Introduction to KEK-B-factory

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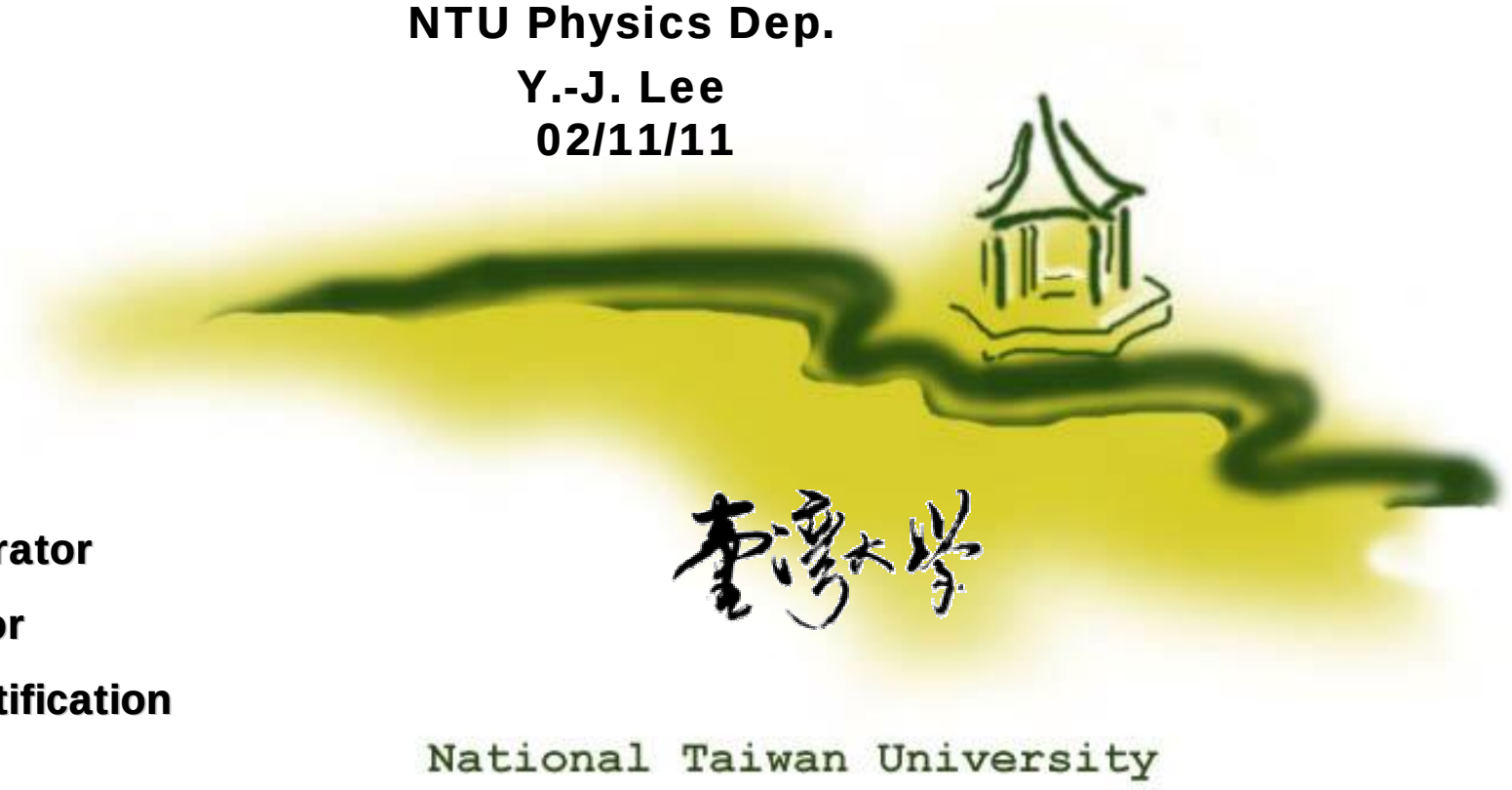


Outline

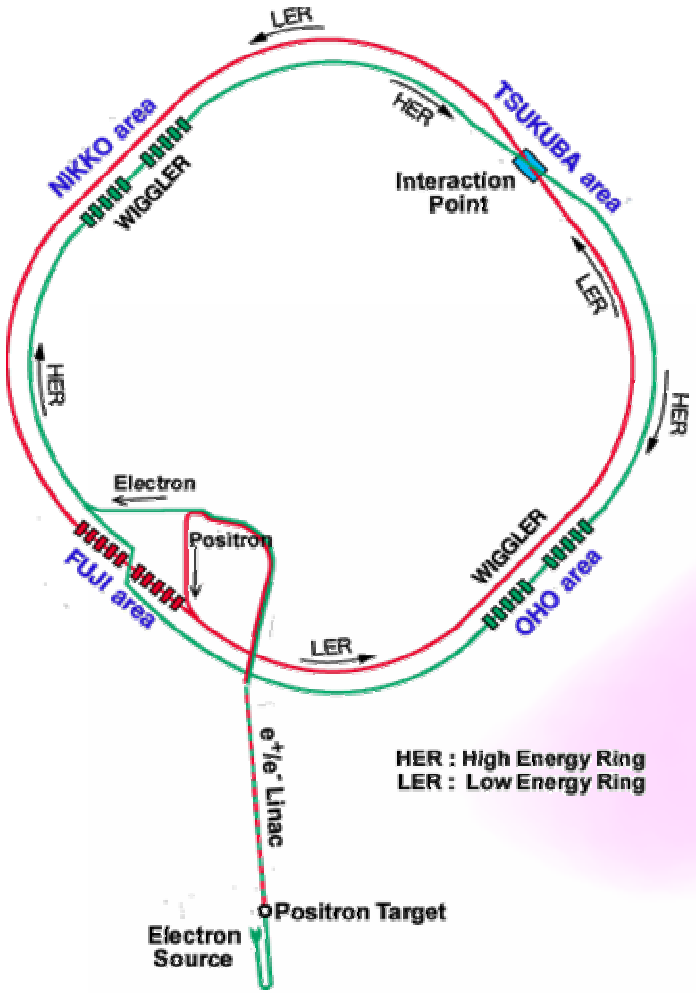
- Introduction
- KEKB Accelerator
- Belle Detector
- Particle Identification

