

Automatic scanning for cosmic-ray electron observation

Y. Sato (Utsunomiya Univ.),

T. Kobayashi, J. Nishimura, Y. Komori and K. Yoshida
(Aoyama Gakuin Univ., ISAS, Kanagawa P.C., Kanagawa Univ.)

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Outline

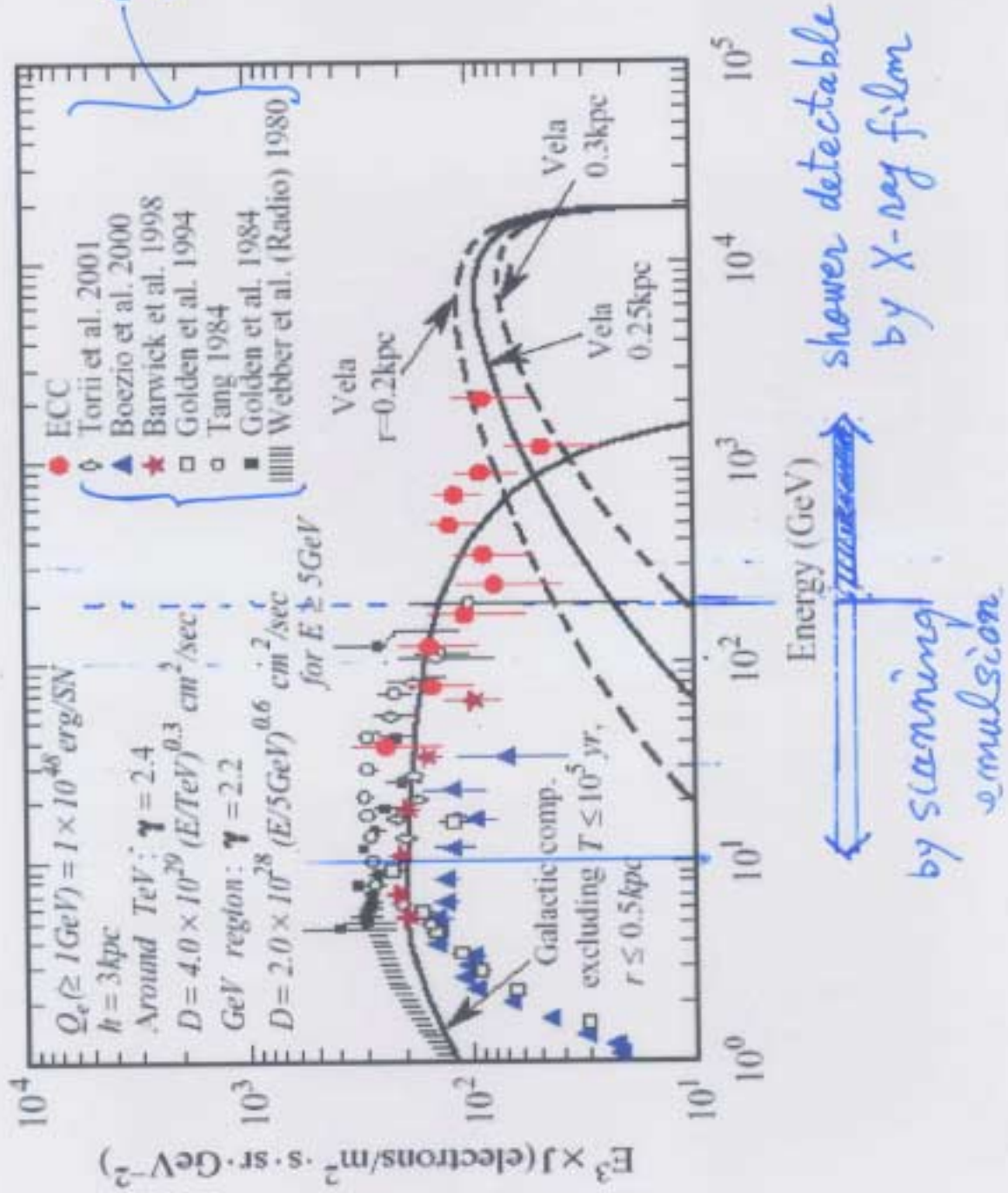
- Motivation
- Study of NTS basic characteristic
- Pilot scanning of balloon ECC
- Summary and outlook

Motivation

- Energy spectrum of electrons have no high statistics below 200GeV observed by ECC.
- To detect showers less than 200GeV needs automatic scanning emulsion.
- High energy showers $>200\text{GeV}$ in ECC are detectable by X-ray film.

Differential energy spectrum of electrons

T. Kobayashi et al. (2001)



Study of NTS basic characteristic

- Test experiment
- Pulse height distribution vs. gain
- Pulse height distribution vs. incident angle
- Pulse height distribution vs. azimuth
- Scanning efficiency

Automatic scanning system at Utsunomiya Univ.
(MTA)

