Identification of low energy electron using ECC

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CONTENTS

Motivation

* Electron ID in ECC

* Electron energy measurement in ECC

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Japan Synchrotoron Radiation Research Institute

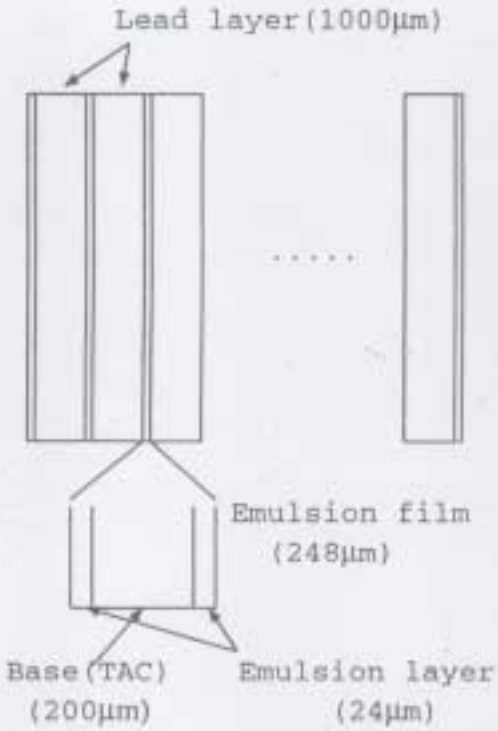
"SPring-8"

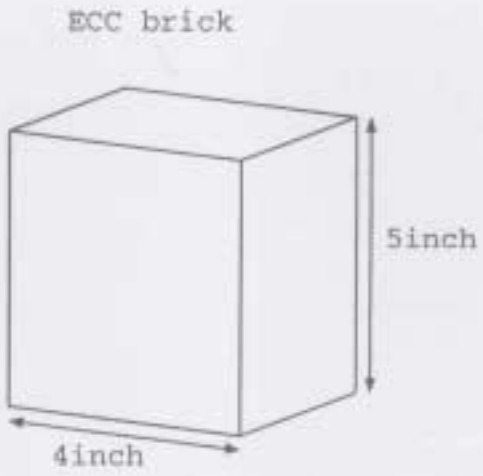
* Beam Line
  RCNP
  Laser-Electron Photon facility at SPring-8 (LEPS) BL33LEP
  - The backward-compton scattering of laser photons ~~form~~ from 8GeV elestcons produces linearly or circularly polarized photon beam with the maximum energy of 2.4 GeV.
  - 2.0, 1.0, 0.5 and 0.25 GeV/c electron beam.

ECC(Emulsion Cloud Chamber)

Structure:

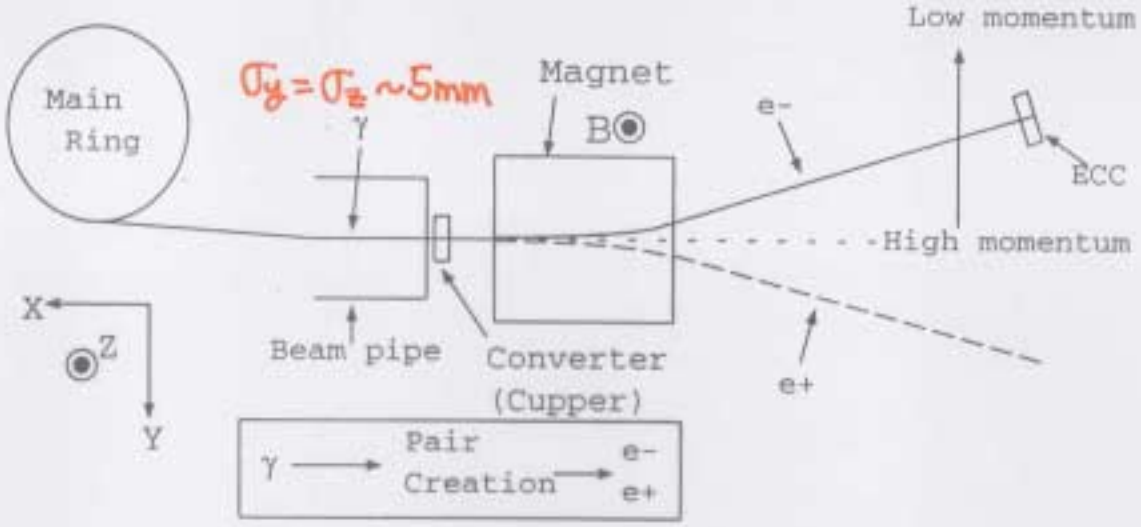
Emulsion plates are interleaved with lead plates.





Electron Beam exposure @ SPring-8

SPring-8, RCNP,BL33LEP



Stack No.	Number of Emulsion plates	Beam momentum (GeV/c)
STACK1	18	0.5,0.25
STACK2	24	1.0,2.0

- Refreshed emulsion films were used.
- Exposed ECC to cosmic rays for 3days.
- Emulsion films were processed just after the exposure at Nagoya Univ.

Scanning system of TOHO Univ. (UTS)

SYSTEM9 equipped with UTS.

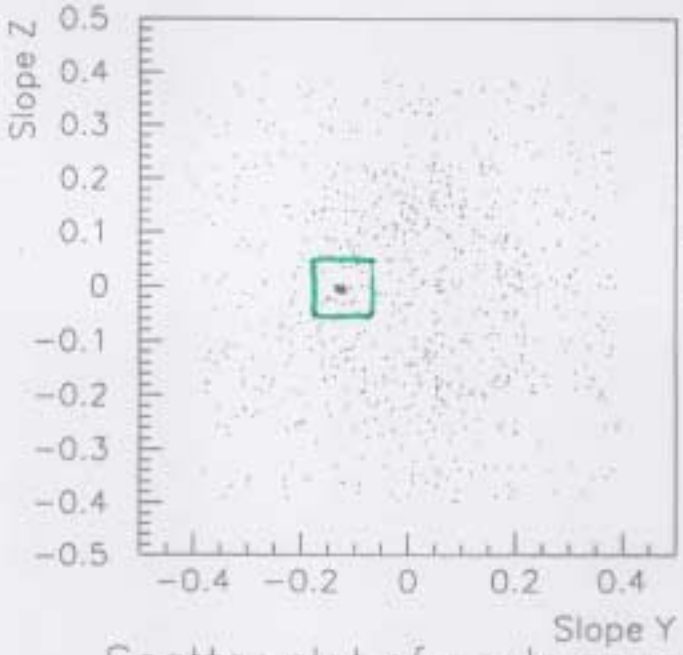
Scanning speed

- Area 71 [mm^2](81 $\times$ 81 [views])
  Angle $-0.4 \sim 0.4$ $\sim$ 1 [hour]
- 6 [positions/plate] $\sim \frac{1}{6}$ [hours]