Introduction

- The KEK-B accelerator is located in the High Energy Accelerator Research Organization (KEK) of Tsukuba, Japan.

- The KEK-B-Factory has the goal to study the physics of CP violation and to measure the rare-B decay modes with very small branching fractions.

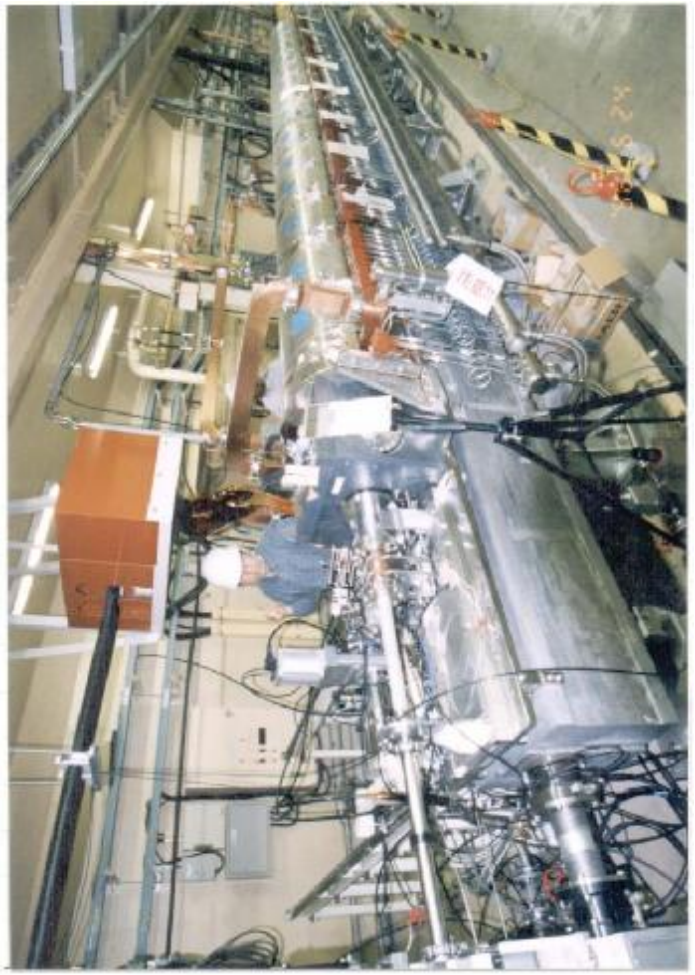
KEK-B Ring


LER
HER
NIKKO area
WIGGLER
Interaction Point
TSUKUBA area
LER
HER
HER
Electron
Positron
FUJI area
WIGGLER
OHO area
LER
e+/e- Linac
Positron Target
Electron Source
HER : High Energy Ring
LER : Low Energy Ring

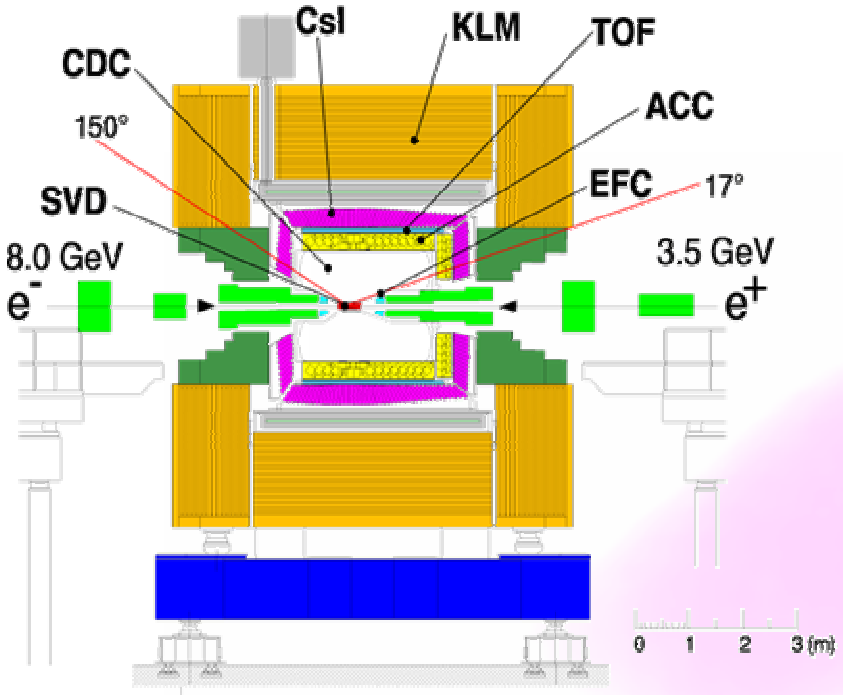
KEKB Accelerator

e+ Generator of linac

- 3km long tunnel & 508 MHz RF system
- Asymmetric energy collision of electron = 8GeV, and positron = 3.5GeV
- Ring circumference : 3km
  RF frequency : 508MHz
  Target Luminosity = 10^{34} /cm2/sec to produce more than 100 million B meson pairs in a year



