Activity Report of the JLC CDC Group in the Fiscal Year 2000

1. Laser Beam Experiment
   (a) Lorentz angle measurement
   Motivation: Small Lorentz angle is favorable for a jet-type chamber to reduce dead region in the sensitive volume under a magnetic field.
   (b) Detailed study of two-track separation capability
   Motivation: Precise measurement of coordinate and dE/dx for each track densely populated in jets is required from the JLC CDC.
2. Particle Beam Experiment at KEK PS
   Study of dE/dx Resolution
   Motivation: Particle identification by dE/dx measurements can be a powerful tool for physics research.
3. Development of VME Flash ADC
   Motivation: CAMAC flash ADCs currently used are too slow in data transfer.

Results and Present Status

- Lorentz Angle Measurement

  We have developed a new Lorentz angle measurement system featuring the use of double laser beams and flash ADC readout. This system enabled us to measure Lorentz angles in CO_2 based gas mixtures with small systematic errors. The measurement showed a small Lorentz angle (α) of 6.8° under 1.5 T magnetic field (B) and 1.0 kV/cm electric field (E) in the CO_2(90%) - isobutane(10%) mixture at atmospheric pressure. The magnetic deflection coefficient (ψ) defined by $\tan\alpha = \psi\left(\frac{B}{E}\right)w_0$, with w_0, the drift velocity in the absence of magnetic field, was found to be close to unity almost independently of the applied electric field (0.6 - 2.0 kV/cm) and the magnetic field (0.3 - 1.5 T). Assuming a constant value of ψ, the Lorentz angle under B = 2 T is expected to be 9.0° in the drift region of the JLC CDC. [Fig.1 to Fig.5]

- Detailed Study of Two-Track Separation Capability

  Now under analysis.

  We have observed clear evidence of the effect of positive ions left by a preceding avalanche upon the size of following avalanche using a setup similar to that of the Lorentz angle measurement. [Fig.6]

- ## Study of dE/dx Resolution

  An experiment was carried out at KEK PS to study particle identification capability of CO_2 based gas mixtures using 0.5 - 2.0 GeV/c protons, pions and positrons. We used a drift chamber having a cell structure similar to that assumed for the JLC CDC with a gas mixture of $CO_2(90\%)$ - isobutane(10%). The study shows that reasonable particle-identification capability using dE/dx measurements can be achieved while maintaining high spatial resolution. The dE/dx resolution of $\sim 7\%$ was obtained for minimum ionizing particles by applying the truncated mean method using the smallest 70% of 80 measurements, each for 1-cm sample thickness. [Fig.7 to Fig.9]

- ## Development of VME Flash ADC

  A prototype module of VME-based flash ADC will soon be ready for performance evaluation. It is designed to have 200-MHz sampling rate, 10-bit ADC resolution and several intelligent functions such as pedestal subtraction and zero-data suppress. These modules are expected to substitute the currently used CAMAC flash ADC modules, which are rather slow in data transfer and limited the data acquisition rate in the experiment at KEK PS to $\sim$ 1 Hz.

