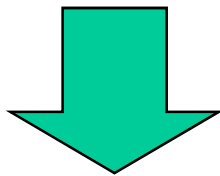# Pair Monitor Studies

'08 3/7 Y. Takubo

(Tohoku university)

Introduction

Pair monitor

- Monitor of the beam size, position and crossing angle at IP.
- The pair B.G. is used to measure the beam profile.
    - ➤ The same charge with respect to the oncoming beam is scattered with large angle.
   - ➤ The distributions have the beam information at IP.

Today's my talk

- Performance check by the simulation
- Development of the readout ASIC
- Study of pair monitor at ILD

e^+

e^+ e^+ e^-

e^-

e^-
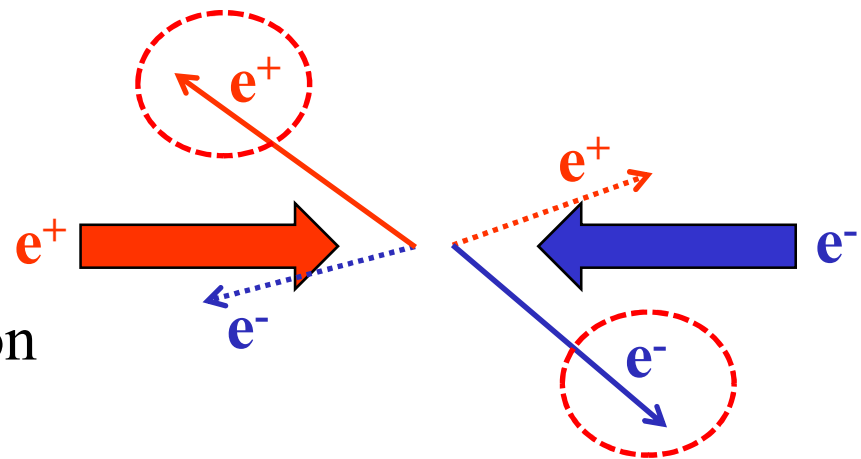
Simulation study

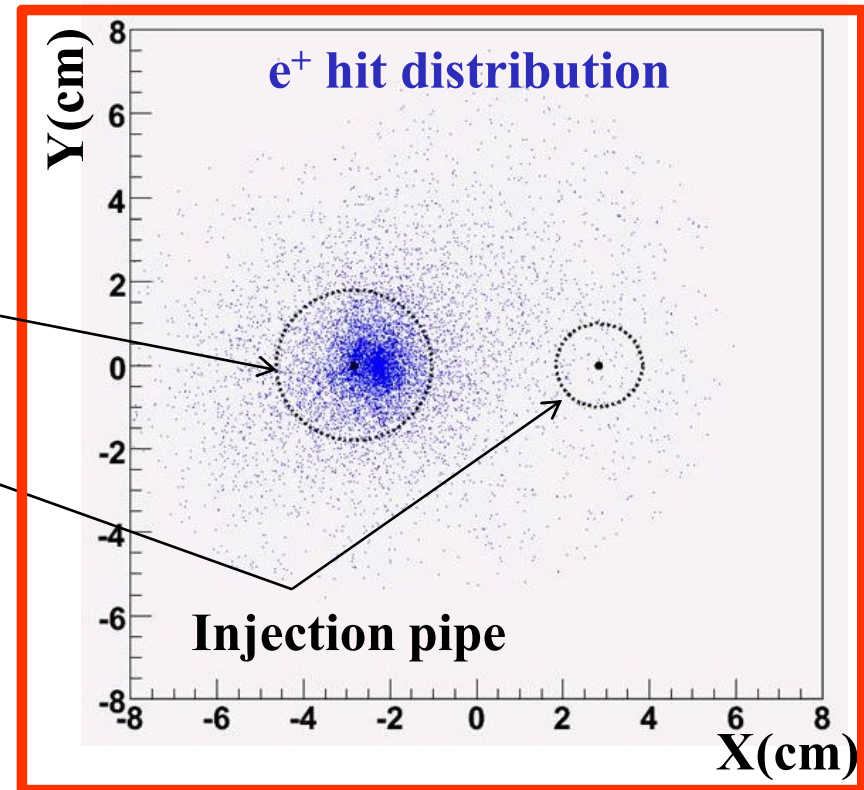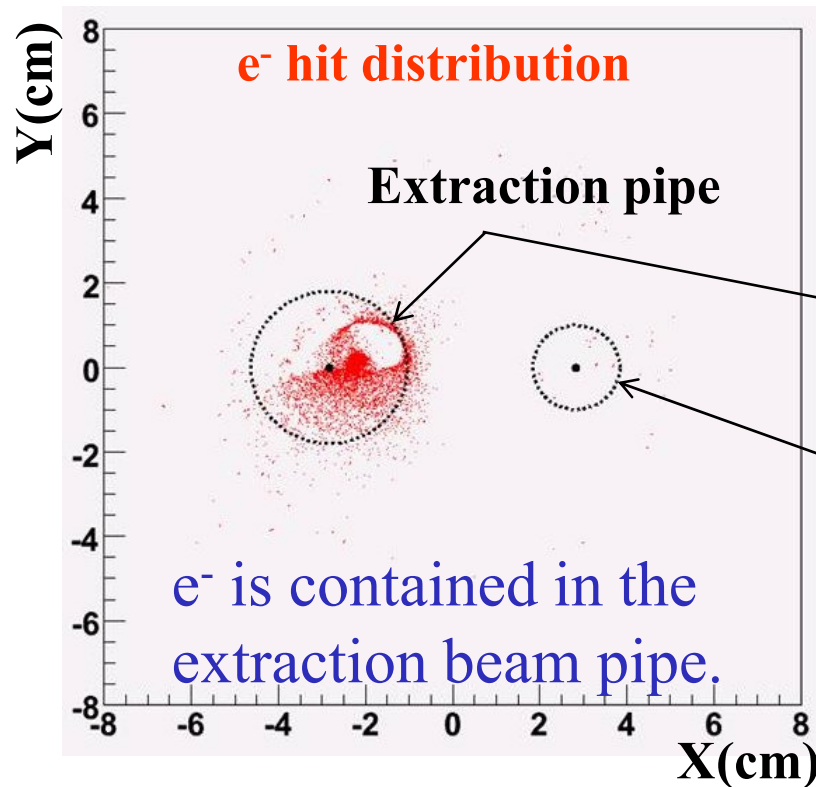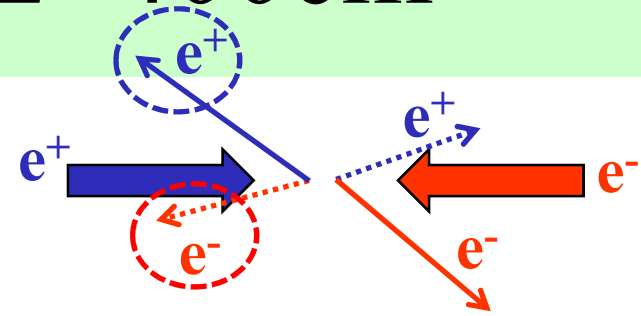## Simulation setup