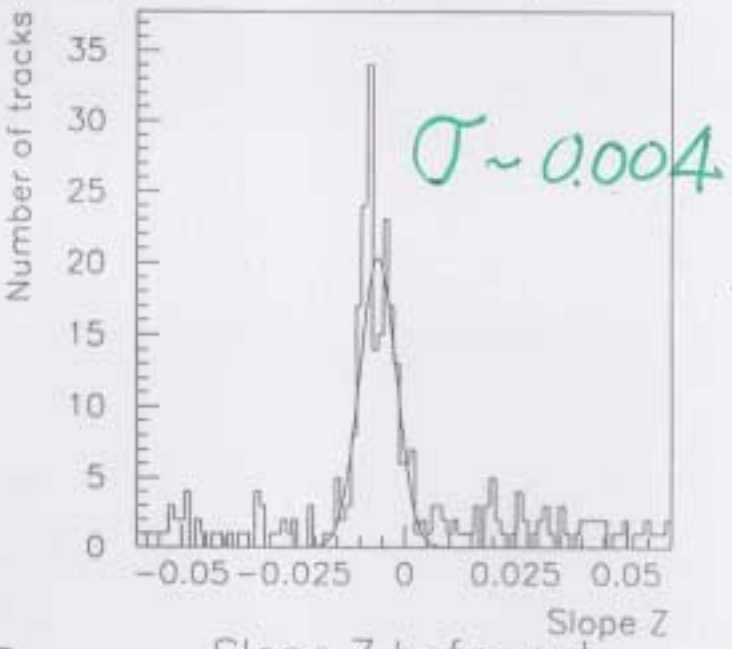
Beam density and background

2GeV/c Electrons

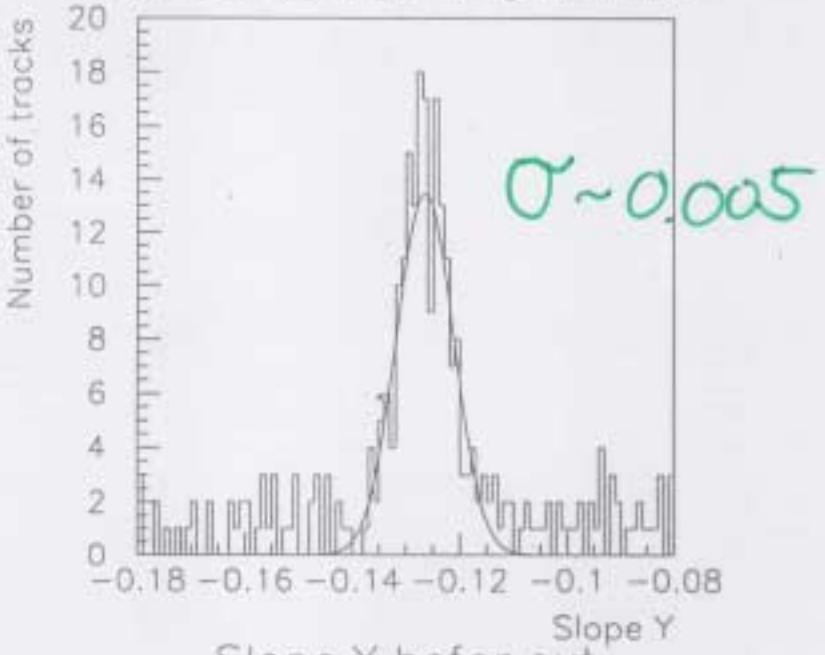
Number of tracks in scanning area :918 [tracks]



Scatter plot of angle space



Slope Z befor cut



Slope Y befor cut

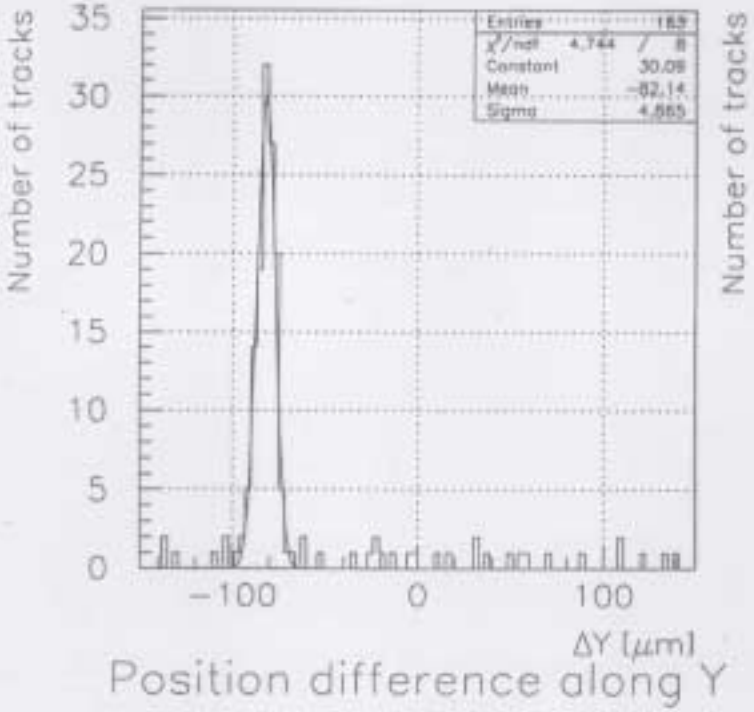
$3\sigma(= 0.0123\,[\mathrm{rad}])$ cut $\rightarrow 164\,[\mathrm{tracks}]$