Fig.1. Setup of the Lorentz Angle Measurement

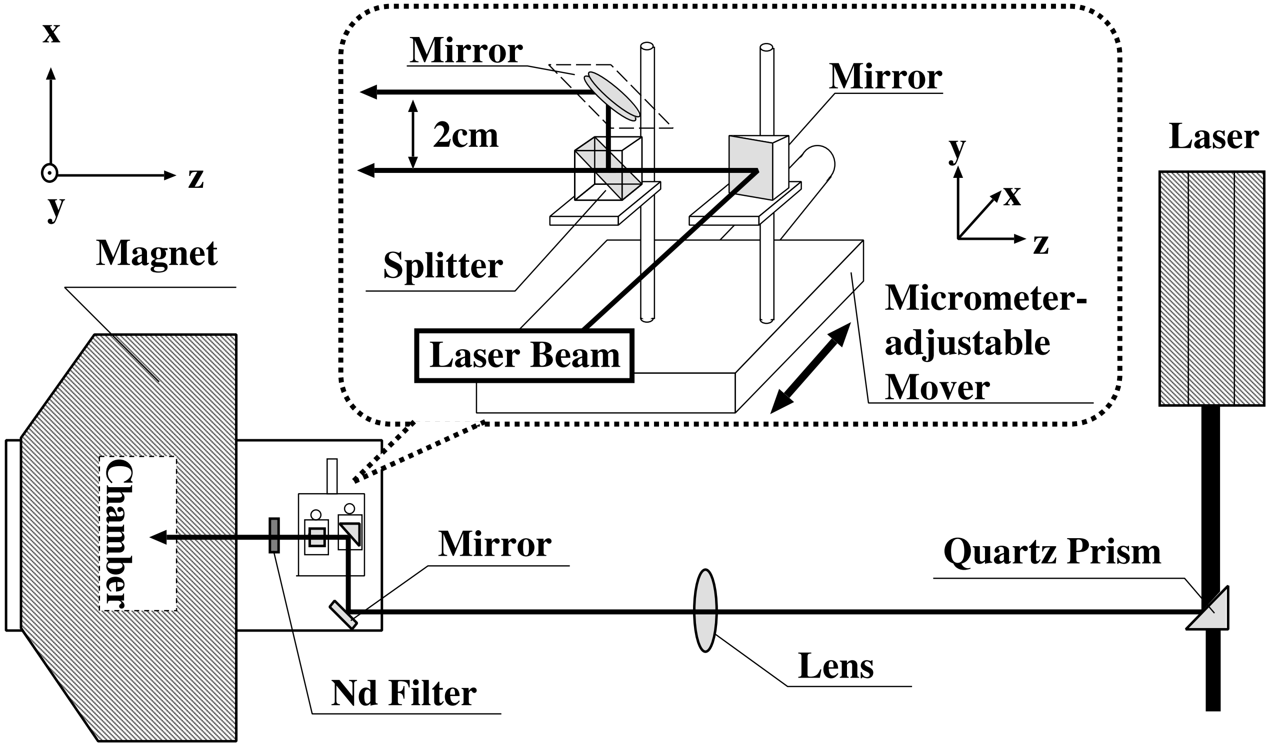


Fig.2. Side View of the Chamber
used in the Lorentz Angle Measurement

(a)