- e^+e^- pair generator : CAIN
  - Beam size :
  $(\sigma_{X0}, \sigma_{Y0}, \sigma_{Z0}) = (639nm, 5.7nm, 300\mu m)$

- Tracking simulator : Jupiter
  - Magnetic field : 3T with anti-DID

- Pair monitor
  - Located at 400 cm from IP.
  - In front of Polyethylene mask layer

- Scattered e^+ distribution is studied.

GLD detector

e^+

e^+

e^-

Pair monitor

Polyethylene mask layer
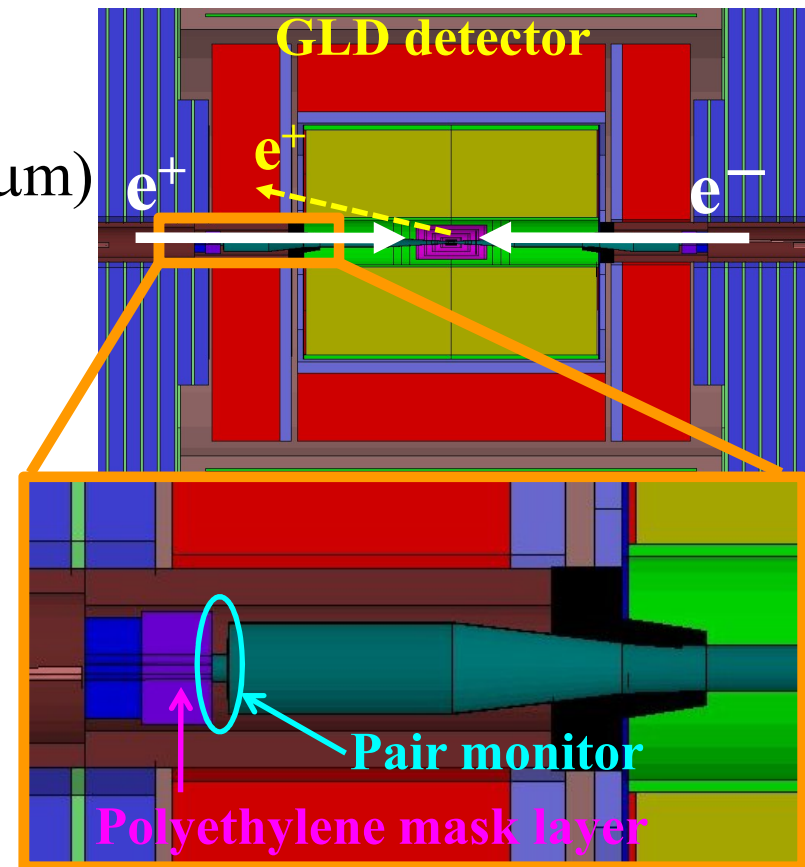
e⁺e⁻ distributions at Z=400cm

e⁺e⁻ distributions are checked at Z=400cm.