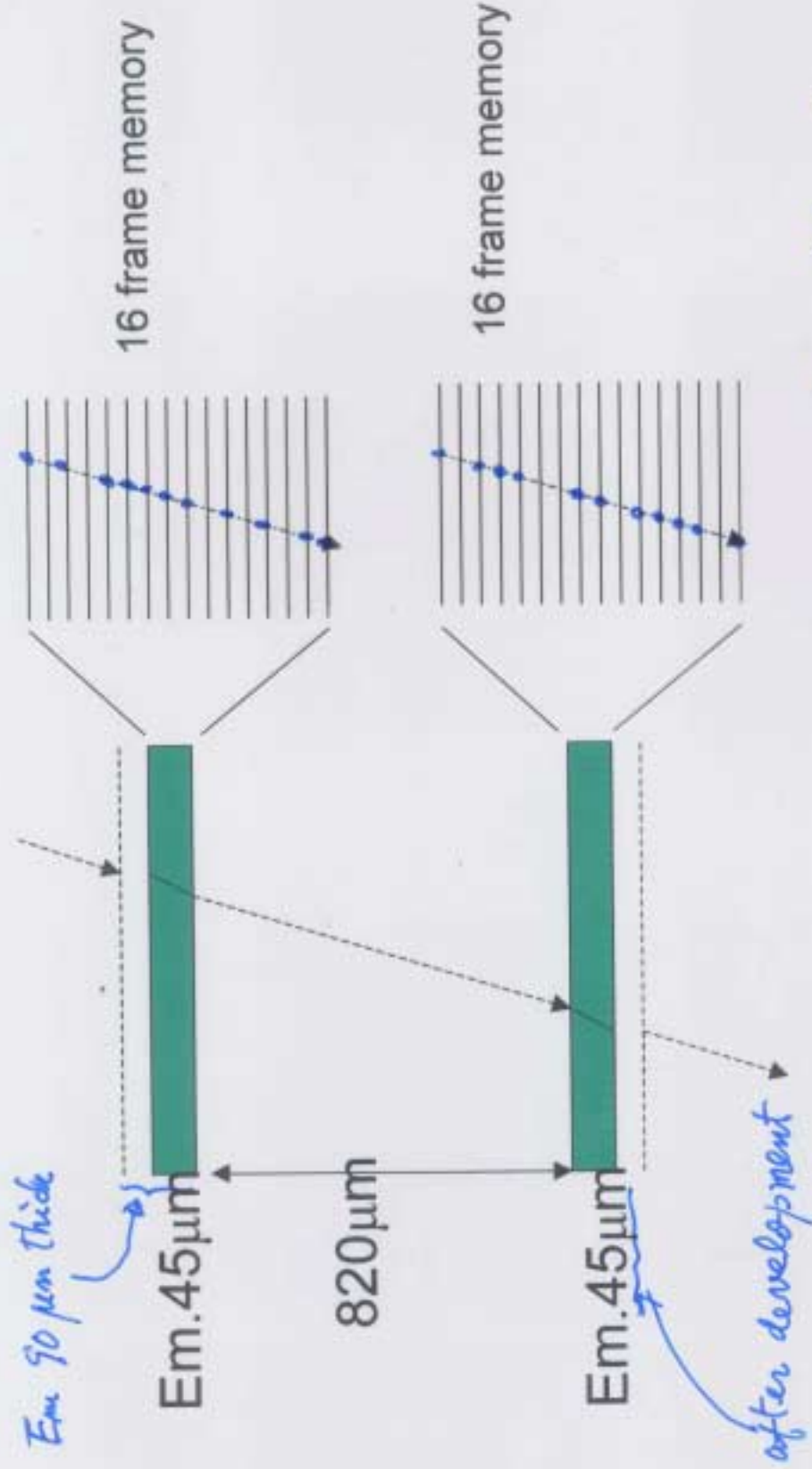


Temperature and humidity in this room is
stabilized: $23 \pm 0.2^{\circ}\text{C}$, $62 \pm 2\%$

Test experiment

- 200MeV electron at Tohoku Univ. (9/8-12/2001)
- Density: $10^4/\text{cm}^2$
- Incident angle vertical to emulsion
 $\tan \theta = 0.02, 0.08, 0.15, 0.20, 0.25, 0.30,$
 $0.35, 0.40, 0.45, 0.50, 0.55$
- Chamber structure: 4 emulsion plates
- $800 \mu\text{m}$ base + $90 \mu\text{m}$ emulsion on both sides
- Nuclear emulsion: Fuji ET-7D