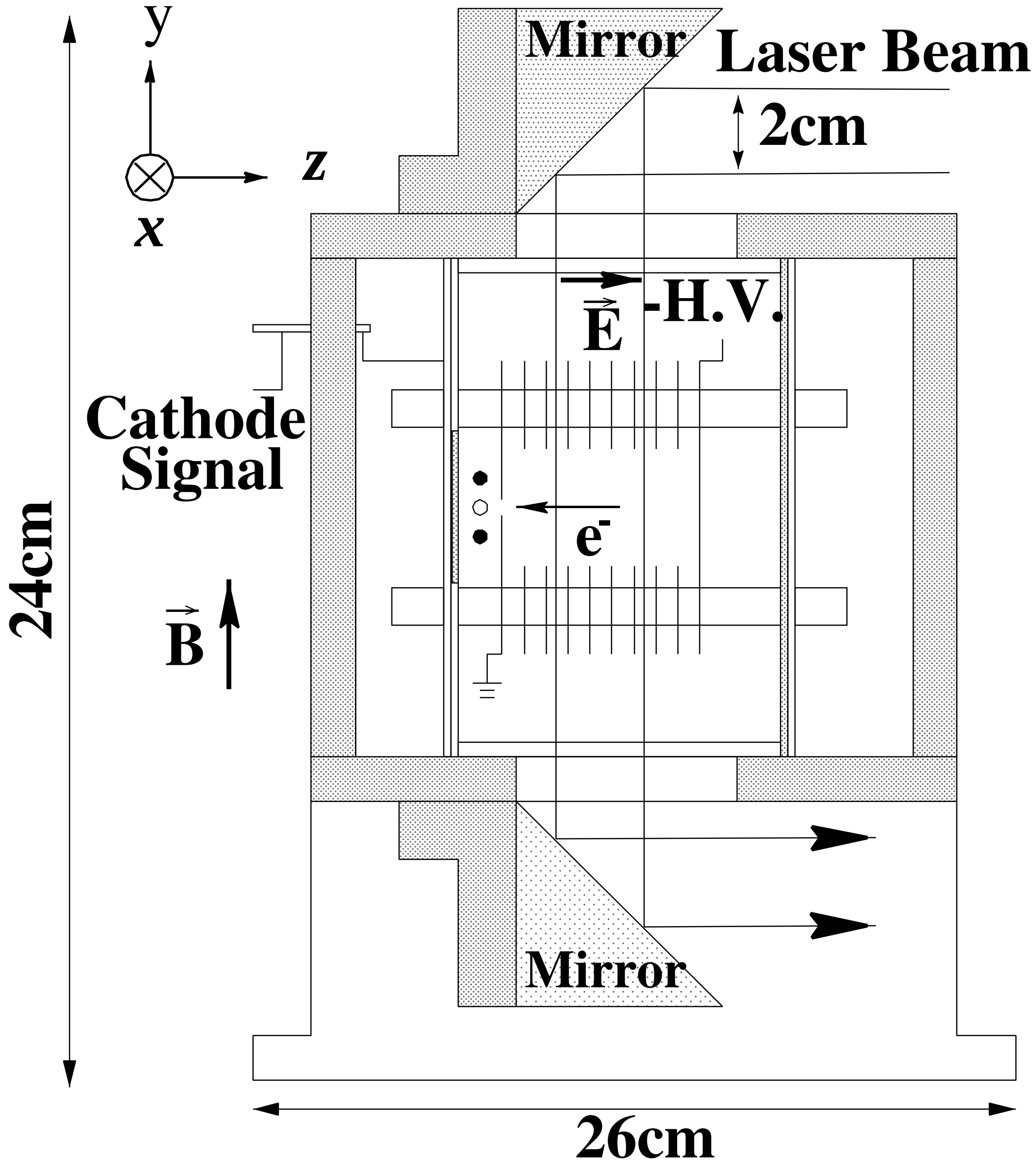
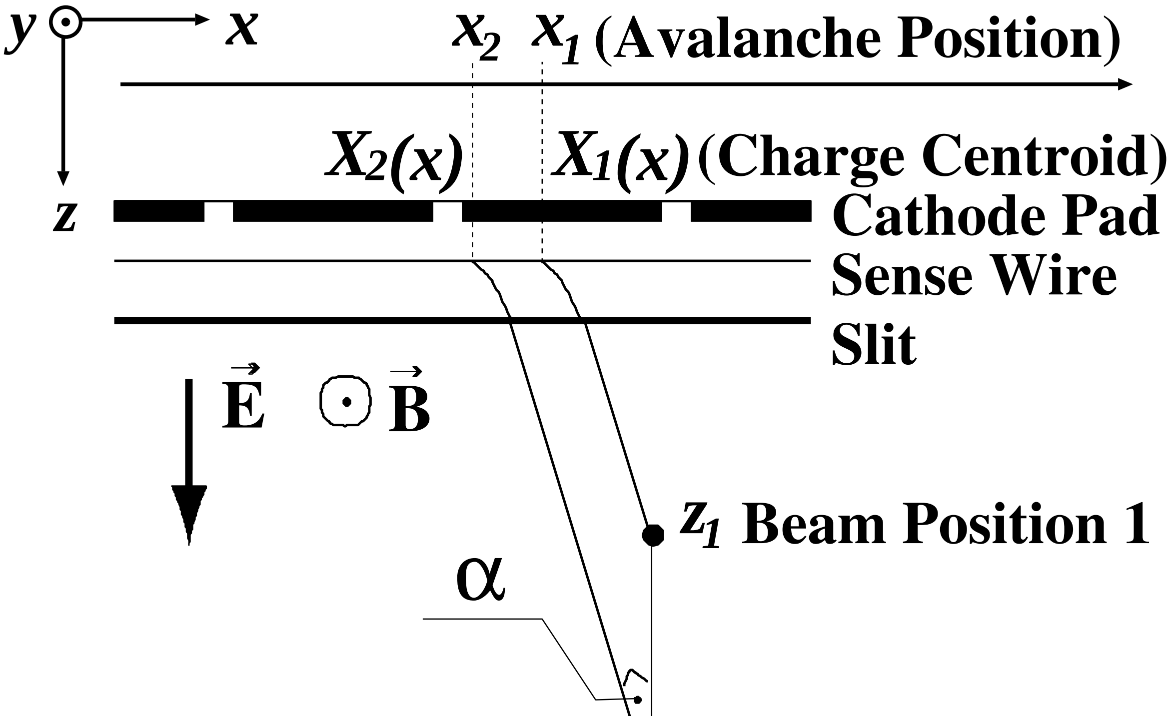