- e⁻ is not scattered so much.
- e⁺ is scattered with large angle.

e⁻ hit distribution

Extraction pipe

e⁻ is contained in the extraction beam pipe.
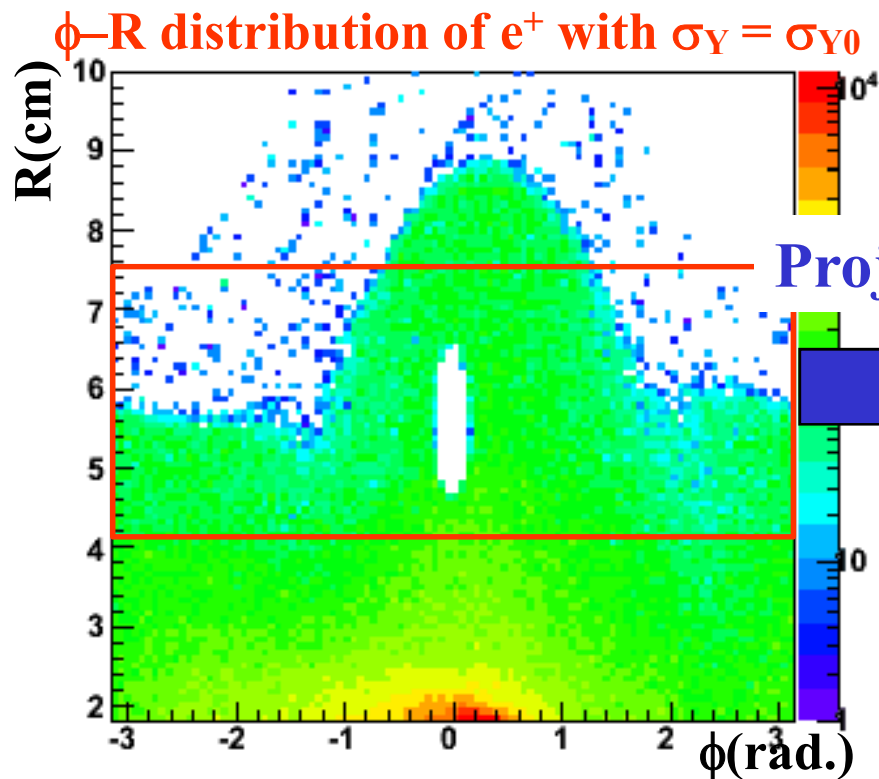
e⁺ hit distribution

Injection pipe

e⁺ hit distribution around the extraction beam pipe is used to measure the beam profile.

Measurement of vertical beam size

Y R φ X

Extraction pipe
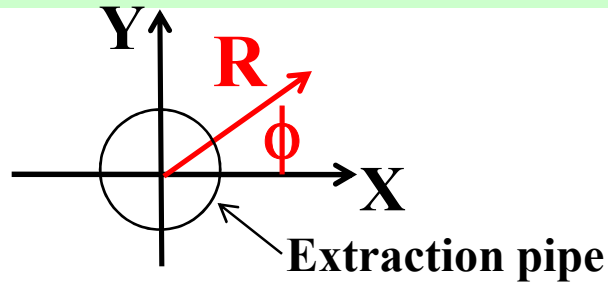
φ-R distribution was checked to derive information of vertical beam size.

φ–R distribution of e+ with $\sigma_Y = \sigma_{Y0}$

R(cm)

φ(rad.)