Belle Detector

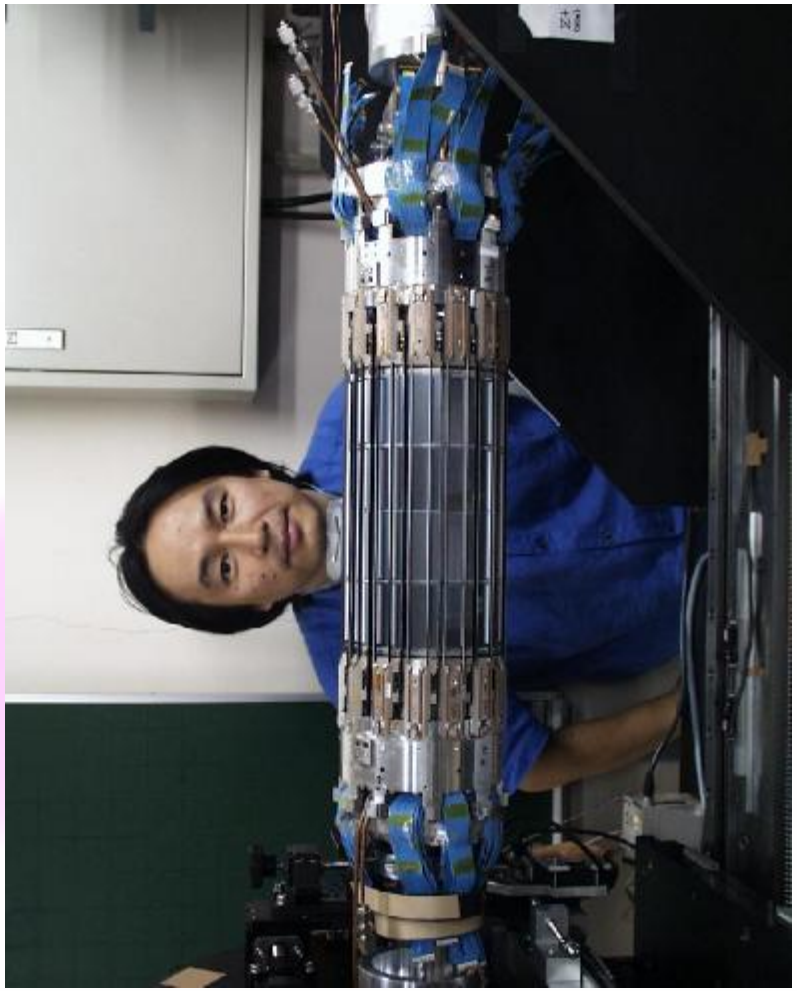


Belle Detector – SVD

Silicon Vertex Detector

- The SVD has a good position resolution of ~100 micro-meter to distinguish two decay points of B-mesons in order to observe the **time-dependent CP asymmetries** in the decays of B mesons.