Track selector



Pulse height = number of hit on frame memory

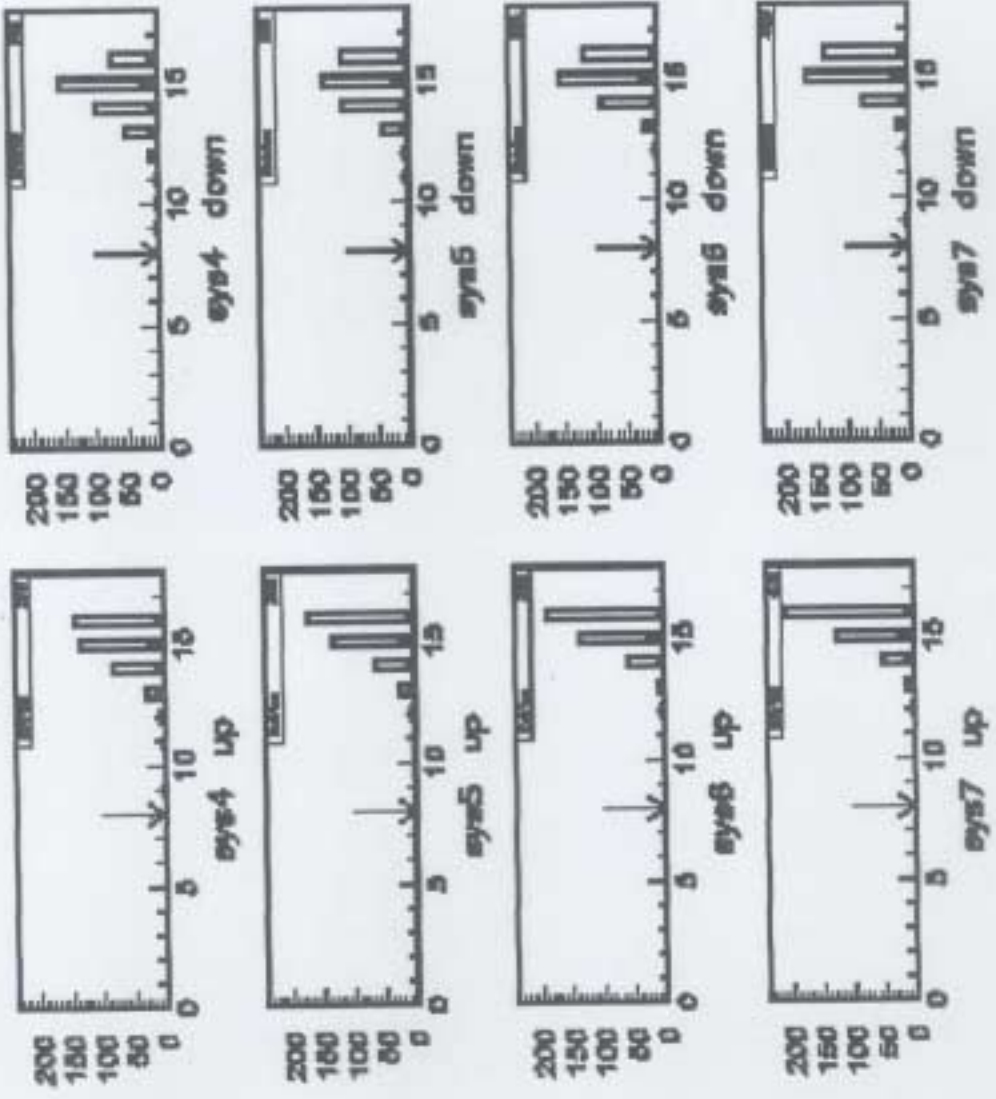
16 ~ 0

Pulse height distribution vs. Gain

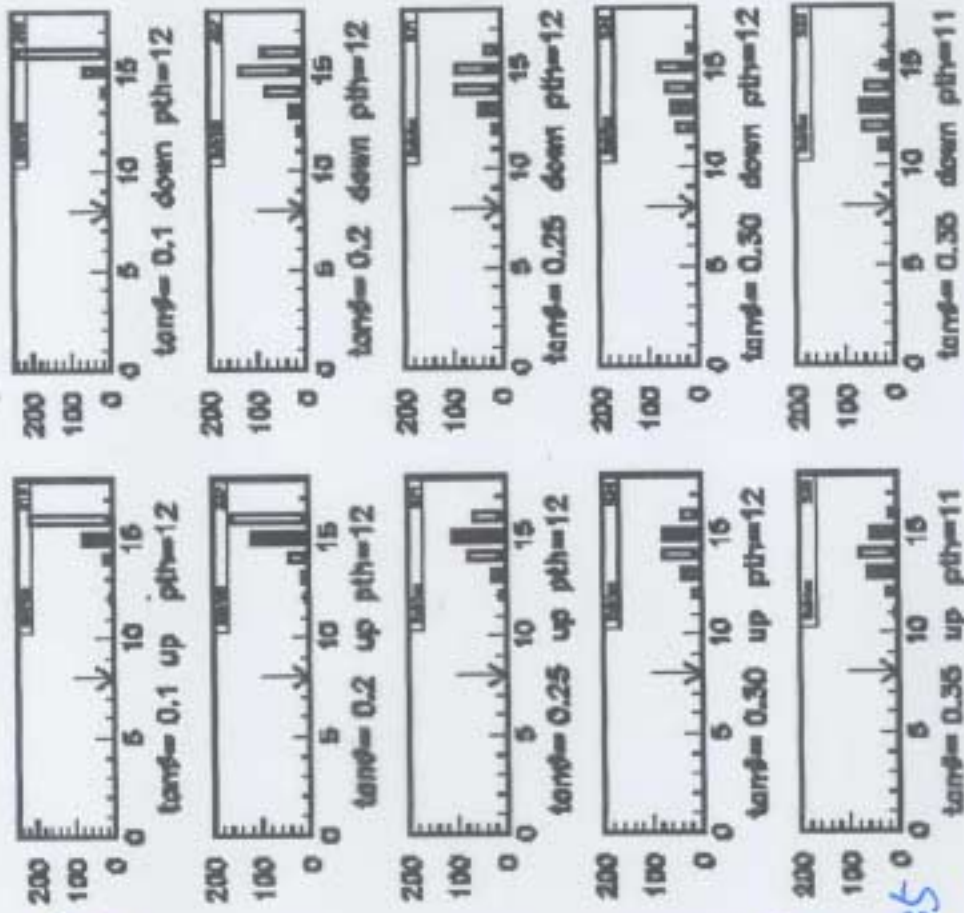
system.prm tan θ =0.1

low gain

high gain



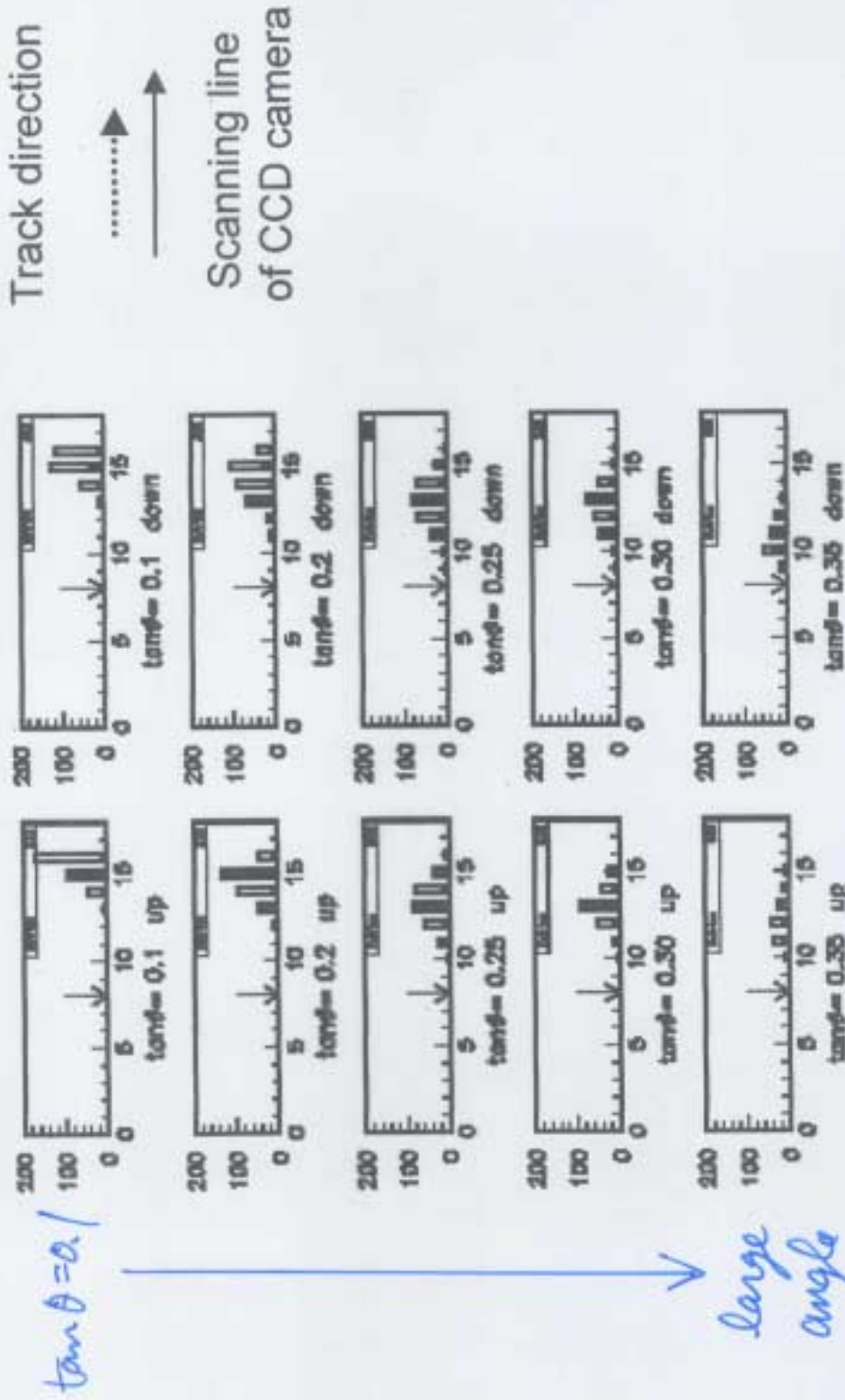