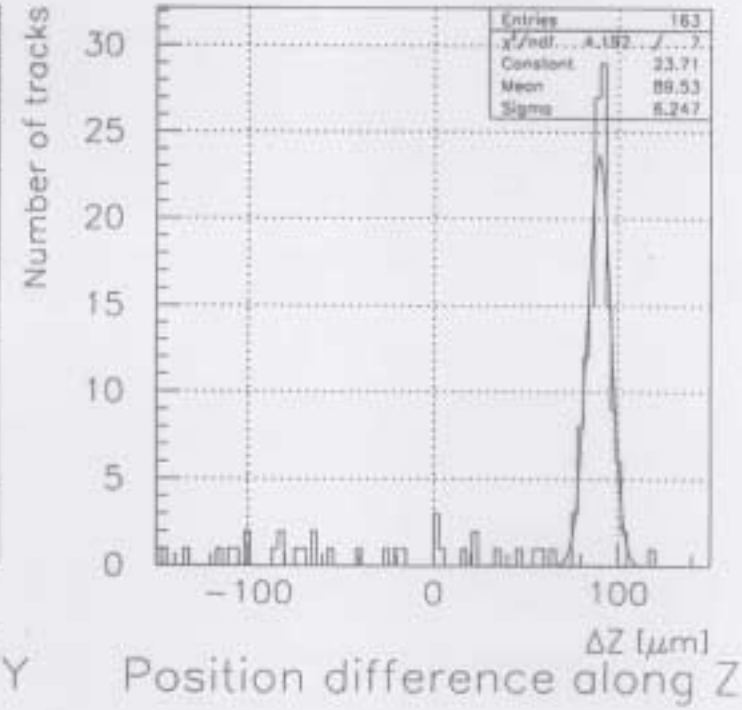
Electron track density : $231\,[\mathrm{tracks/cm^2}]$

background contamination : $\sim 1.9\,[\mathrm{tracks/cm^2}]$

* Good parallelity
* Background is very low in electron beam.
* Purity $\geq 99\%$