- Cover a solid angle $23^o < \theta < 139^o$

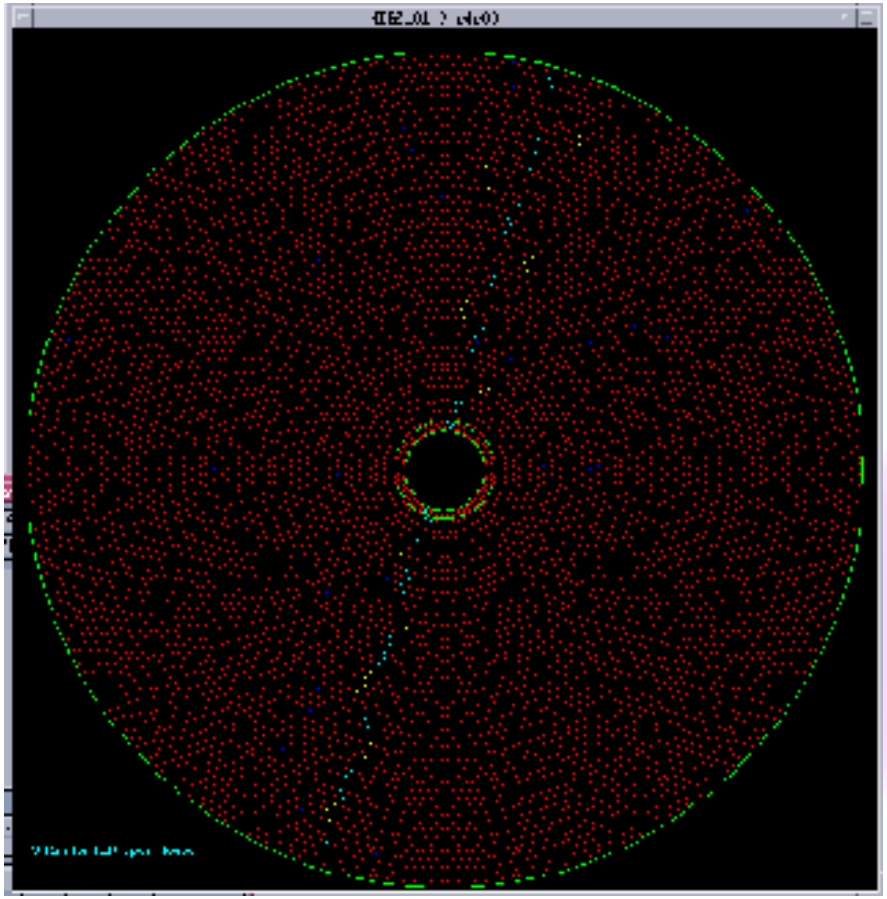


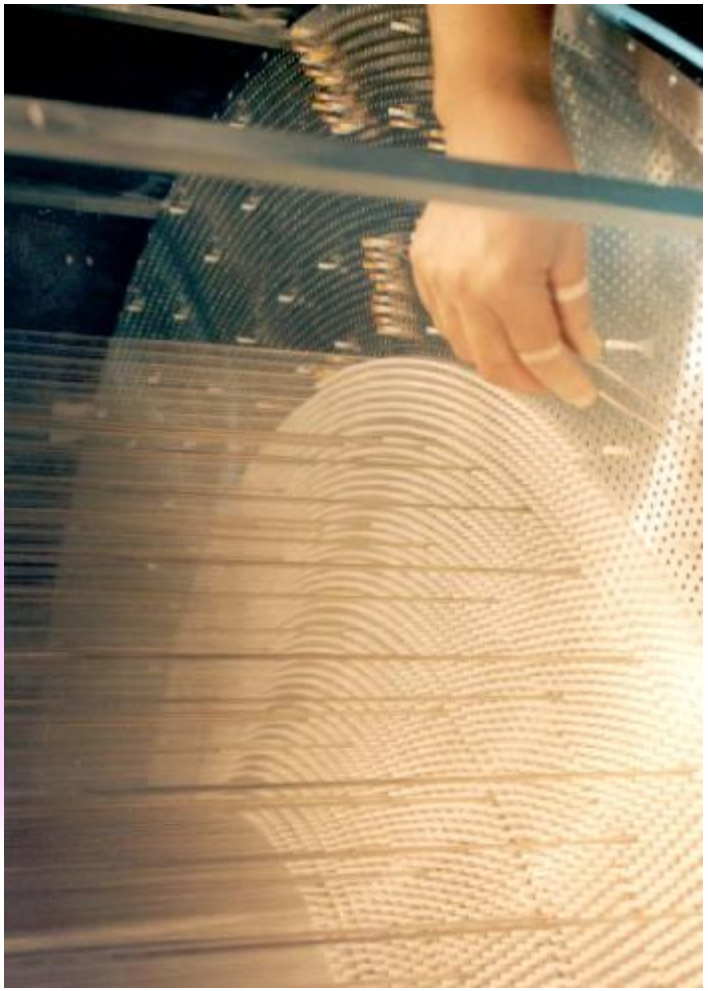
Belle Detector – CDC
Central Drift Chamber

- The central drift chamber is used for the detection of charged tracks and dE/dx measurements.
- CDC's function is made by the charged particles ionizing the gas contained in the CDC and detected by Sense wire (30 micron diameter gold plated tungsten(鎢))
- Cover angle $17^o < \theta < 150^o$