Projection to φ-axis

φ distribution for $0.5R_0 < R < 0.8R_0$

$\sigma_Y = \sigma_{Y0}$

$\sigma_Y = 3 \times \sigma_{Y0}$

φ (rad.)
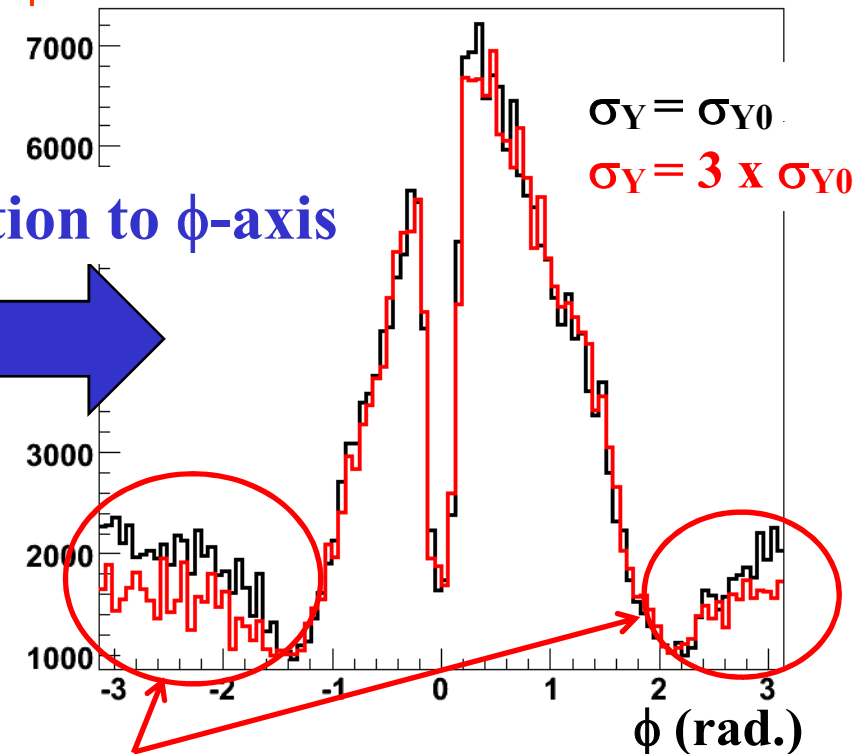
This region has the beam information.

Resolution of vertical beam size

- Ratio of $(N_A+N_B)/N_{ALL}$ was studied as a function of σ_Y.
- The resolution is estimated by using statistical error on the ratio.
  - The error is scaled to the 164 bunches.