Pulse height distribution vs. Angle



$\tan\theta = 0.1$

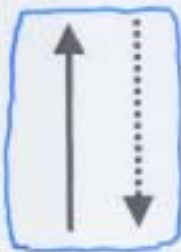
$\tan\theta = 0.35$

Pulse height distribution vs. Angle

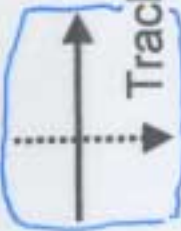


$\tan\theta = 0.35$

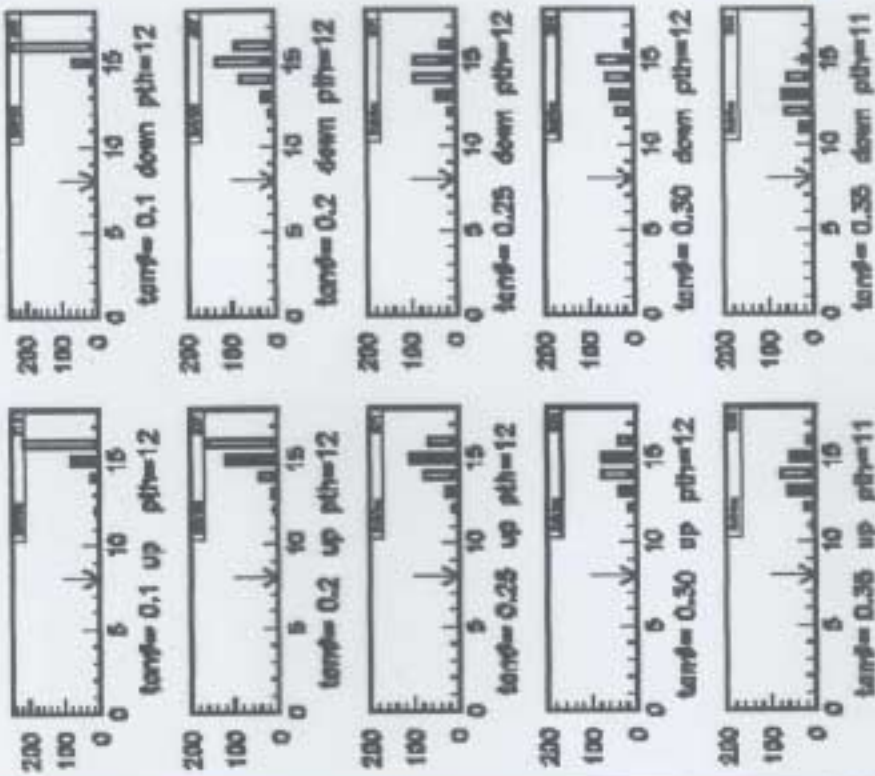
Pulse height distribution



Scanning line of CCD camera