Belle Detector – CDC

Central Drift Chamber

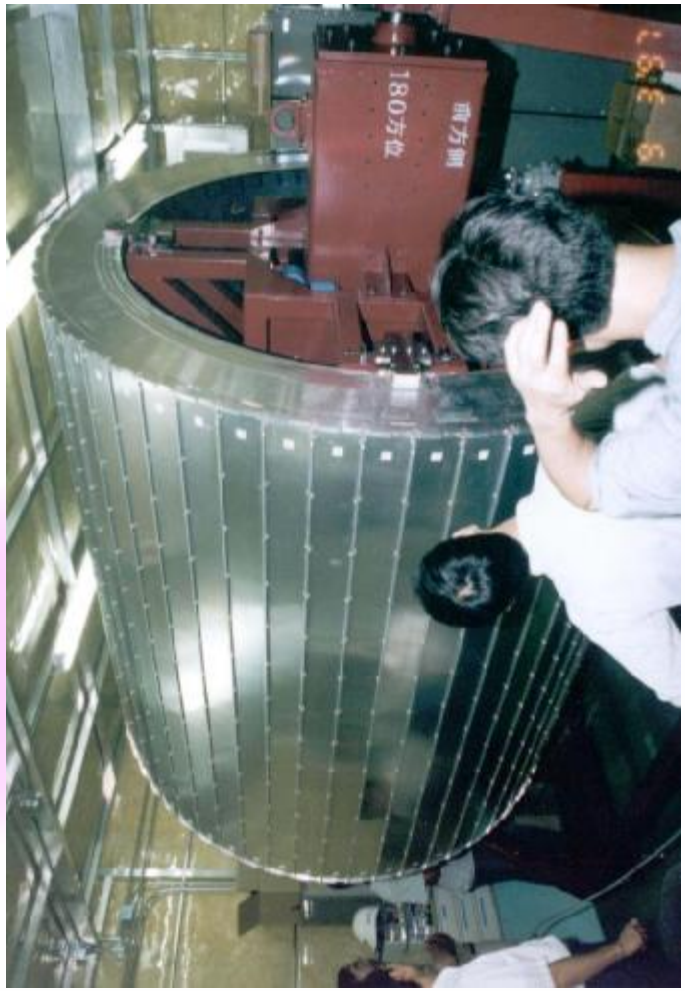




Belle Detector – ACC
Aerogel Cerenkov Counter

- The ACC is used to distinguish K^{+-} from π^{+-} in the momentum range from 1.2GeV/c to 3.5 GeV/c.

- The ACC consists of blocks of silica aerogel in aluminum boxes.



Belle Detector – ACC

Aerogel Cerenkov Counter

When a particle is pass through a transparent material, whose refractive index is n, with the velocity faster than the speed of light (c/n) then the Cerenkov radiation is emitted.

Cos θ_c = [(c/n)*dt]/ [βc* dt]

à $\beta_{threshold}$ = 1/n

à $P_{threshold}$ = 1/$\sqrt{}$(n^2-1)

Number of photon ~ $\sin^2\theta_c$

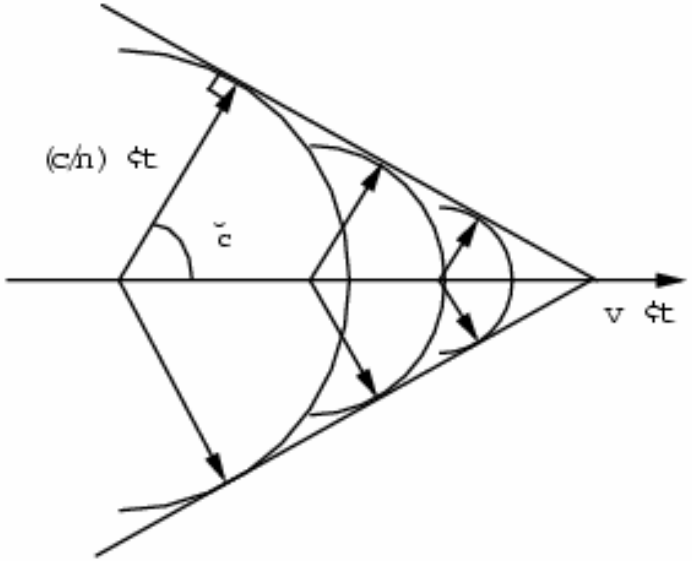
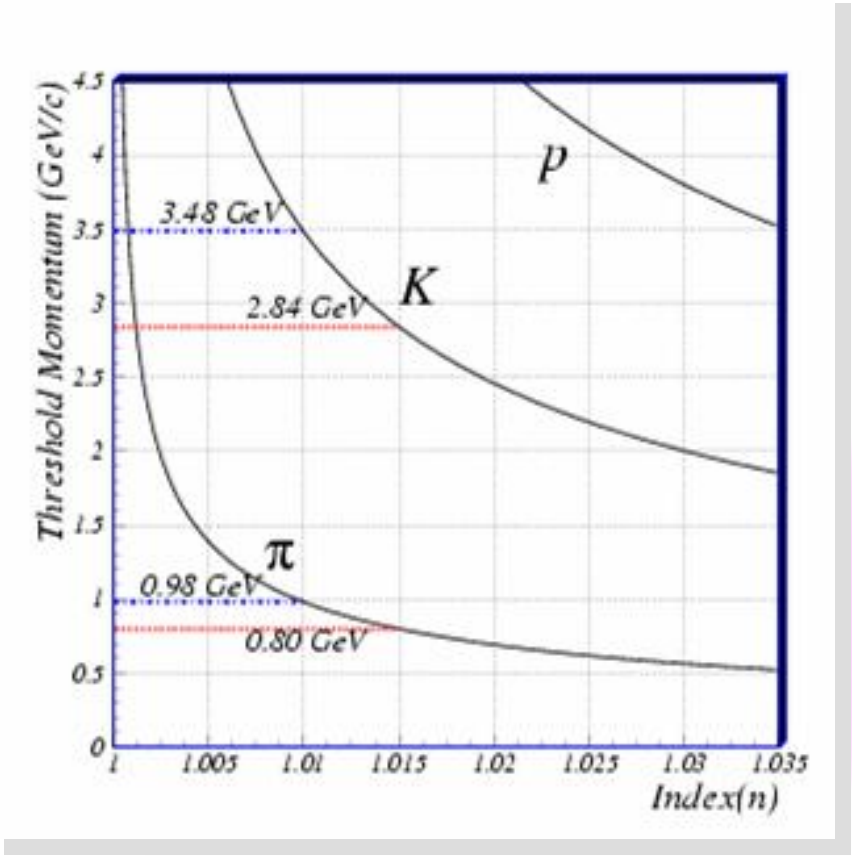


Figure 3.3: Čerenkov light radiation.