ϕ–R distribution of e^+ with $\sigma_Y = \sigma_{Y0}$

σ_Y v.s. $(N_A+N_B)/N_{ALL}$
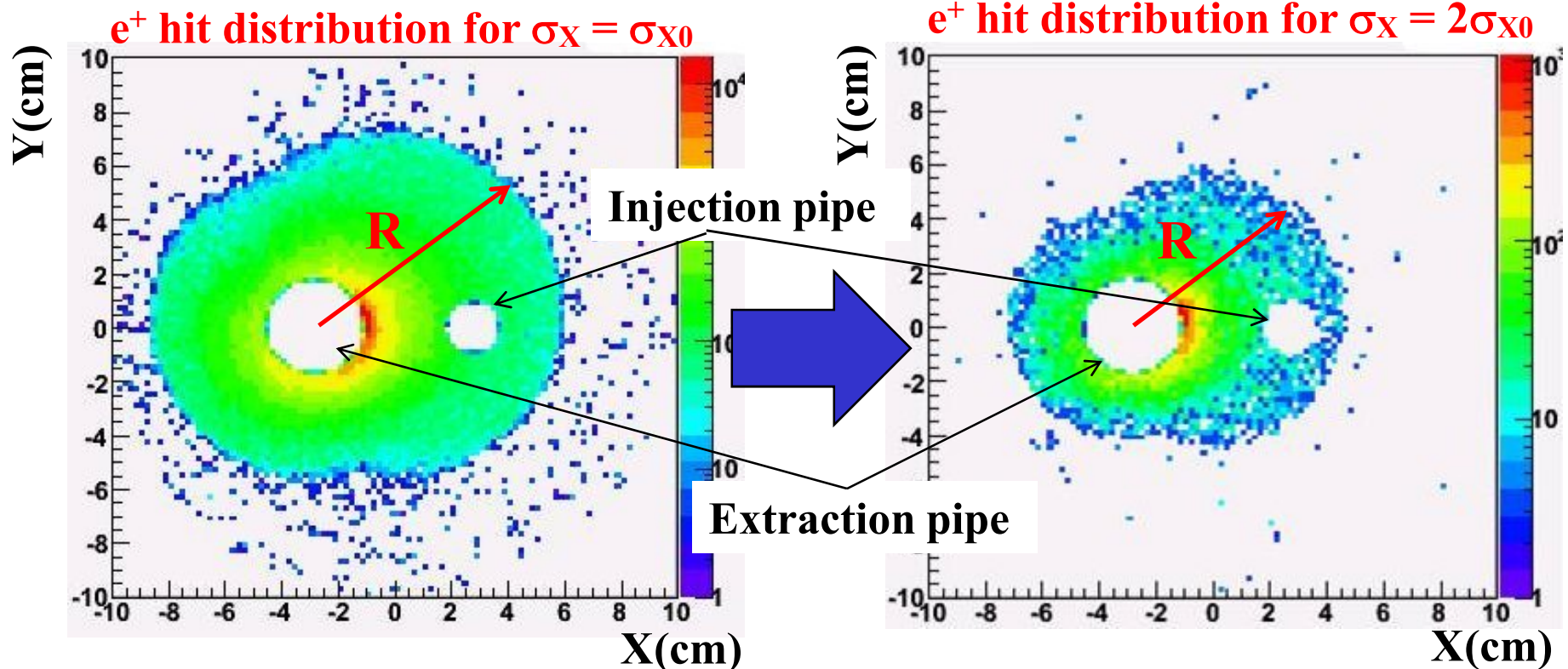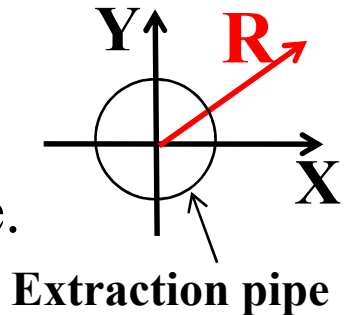
$$\frac{N_A+N_B}{N_{ALL}}$$
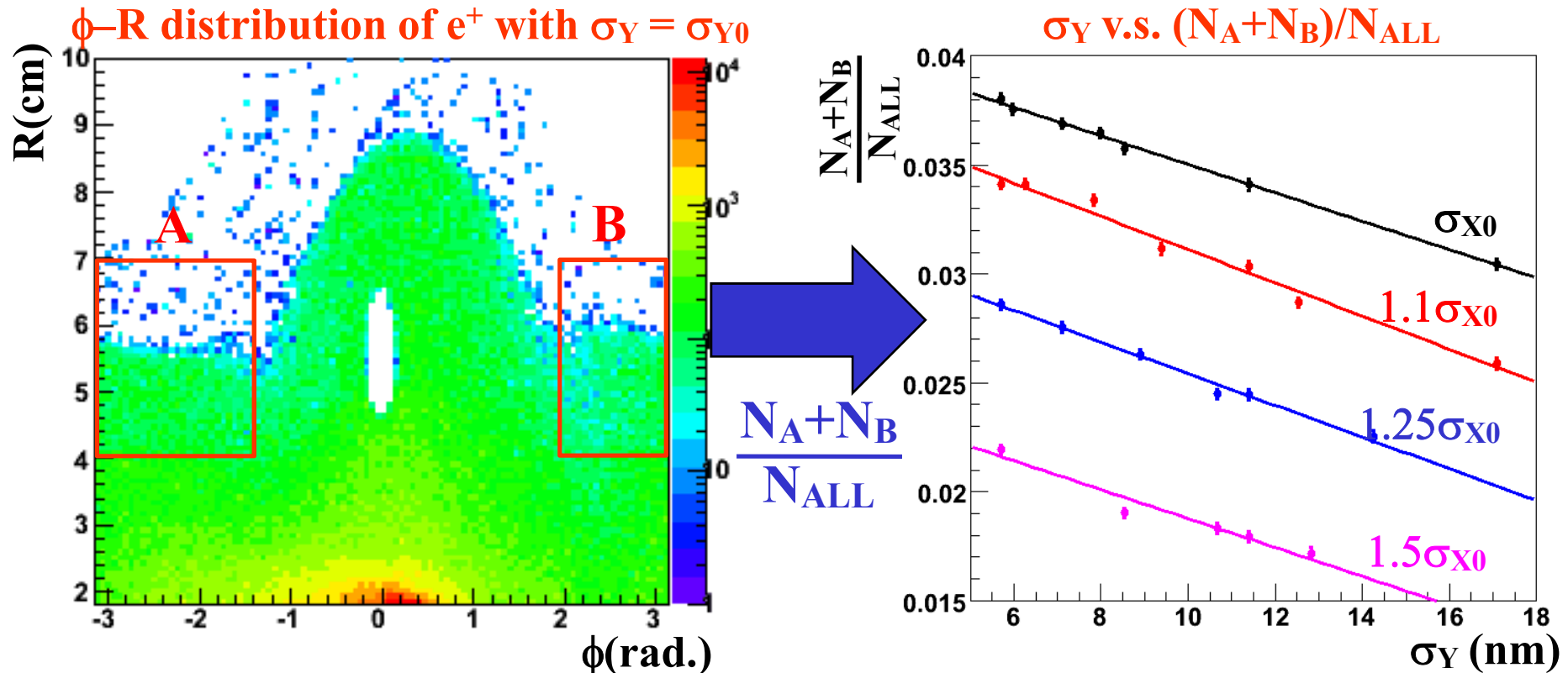
The resolution of 0.20nm (3.5%) was obtained.

Measurement of horizontal beam size

Measurement of horizontal beam size

- R : Distance of the e+ hit from the extraction beam pipe.
- R distribution seems to depend on the horizontal beam size.
  → R distribution was studied.

e+ hit distribution for $\sigma_X = \sigma_{X0}$

e+ hit distribution for $\sigma_X = 2\sigma_{X0}$

Horizontal beam size v.s. R distribution

- R_0 is defined as R to contain 99.8% hits.

- R_0 has the linear dependence on σ_X.