Track direction



Track direction

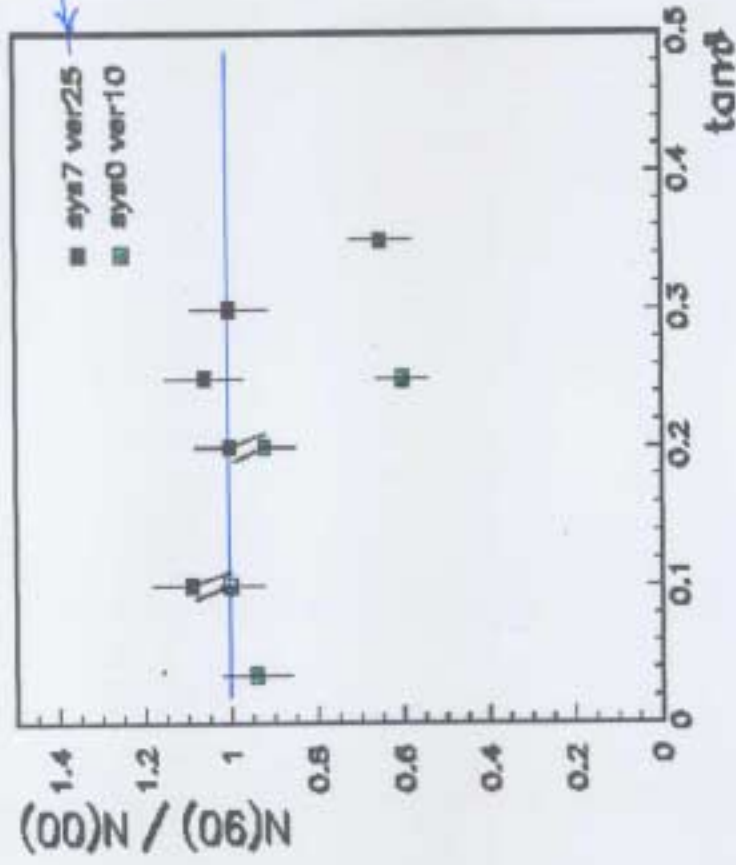


$\tan \theta = 0$

$\tan \theta = 90$

Comparison \leftarrow gain high \rightarrow

Scanning efficiency vs. incident angle



N(90): number of tracks parallel to CCD scanning line