Belle Detector – ACC

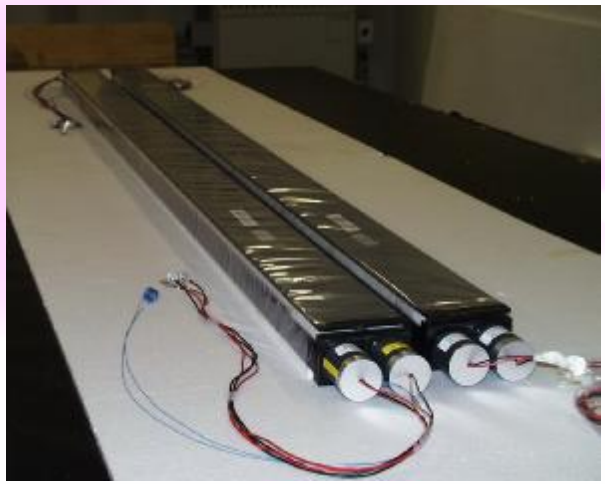
Aerogel Cerenkov Counter



Belle Detector – TOF

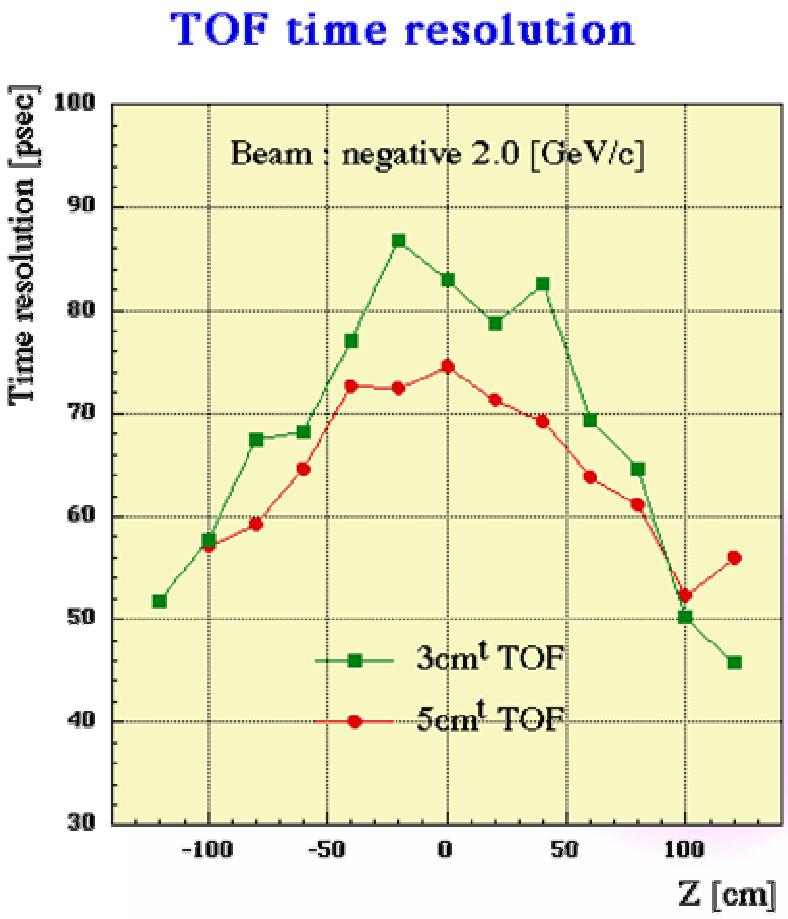
Time of Flight

- The low momentum(up to 1.2GeV) π^{+-}/K^{+-} is separated by the timing of plastic scintillation counters with 100ps time resolution.

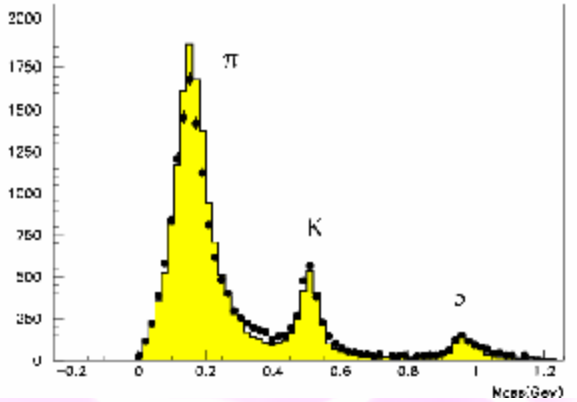


Belle Detector – TOF

Time of Flight



$$mass^2 = (\frac{1}{\beta^2} - 1)P^2 = ((\frac{cT^{twc}_{obs}}{L_{path}})^2 - 1)P^2.$$