  - σ_X -resolution of 0.96nm(0.15%) is estimated for $\sigma_X = \sigma_{X0}$.
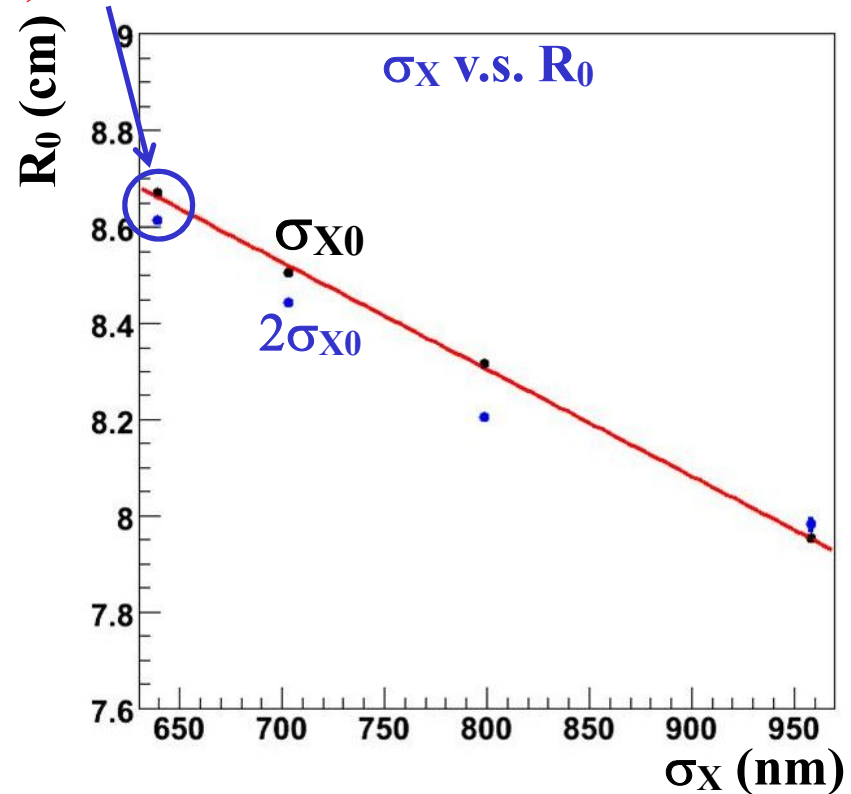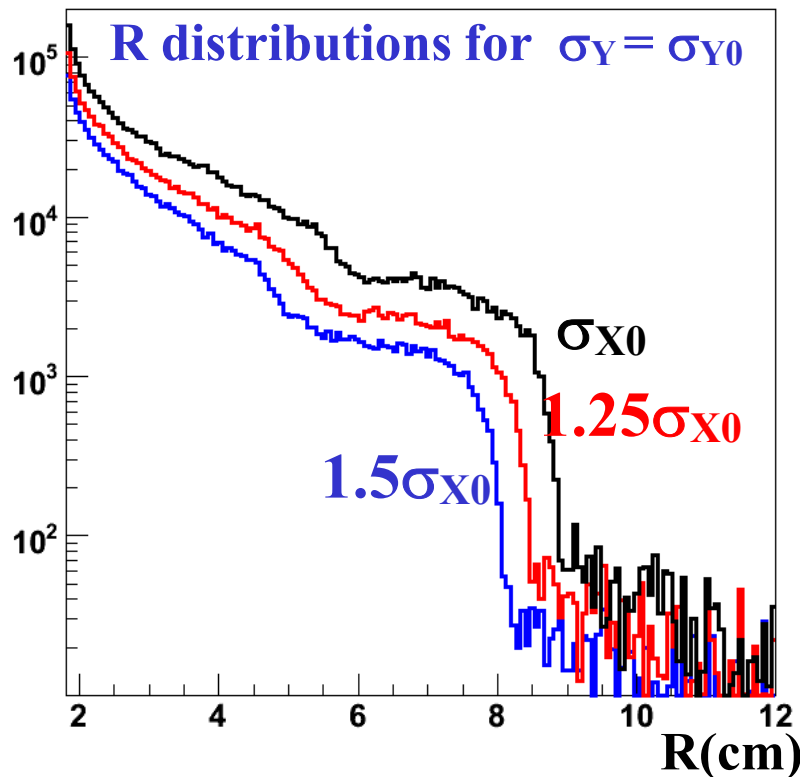