Emulsion Plate alignment

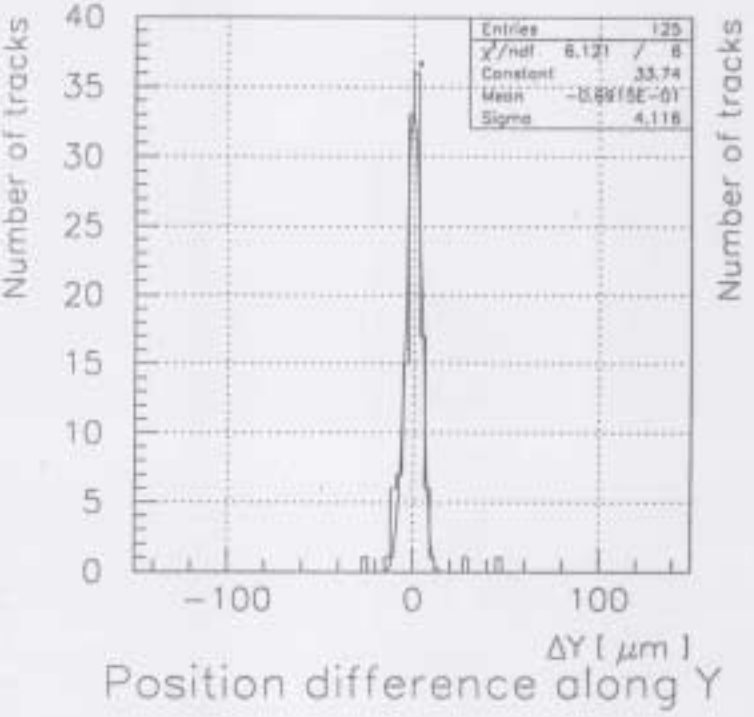


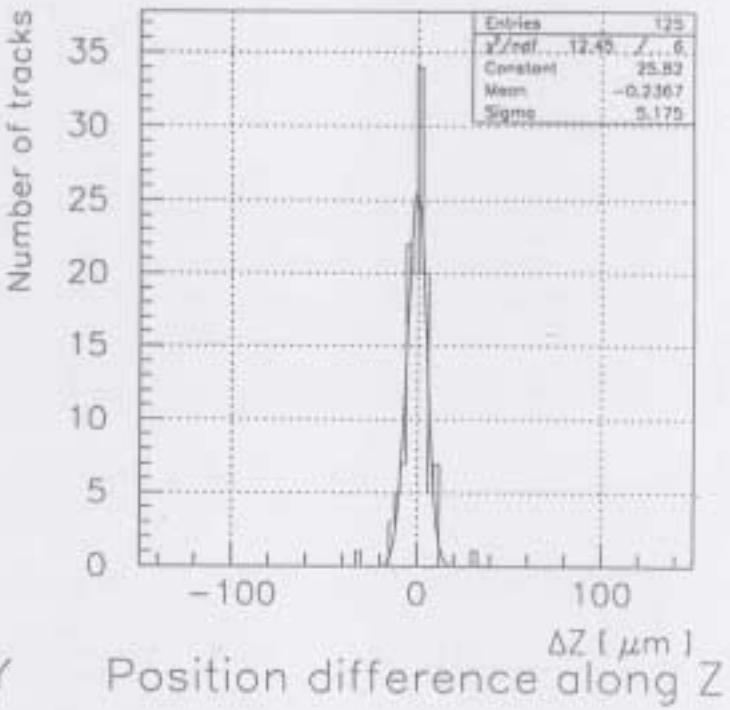


1 Rotation,rough Y-Z shift adjustment(Cosmic rays)

2 X shift adjustment (Cosmic rays)

3 Fine Y-Z shift adjustment at beam center ($\sigma \sim 5\mu\mathrm{m}$)
(Electron)

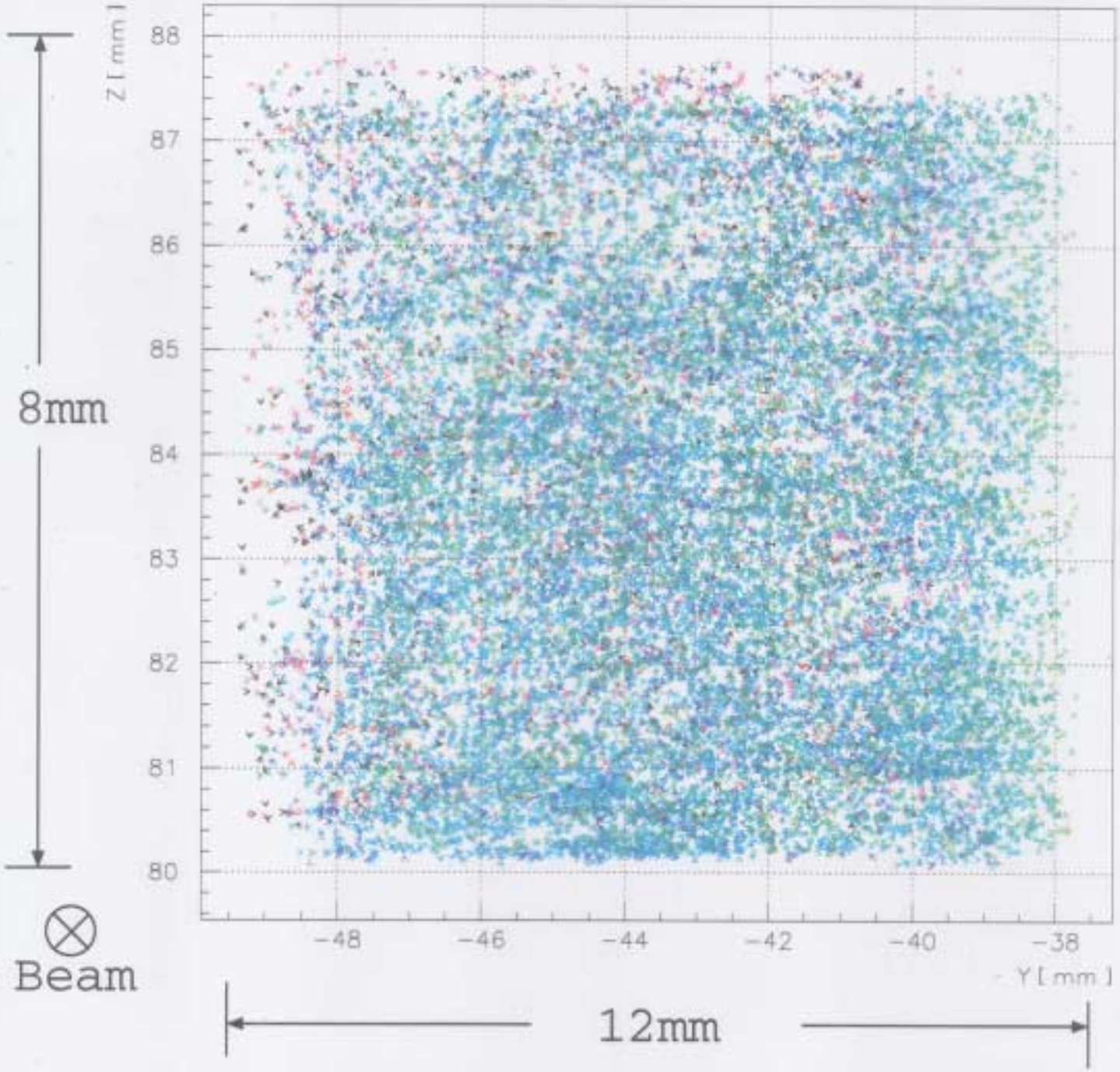




All tracks found in 15 ~~films~~ Plates after alignment

Total 18325 [track segments]

→ Ave. 1221.7 [track segments/plate]