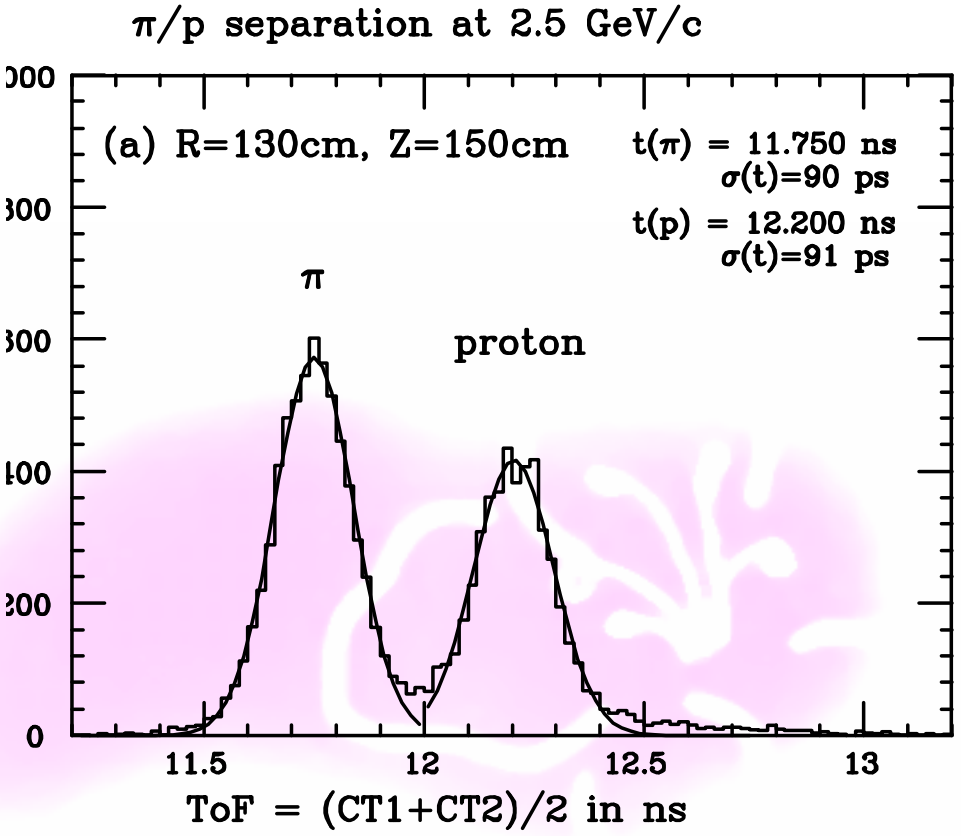


P < 1.2GeV

Belle Detector – TOF

Time of Flight

The TOF system can provide 3 σ of K/ π separation with the momentum from 0.8-1.2Gev/c and good P/ π separation



Belle Detector – ECL

Electromagnetic Calorimeter

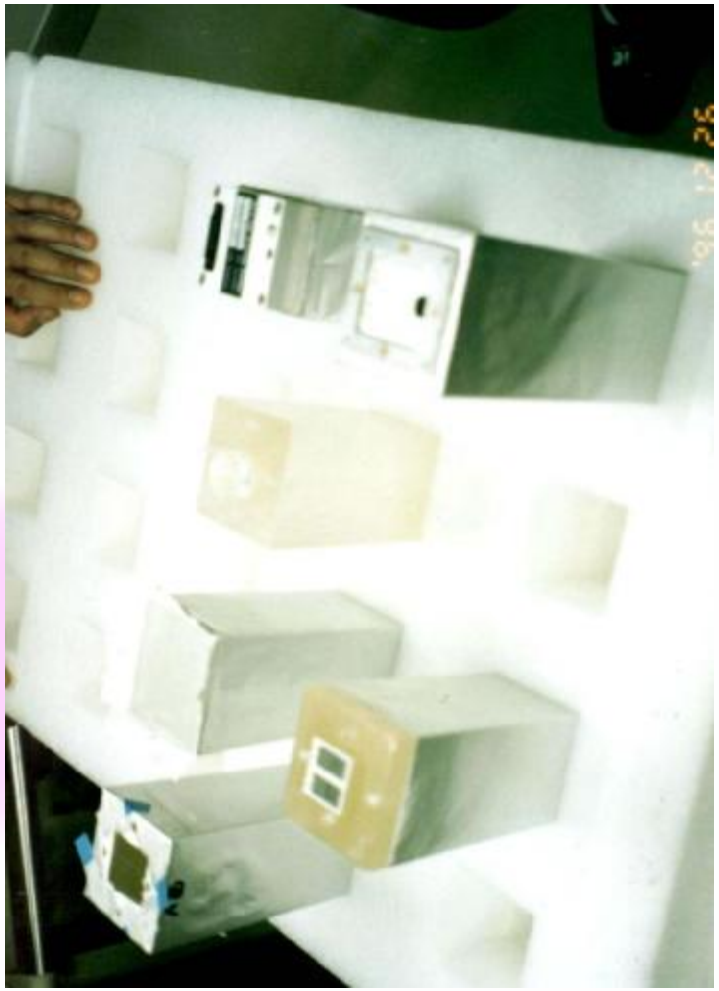
- The Electromagnetic calorimeter is used to measure the energy of electrons and photons.
  8736 pieces of CsI(Tl) crystals are used.

- Cover angle
  $17^o < \theta < 150^o$

Belle Detector – ECL

Electromagnetic Calorimeter

- There are 6624, 1216 and 1040 crystals in the barrel.forward endcaps and backward endcaps.



Belle Detector – KLM

- KLM is designed to detect high momentum (>600MeV/c)kaons and muons which pass through the inner detector.

Belle Detector – EFC

- EFC is a small-angle EM calori- meter designed to extend the BELLE detecting angle ranging from 17º ~ 150º to 6.4º ~173.4º(lab frame). It functions to give the instantaneous luminosity measurment, improve the B physics background rejection such as B to Tau Neu decay mode and relate to a viariety of two-photon physics..