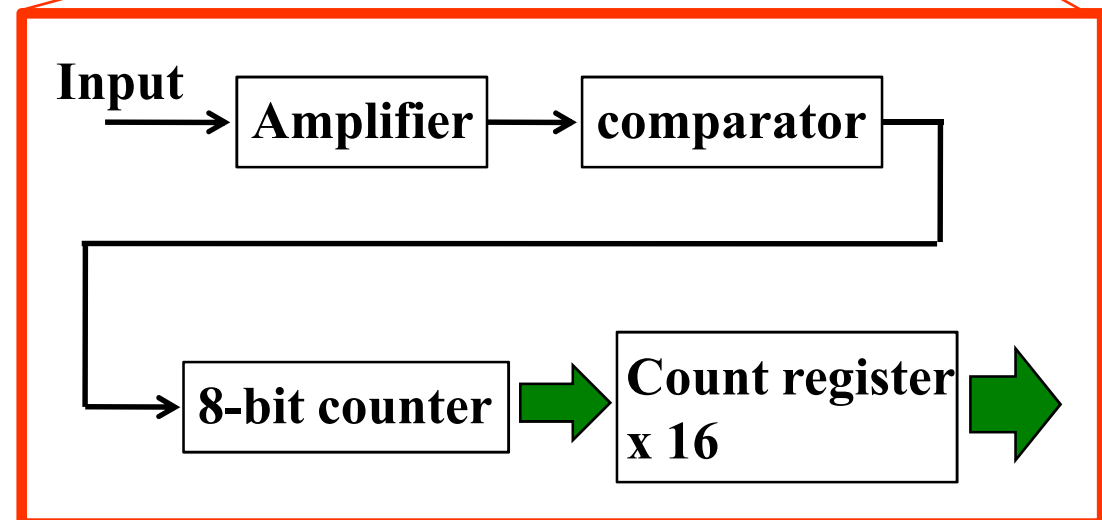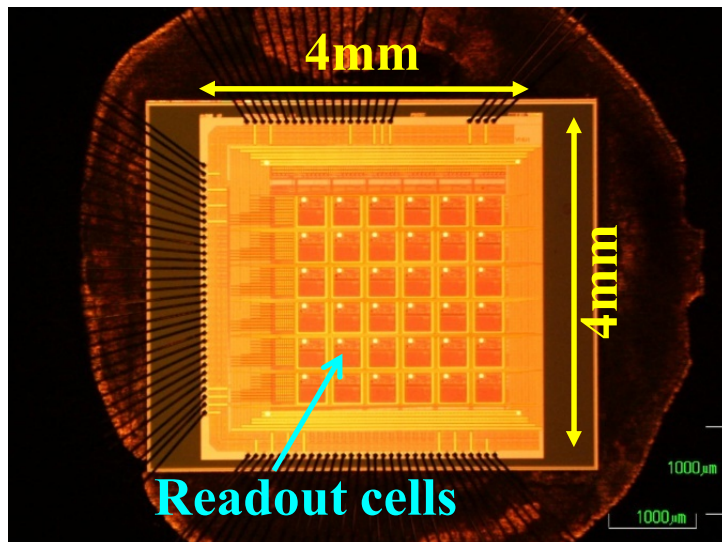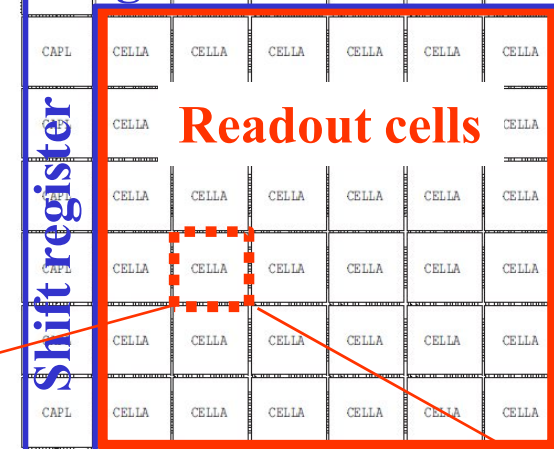