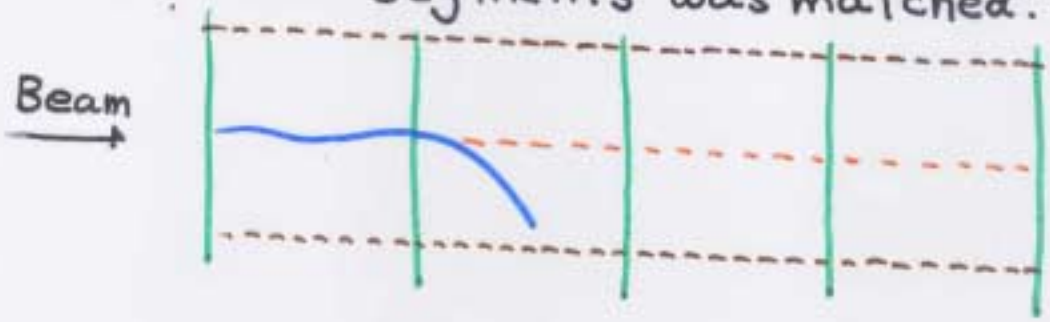
Scanning

1. Follow down 164 track segments in most up stream plate.

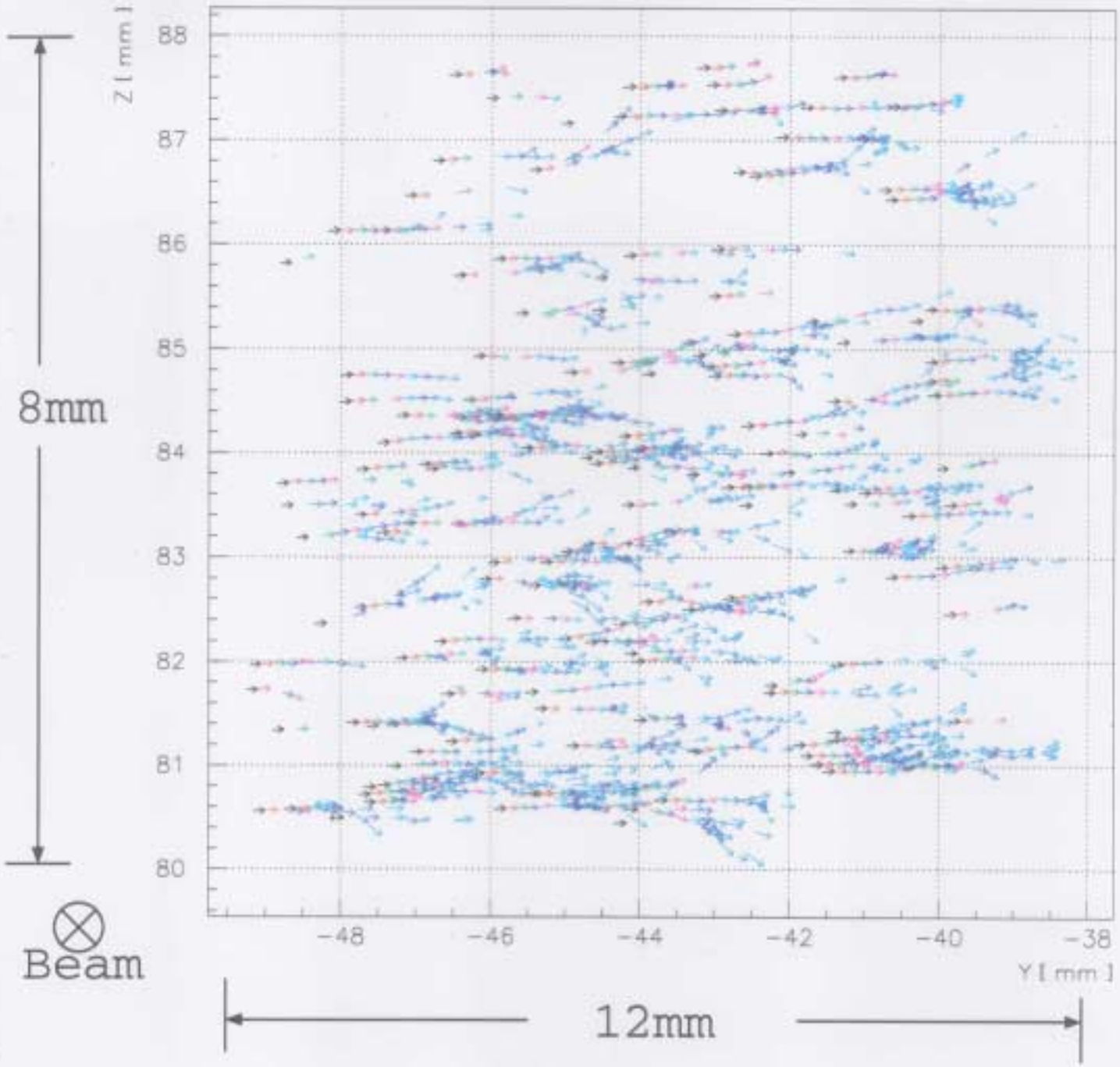
2. Pick up every track segment with in $r = 100\,\mu m$.

3. Remove cosmic rays and keep only connected track segments.

4. Keep following 3 more plates even after no track segments was matched.



Scanning Results



Event Classification

Electron events were classified as follows:

1 Pair creation associated.

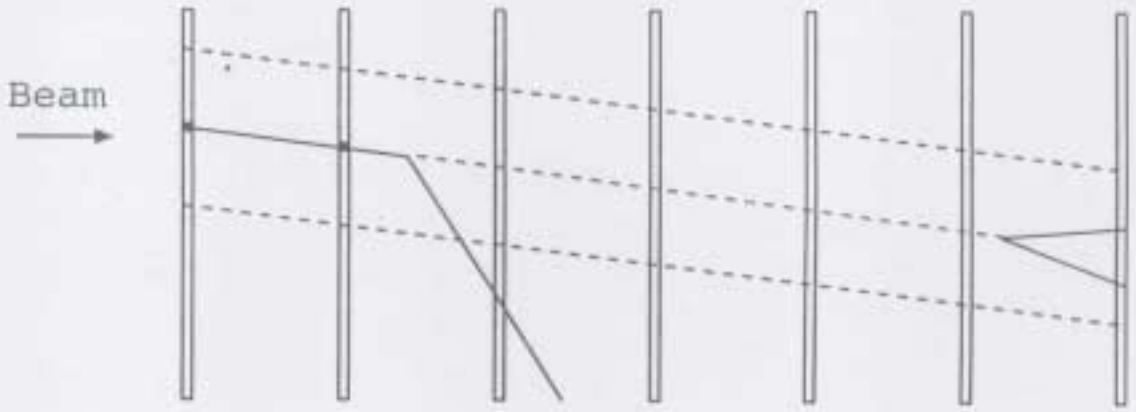
2 Stopped.