N(00): number of tracks vertical to CCD scanning line

Summary

- Scanning efficiency

$$N(90)/N(00) \approx 1.0 \quad \text{for } 0.0 < \tan \theta < 0.3$$

$N(90)$: number of tracks parallel to CCD scanning line

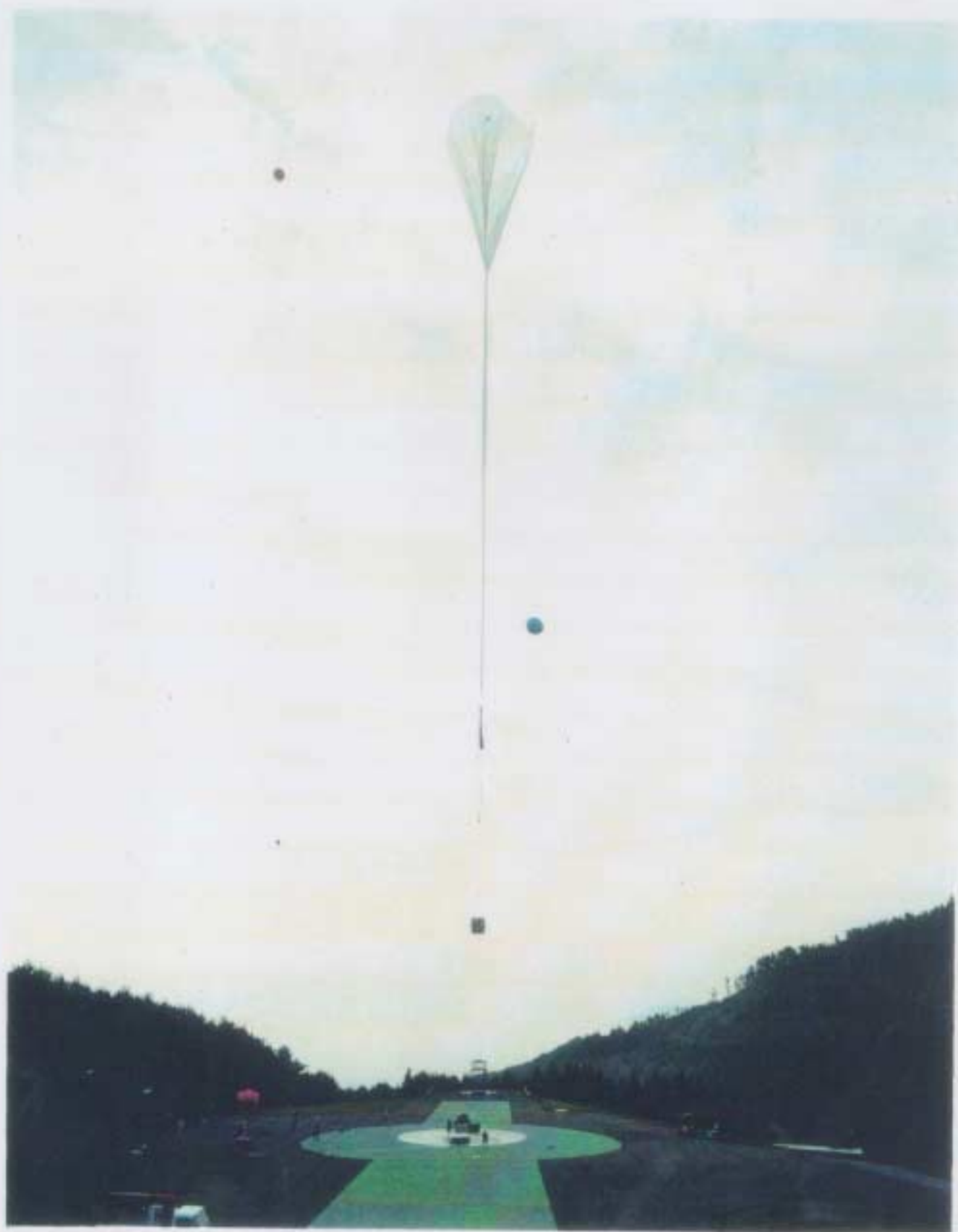
$N(00)$: number of tracks vertical to CCD scanning line