Derivation of the combination of beam parameters is ongoing by using matrix equation.

R&D status of pair monitor

A prototype of the readout ASIC is developed.

- A number of hits is counted for each pixel to obtain a hit distribution.

- # of pixel : 36(= 6 x 6)

- Pixel size : 400 x 400 μm^2

- A sensor will be bump-bonded to the ASIC.

→ The response test is ongoing.

Operation signal distributor

Shift register & Data transfer

Shift register

Readout cells

CAPL CELLA CELLA CELLA CELLA CELLA CELLA

4mm

4mm

Readout cells

1000 μm

1000 μm

Input
→ Amplifier → comparator

→ 8-bit counter → Count register x 16 →
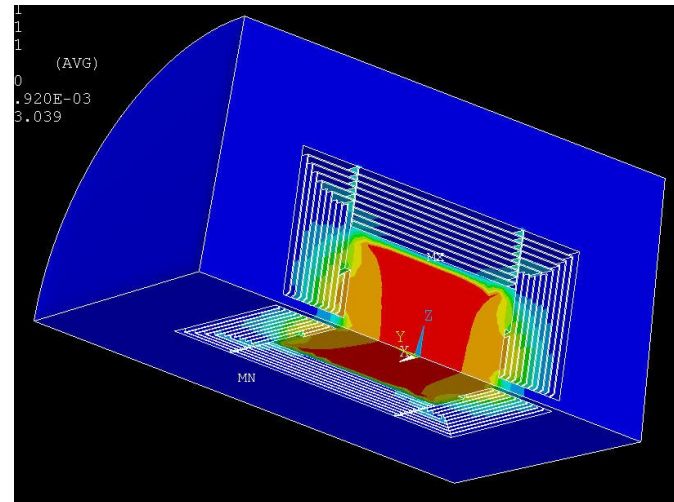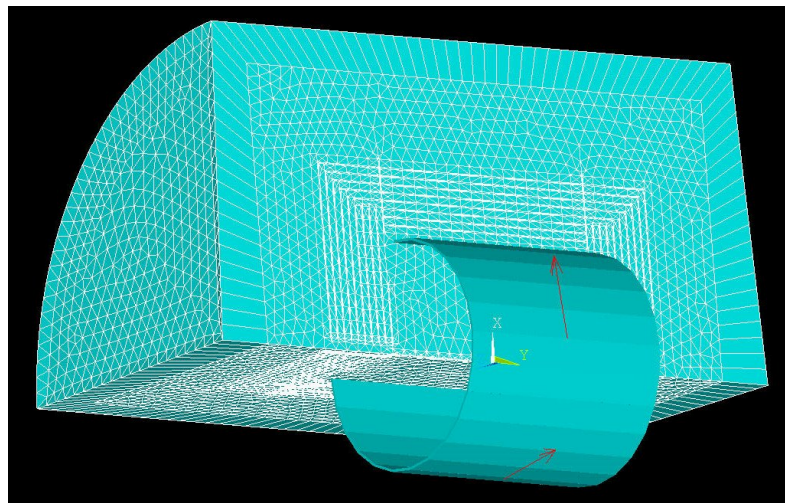
Pair monitor at ILD

Pair monitor at ILD

• The location of pair monitor was discussed at FCAL meeting in TILC08.

• The pair monitor may be located as the first layer of BeamCal.

> ➤ The pair monitor and BeamCal will be complementary detector for beam measurement.

• The optimization study will be started.

• The mechanical design should be also considered.
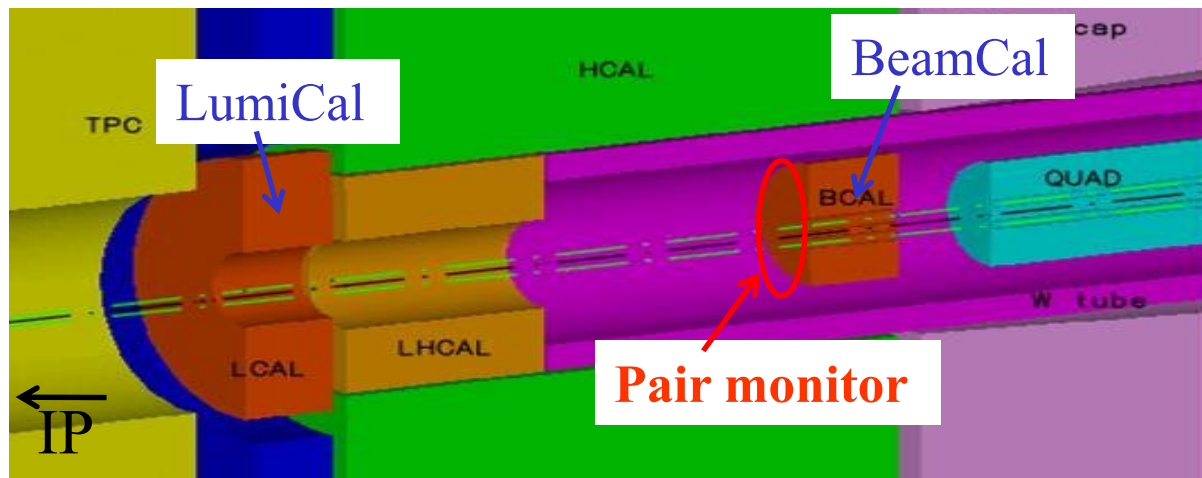
Field calculation at ILD

<u>3D-field calculation</u>

- Calculation of 3D-field was started for ILD forward region by KEK.
    - Software : ANSYS
    - The study is collaborated with Brett Parker.
- The current geometry is still GLD without anti-DID.
    - The next step is implementation of anti-DID.
    - It will be converted to ILD.

Summary

- Study of the pair monitor is performed actively.

- The resolution of the beam size was estimated by simulation study.

  - ➢ Vertical beam size : 0.20 nm

  - ➢ Horizontal beam size : 0.96 nm

- The R&D of the readout ASIC is ongoing.

- Location of the pair monitor will be optimized.

  - ➢ The pair monitor may be located in front of BeamCal.

- Calculation of the 3-D field was started for the ILD forward region.