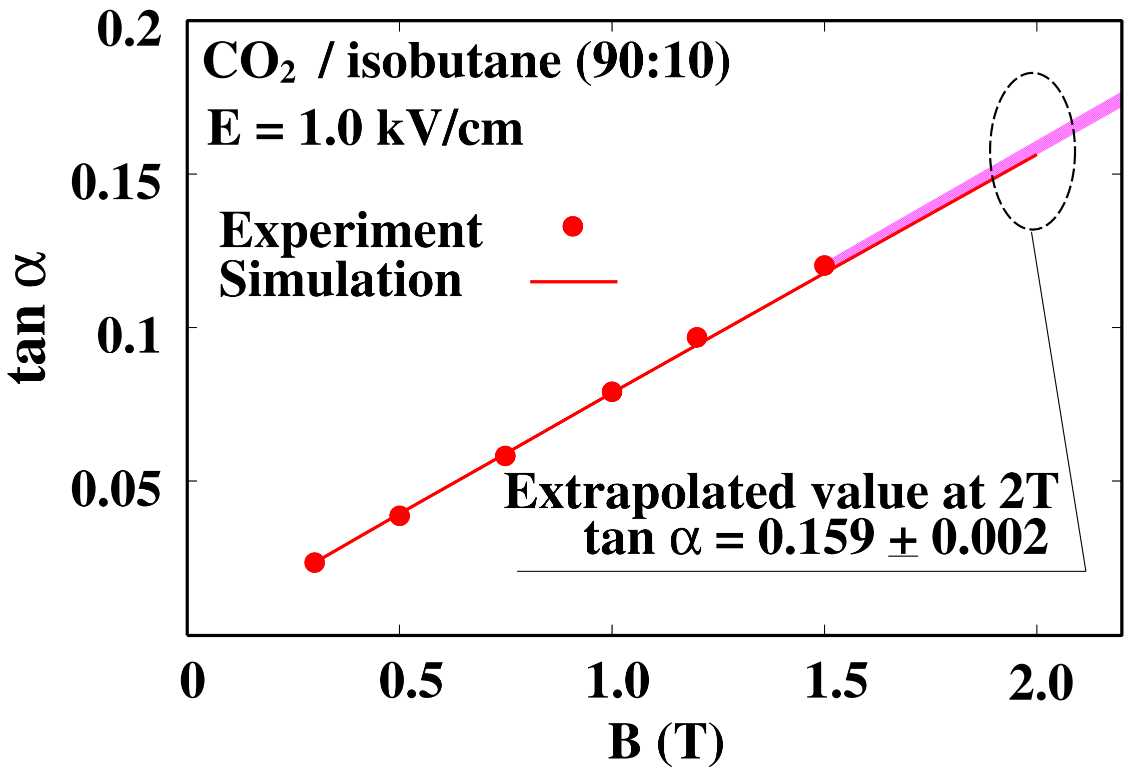