3 Penetrate 10 emulsion plates.

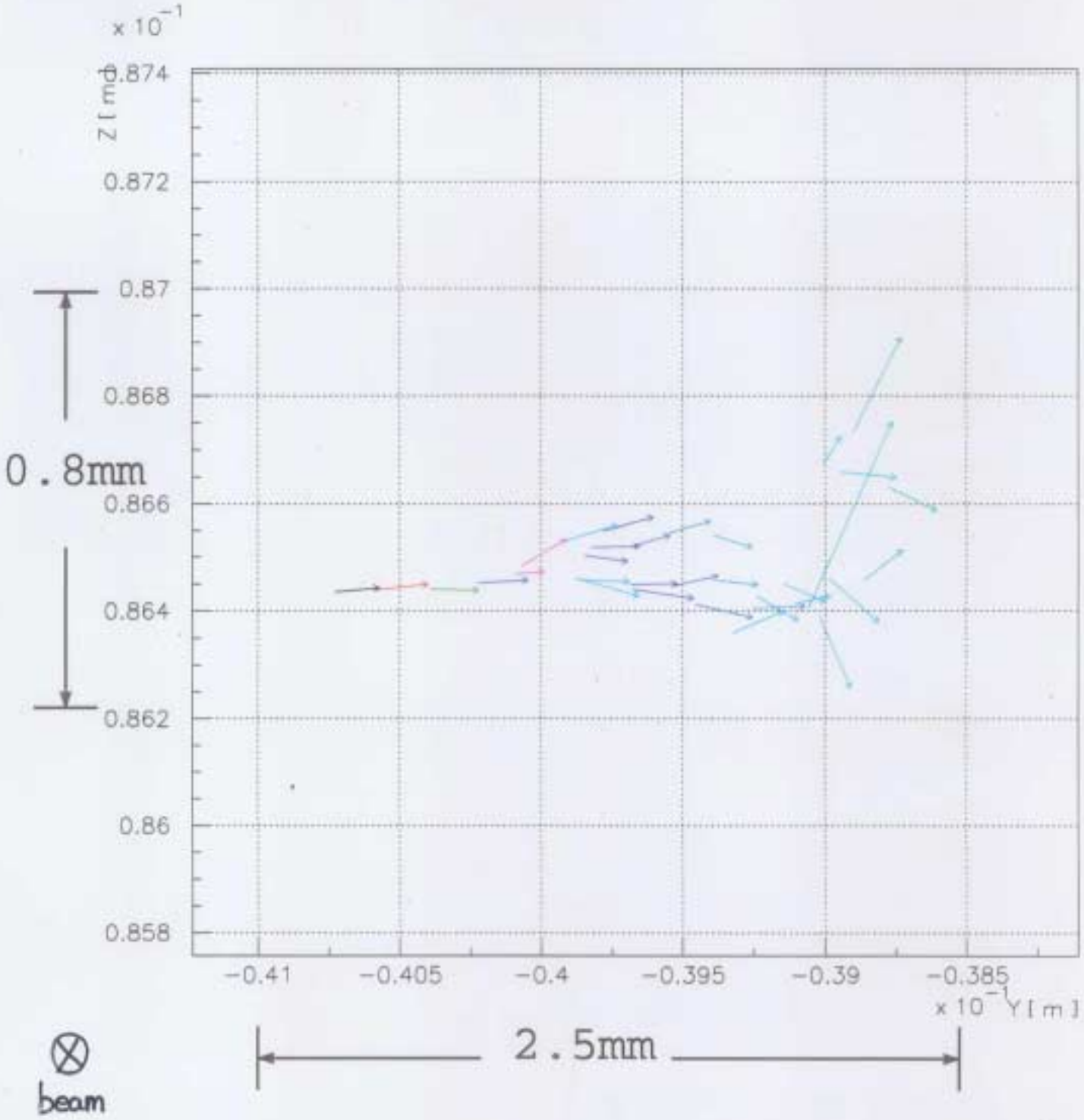
Momentum	Classification	Number of events
2GeV/c		
	pair creation	118(72%)
	stopped	38(23%)
	penetrate	8(5%)
	Total	164(100%)

Stopped:

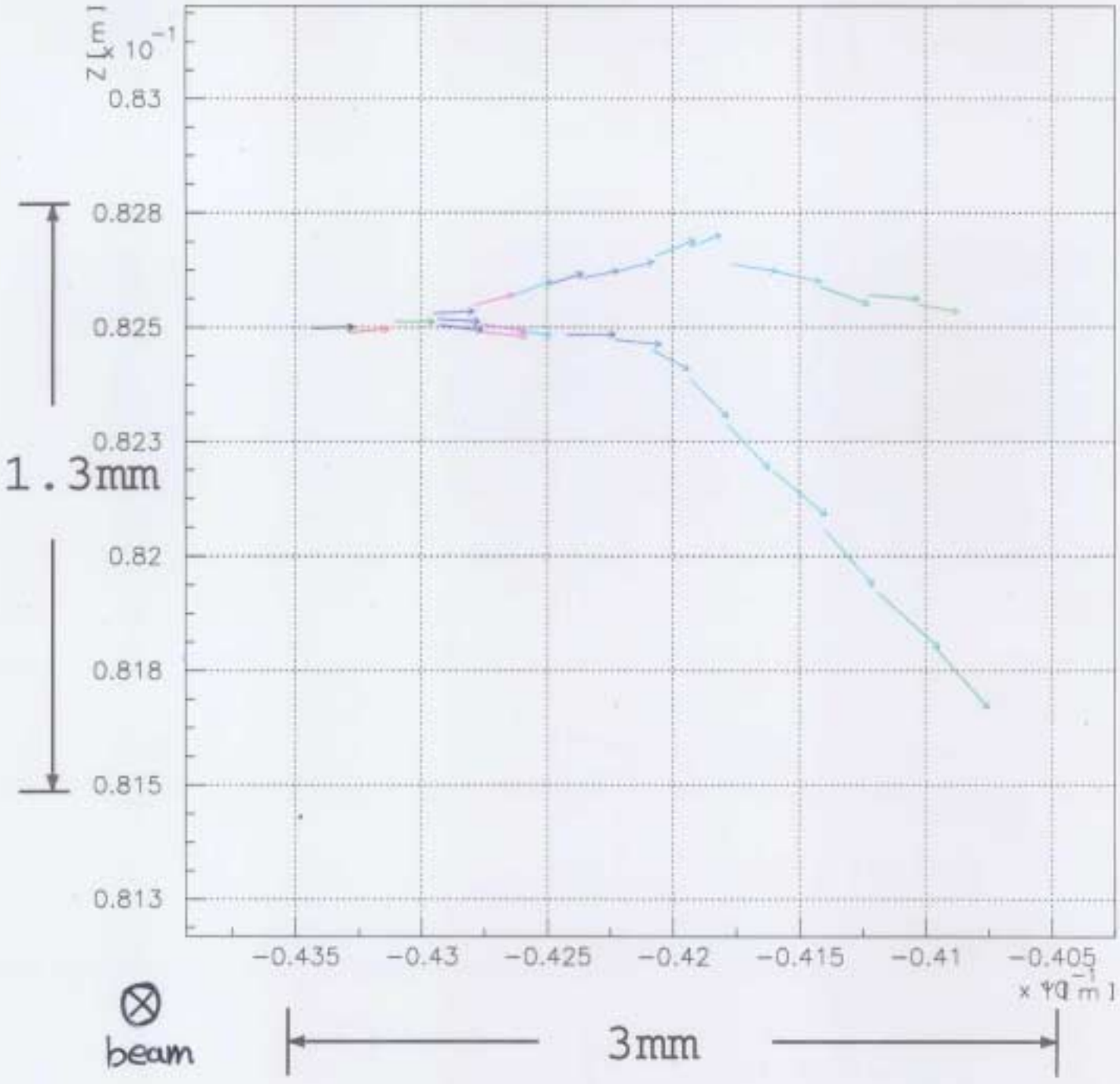
- Pair creation out of scanning volume.