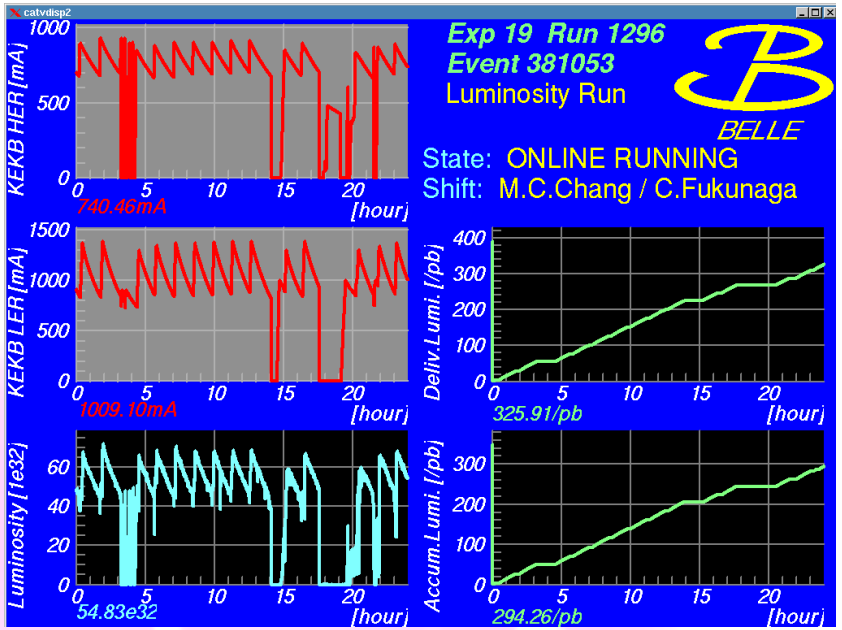
Belle Detector – EFC

- **Principle of EFC online luminosity measurement:**

  L σ ε =R

  - **L : instantaneous luminosity**
  - **σ : Bhabha cross section (1.88 ub in the angle of EFC)**
  - **ε : acceptance of EFC (8.2% in current EFC)**

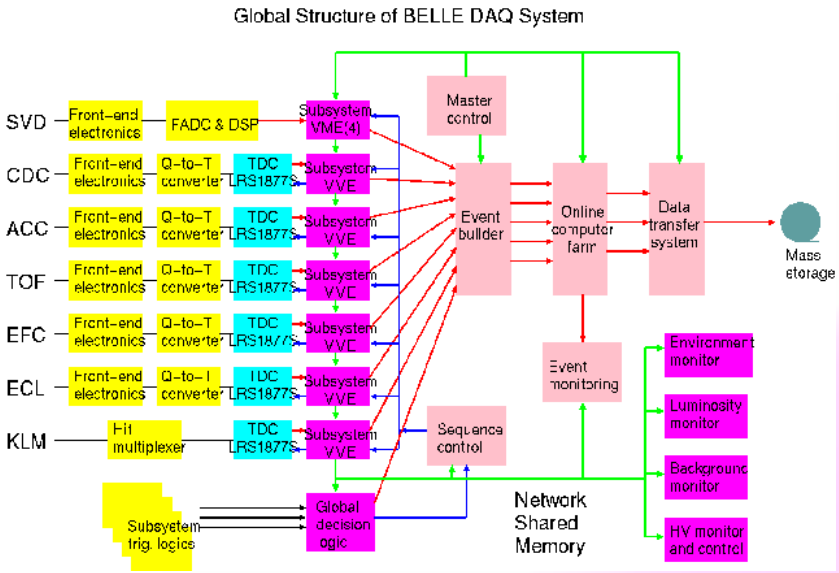
    R : EFC Bhabha rate (the typical rate is 148 Hz for 1033 luminosity)



Belle Detector – DAQ

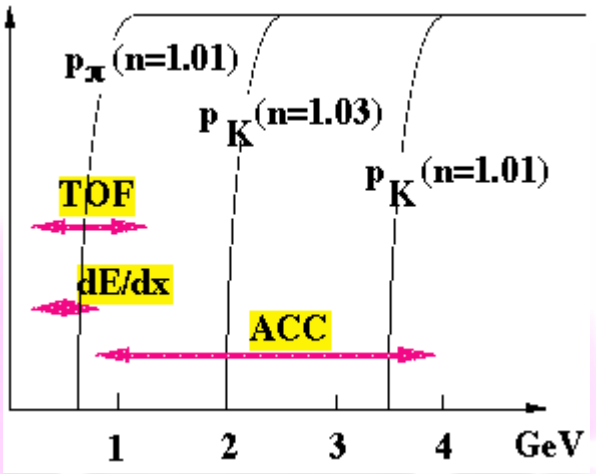
- **Belle control room with event displayer.**

Belle Detector – DAQ



Particle Identification

- The powerful tools for Particle identification are
  - dE/dx for low momentum range.
  - TOF for 0.8-1.2GeV/c momentum range.
  - ACC for 1.2-3.5Gev/c momentum range.
- The particles we are interested are:
  - P
  - π
  - K
  - K_s K_L
  - γ
  - μ
  - E



Particle Identification

This is the plot of dE/dx for different particles.

***dE/dx for low energy p / e / π / μ / K identification**

***ACC for high energy K/pi identification**

***TOF for mediate energy P/K/ π identification**

***KLM for μ K_L detection.**

***ECL for γ /e energy measurement.**