Fig.3. Principle of the Lorentz Angle Measurement



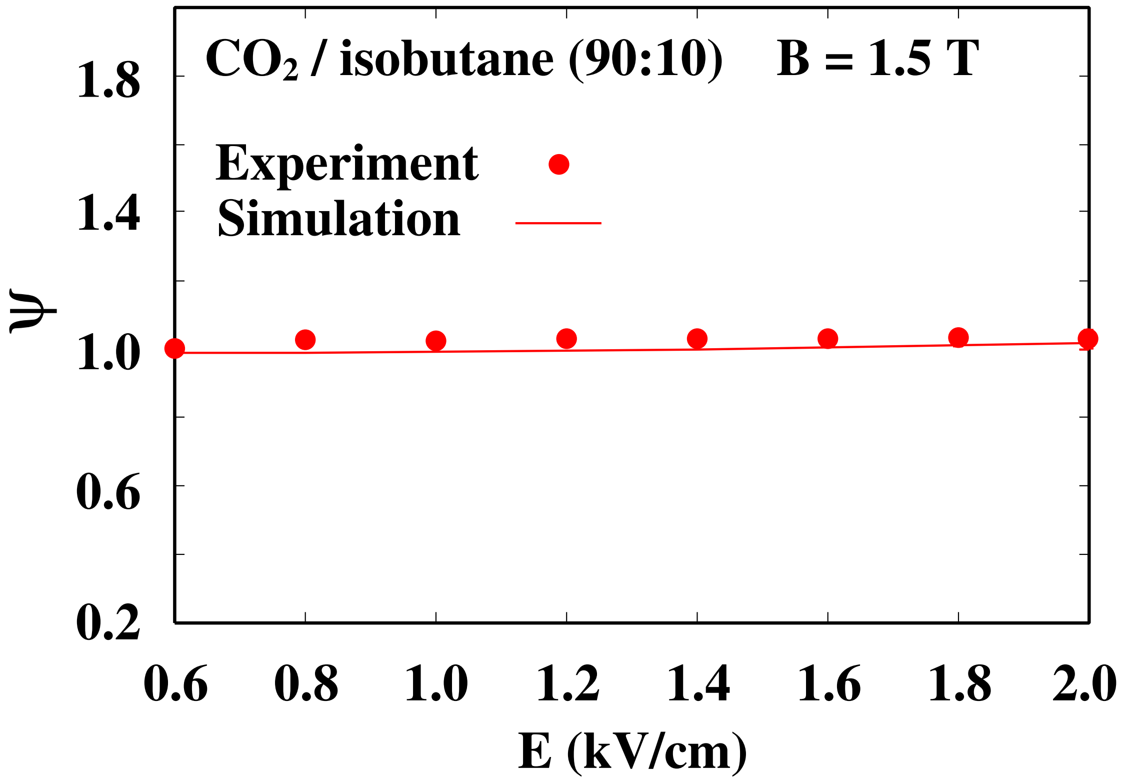
$$\tan\alpha = \frac{x_2 - x_1}{z_2 - z_1}$$