Event 102


x 10^-1
Z [m]
0.874
0.872
0.87
0.868
0.866
0.864
0.862
0.86
0.858
0.8mm
-0.41
-0.405
-0.4
-0.395
-0.39
-0.385
x 10^-1 Y [m]
2.5mm
beam

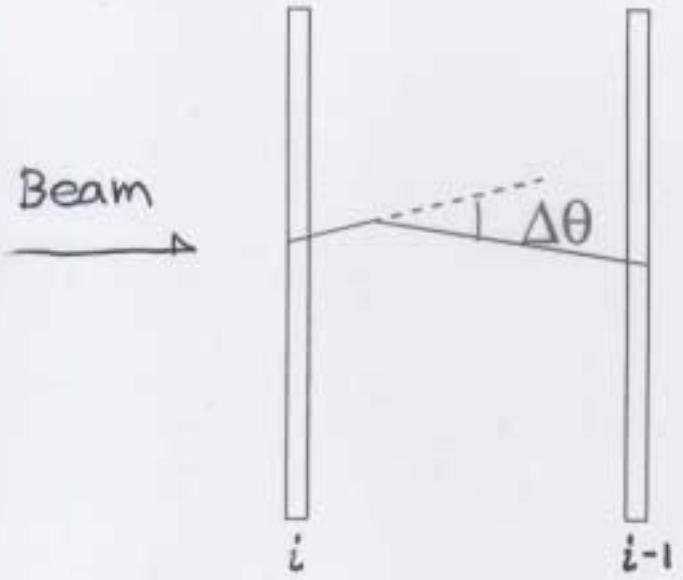
Event 45


Z [m]
x 10^-1
0.83
0.828
0.825
0.823
0.82
0.818
0.815
0.813
1.3mm
−0.435
−0.43
−0.425
−0.42
−0.415
−0.41
−0.405
beam
3mm

Electron ID using scattering

Calculate angle difference each plate.

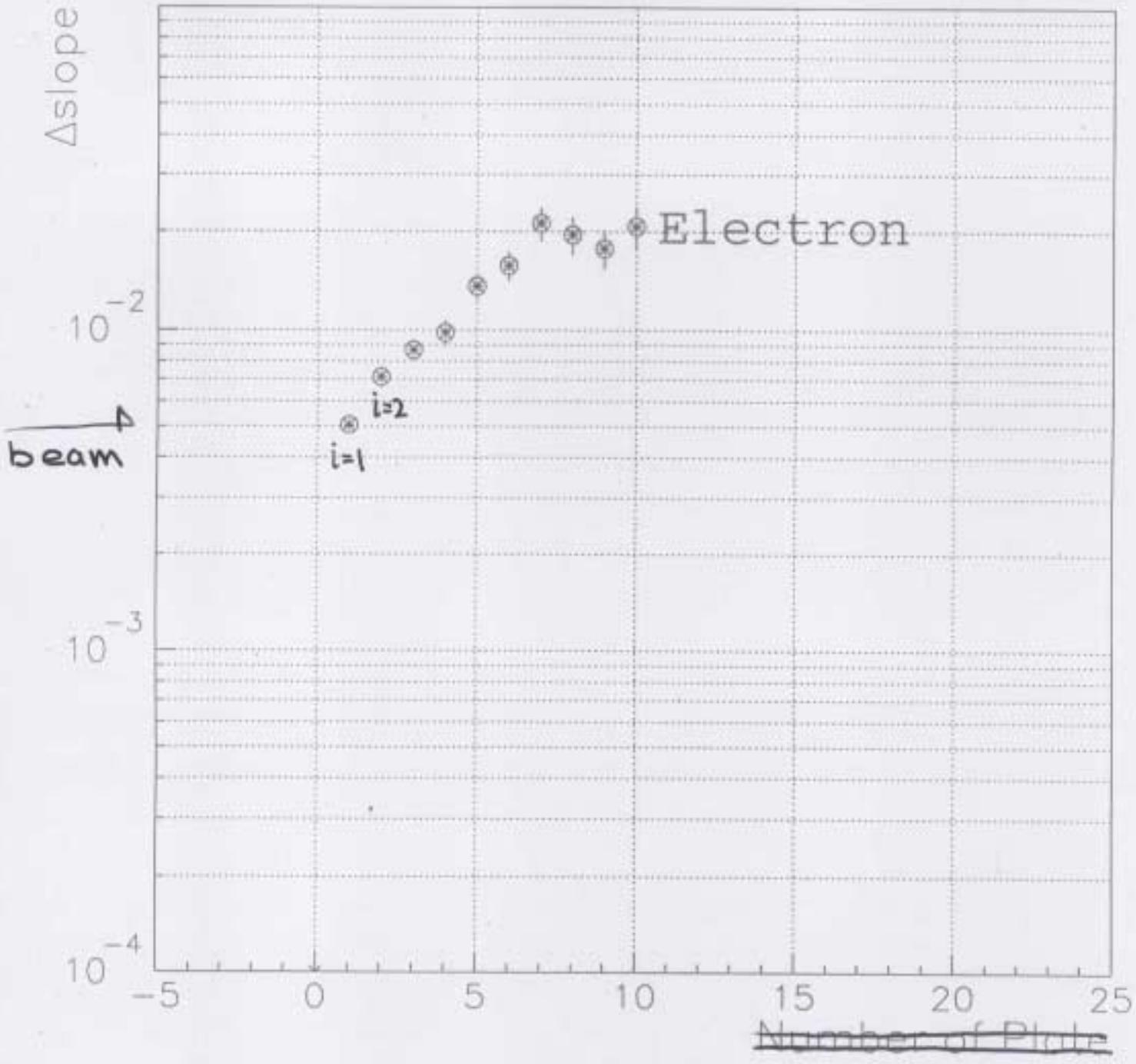
- electron sample(2GeV/c, SPring-8,BL33LEP)
- pion sample(4GeV/c, KEK, π2 Beam Line)



