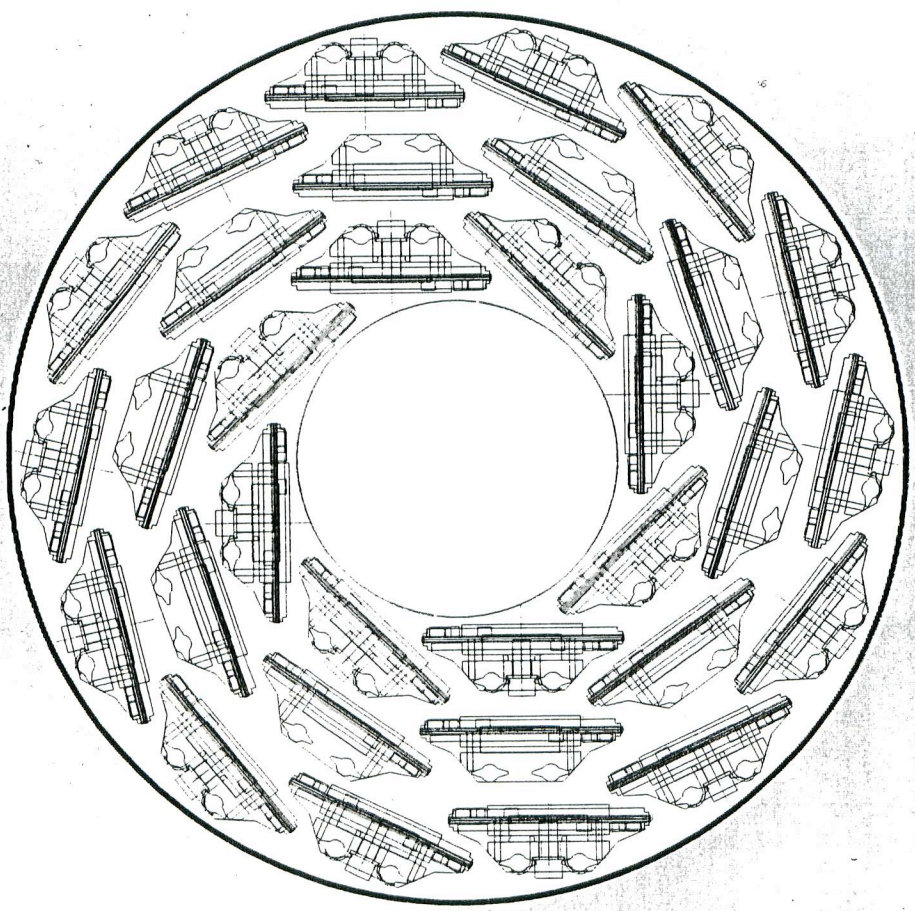
For the KEK B factory

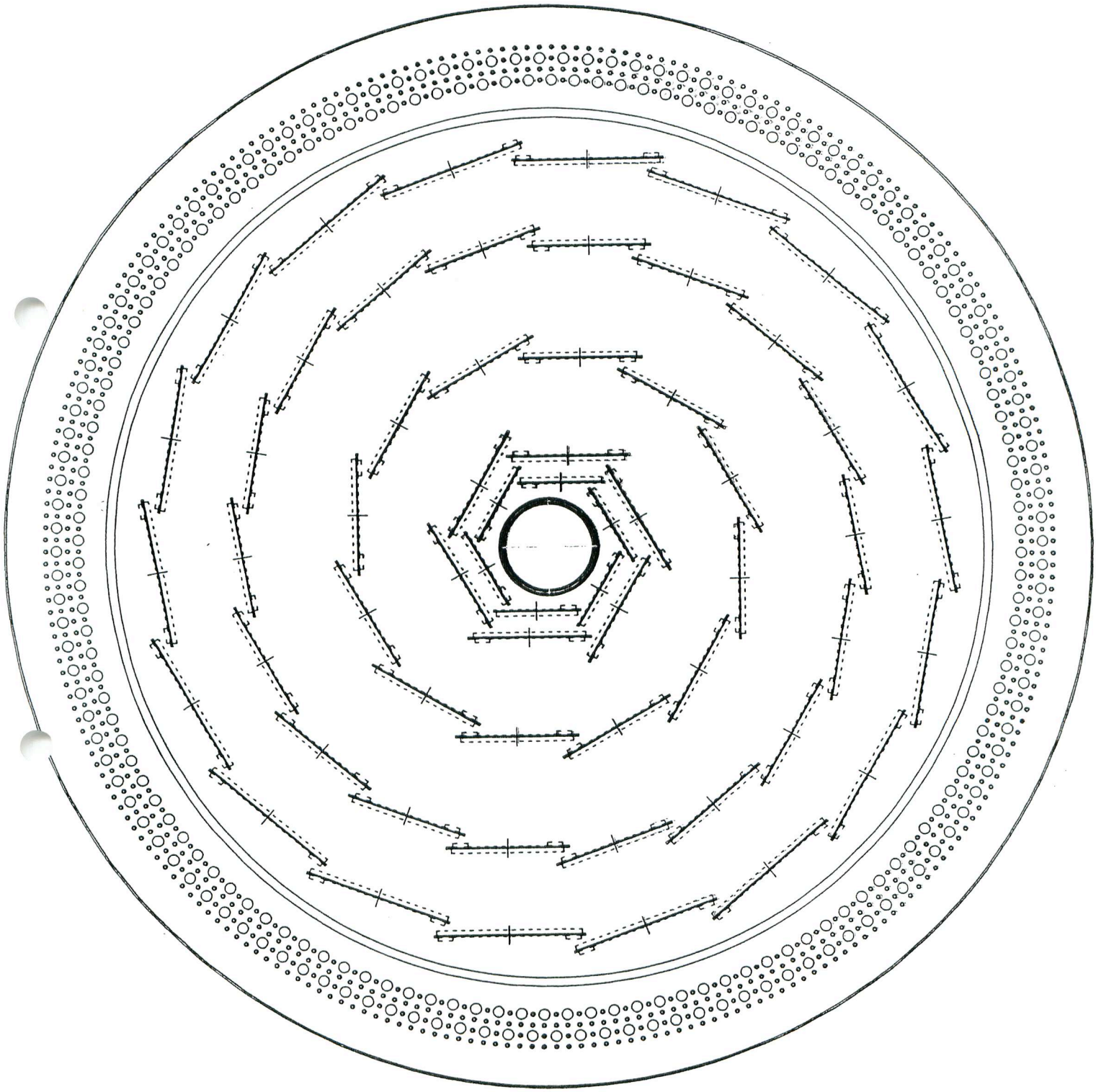






present CDC Inner part





Summary

- Belle detector : working as designed
- Two physics papers : to be published
- Many other papers to follow
- Belle upgrade plan : to be proposed

Belle did a very good start.

However,

Need Much More Luminosity !!