Fig.4. Lorentz Angle vs. Magnetic Field



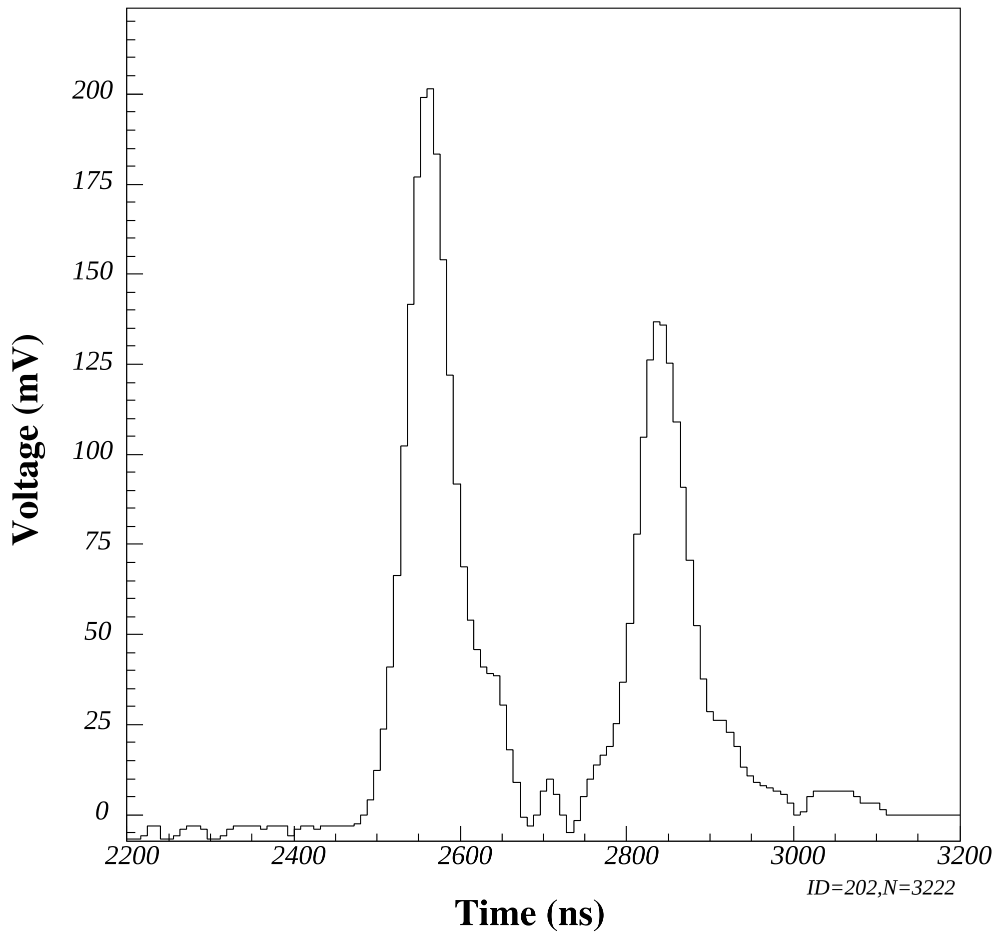
The measured Lorentz angle as a function of Magnetic field strength. Also shown in the figure are the prediction given by GARFIELD and the linear extrapolation of the measured data points to B = 2 T.

Fig.5. Magnetic Deflection Coefficient



The measured magnetic deflection coefficient as a function of electric field strength. The solid line is the prediction given by GARFIELD.

Fig.6. Sense wire signal observed with two laser beams



The wave form observed with parallel laser beams. The beams are 2.2 mm apart in the drift direction and coincide in the sense wire direction. The drift distance is about 25 mm.