Pilot scanning of balloon ECC

- Balloon flight
- Emulsion chamber for cosmic-ray electrons observation
- General scanning
- Shower detection

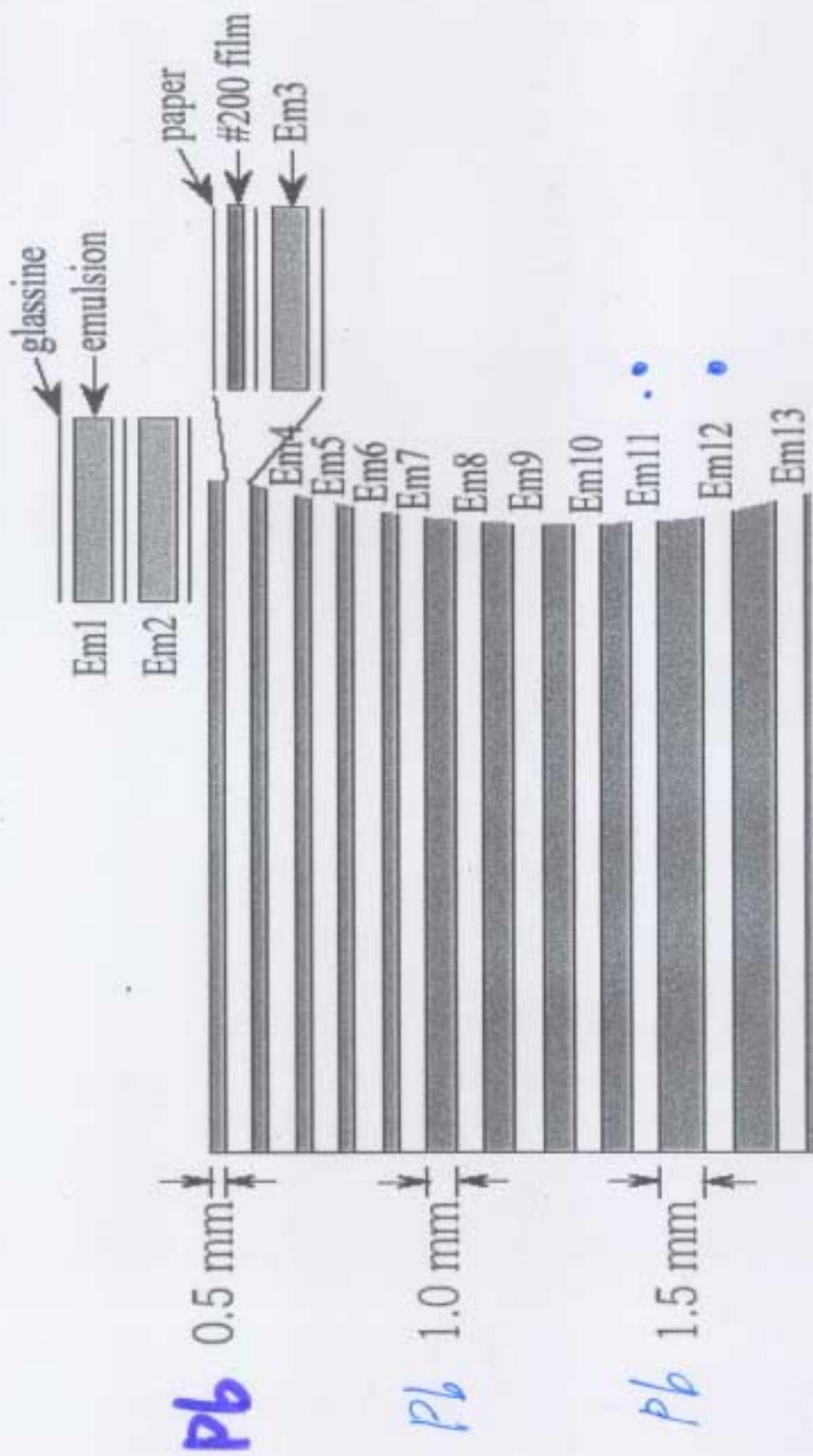


SANRIKU Balloon Flight Center 25-May-0



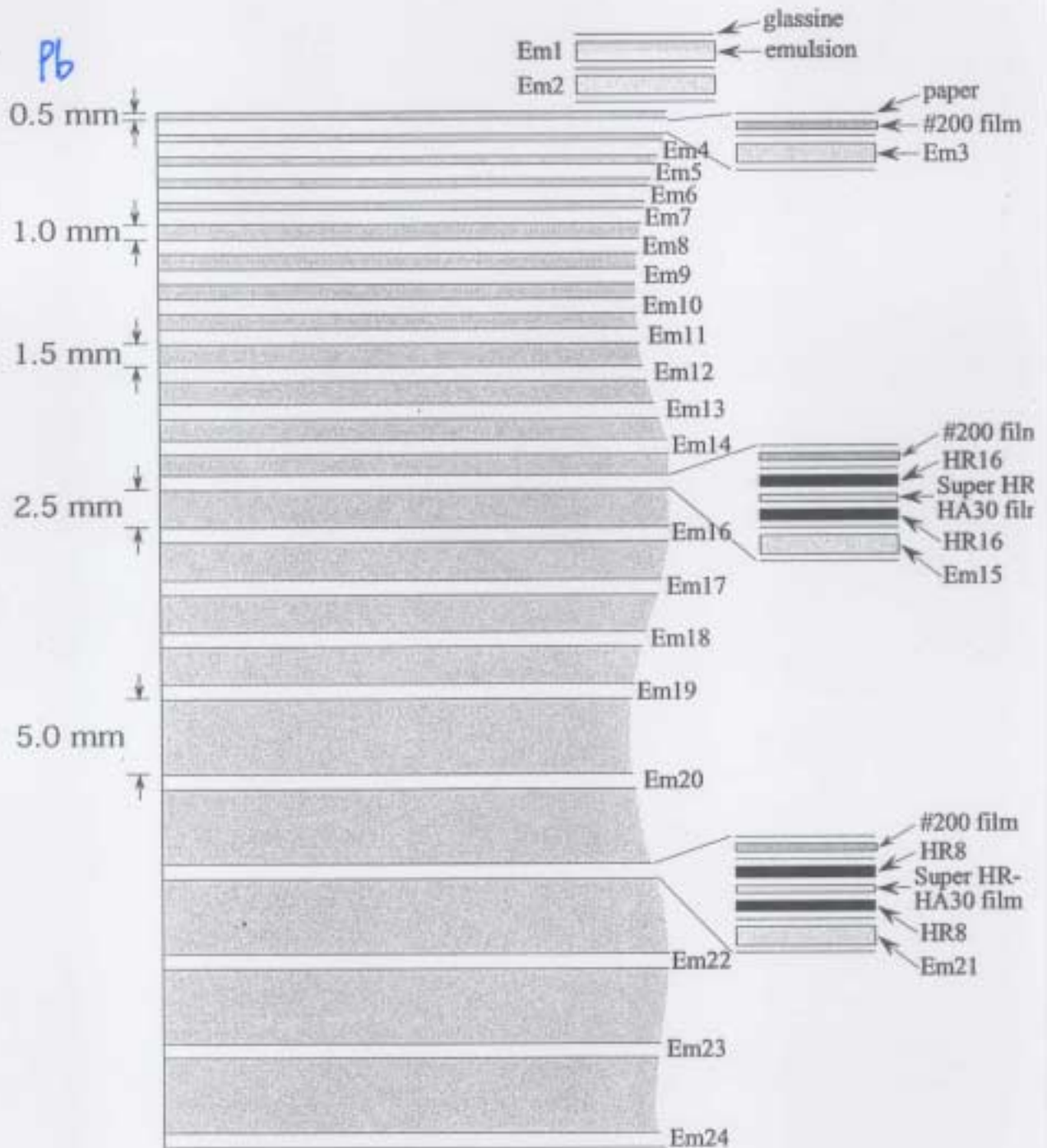
Altitude: 36.1 km (5.5 g/cm^2)
Flight Time: 18^h 28^m

Emulsion chamber configuration for 2001 flight



$\rho = 40 \text{ cm} \times 50 \text{ cm}$, Depth = 9 c.u. $W = 130 \text{ kg}$

Emulsion chamber configuration for 2001 flight



Size : 40cm x 50cm Depth : 9.1r.l. Weight : 130kg Emulsion : ET - 7D

#200 X-ray film : 0.1 ~ 9.1r.l.