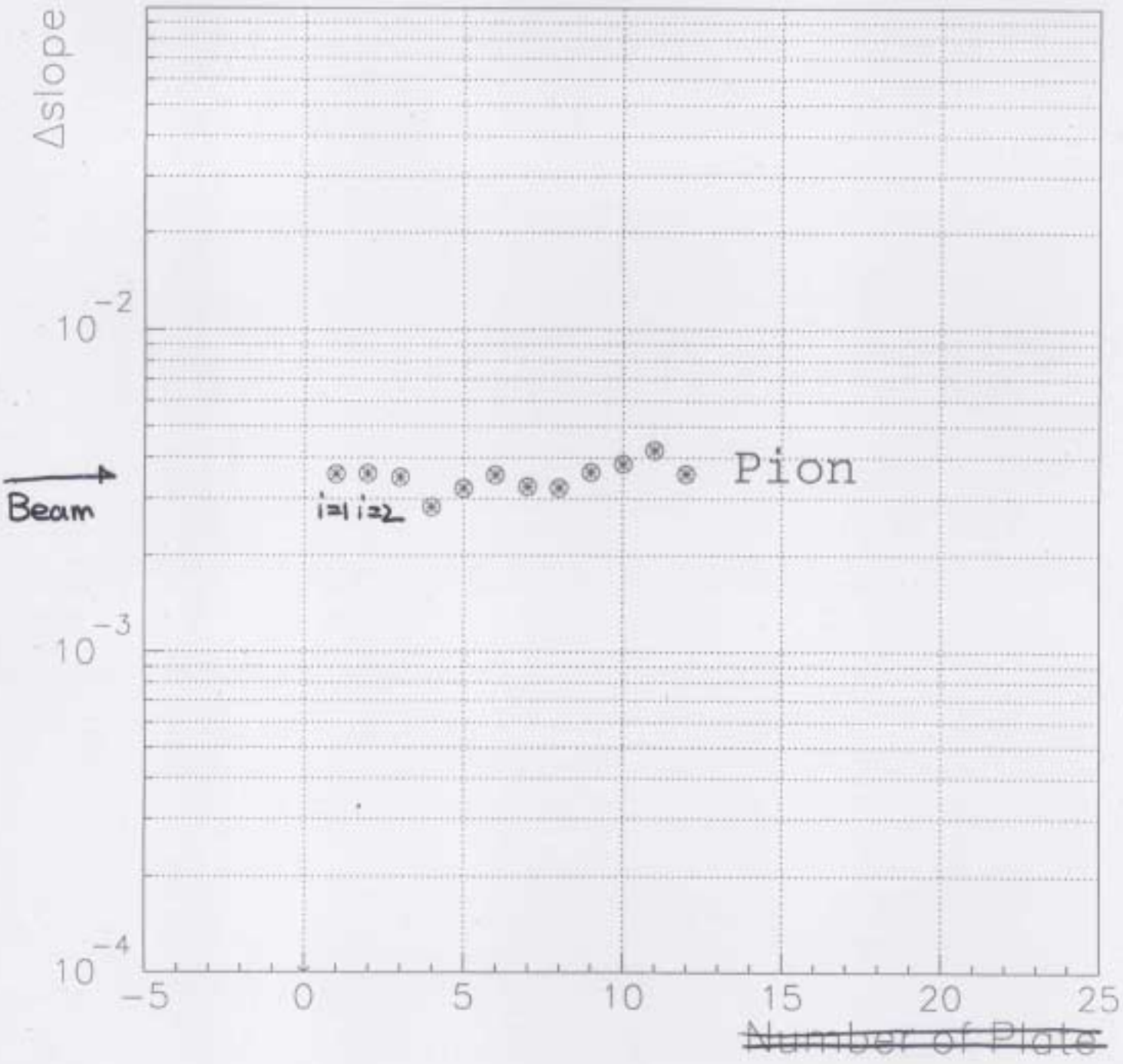
$$\Delta\theta_y = \theta_{y,i-1} - \theta_{y,i}$$
$$\Delta\theta_z = \theta_{z,i-1} - \theta_{z,i}$$

$$\Delta Slope_i = \sqrt{\frac{\sum(\Delta\theta_y^2 + \Delta\theta_z^2)}{2N}}$$

Electron


Δslope
10^{-2}
10^{-3}
10^{-4}
Electron
i=2
i=1
beam
−5
0
5
10
15
20
25
Number of Plate

Pion


Δslope
10^{-2}
10^{-3}
10^{-4}
Beam
i=1 i=2
Pion
−5
0
5
10
15
20
25
Number of Plate

Conclusions

* Low energy, 2.0,1.0,0.5,0.25 GeV/c, electron behavior in ECC bricks was studied using electron beam at BL33LEP of SPring-8.

* Electron beam quality:
  Density: 231[tracks/cm^2]
  B.G. contamination: 1.9[tracks]
  parallelity: $\leq$ 5[mrad]

* Track segments within 71[mm^2] $\times$ 24 plates induced by the electron beam was fully obtained by using UTS.

* Electron tracks and associated electron pair creation were clearly identified after alignment.

* Scattering behavior of electrons was measured and compared to the one of pions

Acknowledgement

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for his help and support

during emulsion handling.