Fig.7. Cell Structure of the Chamber used in the dE/dx Measurement

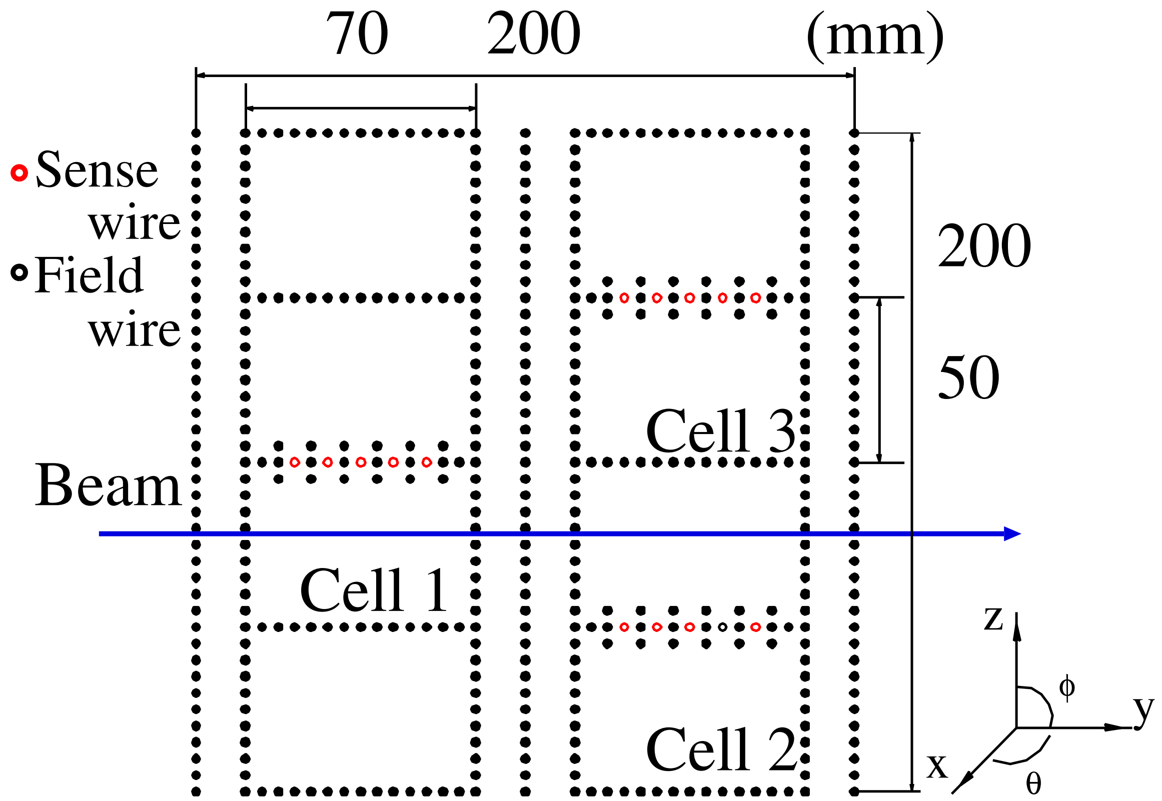
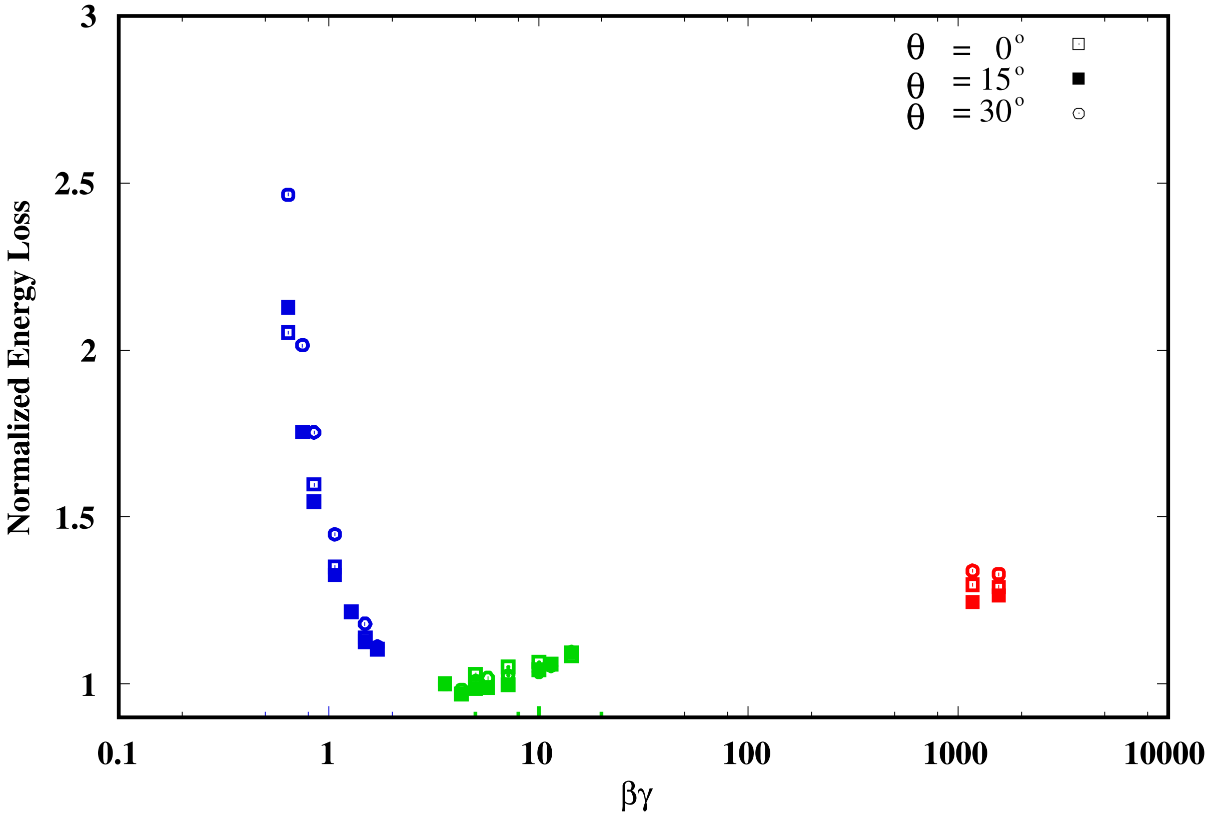
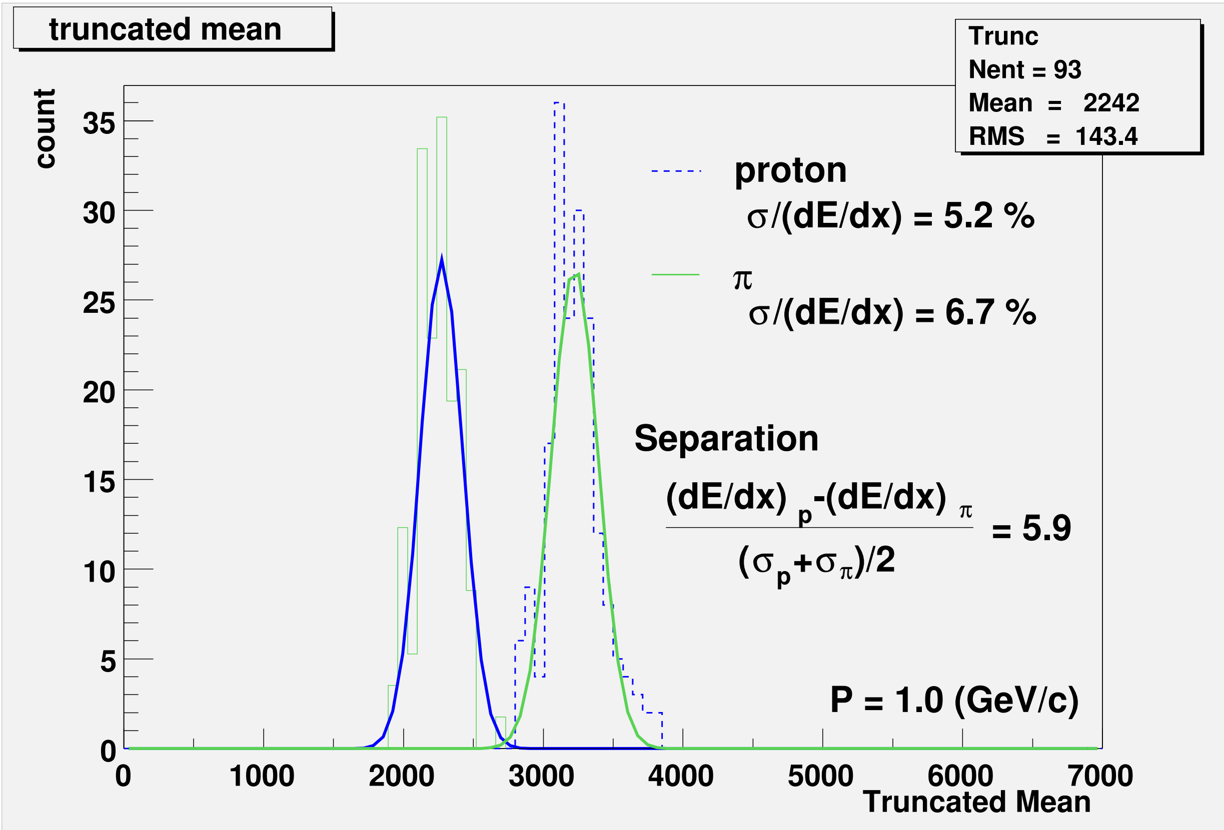


Fig.8. $\beta\gamma$ dependence of dE/dx



The most probable energy loss in 1 cm of CO_2/i-C_4H_{10} (90:10) obtained with 0.5 - 2.0 GeV/c protons, pions and positrons. The energy loss is normalized to that of 0.5 GeV/c pions.

Fig.9. $\pi - p$ Separation by dE/dx Measurement



The pion - proton separation obtained by dE/dx measurement. The energy loss is calculated by the truncated mean method using the lowest 70% of 80 measurements, each for 1-cm sampling length.