HR16 screen + Super HR - HA30 film : 2.4 ~ 5.3r.l., 6 layers

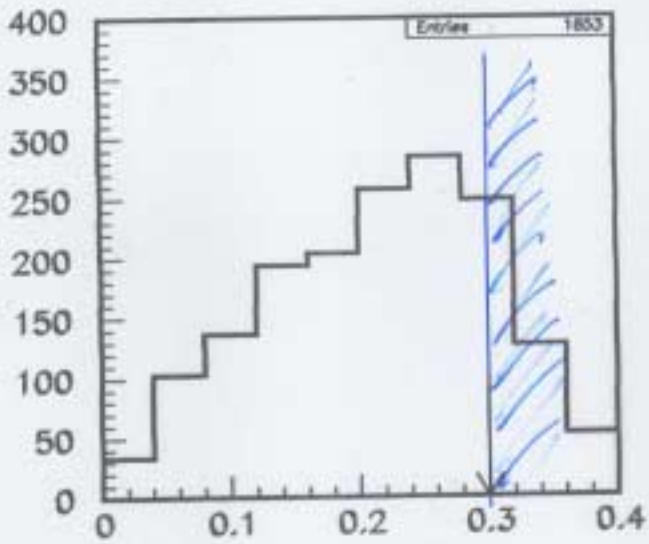
HR8 screen + Super HR - HA30 film : 6.3 ~ 9.1r.l., 4 layers

General scanning

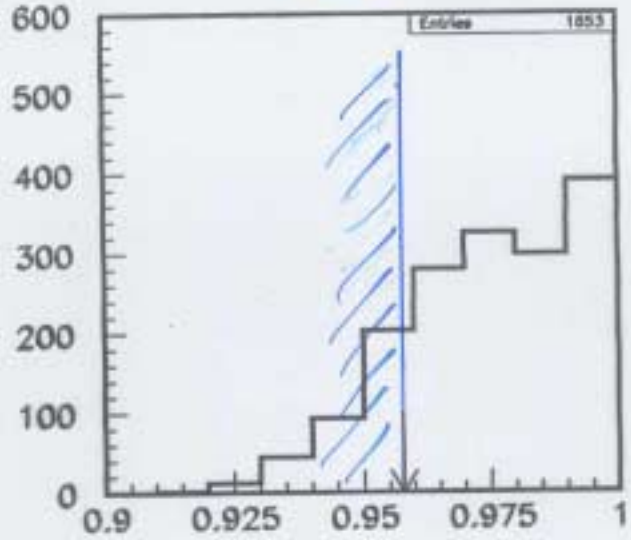
- 1640 tracks with $\tan \theta < 0.3$ are detected in the area of $6 \times 4.3 \text{ mm}^2$.
- It takes 6 hours to scan the area by NTS.
- To scan 1 cm^2 by NTS needs 1 days.

4.47 m_{GeV} \times 4.3 m_{GeV}

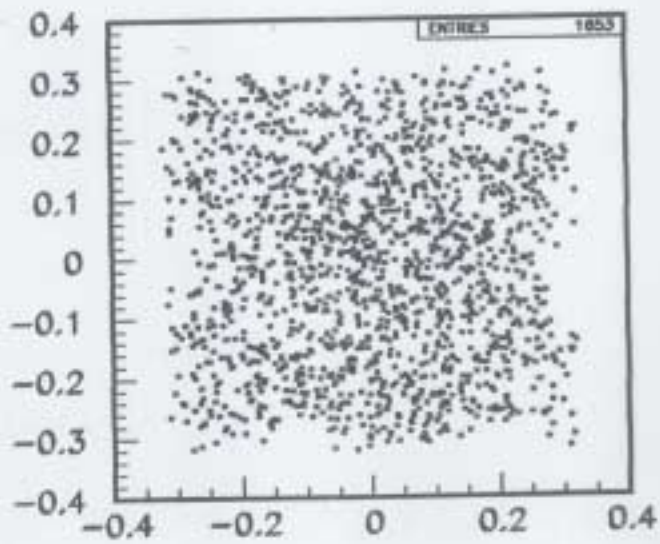
/ BEC01/tpl/gs/ $\tan\theta < 0.32$ / view=1849



$\tan\theta$

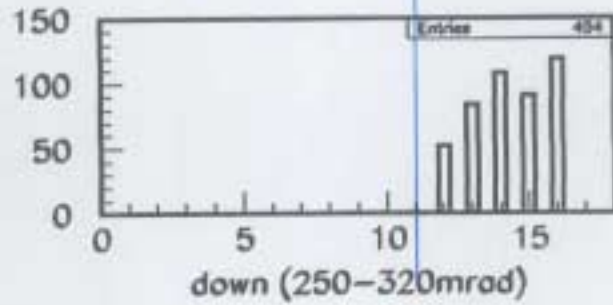
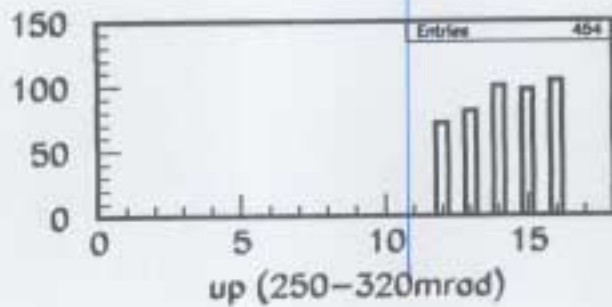
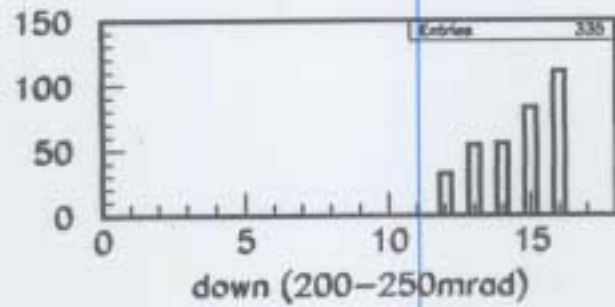
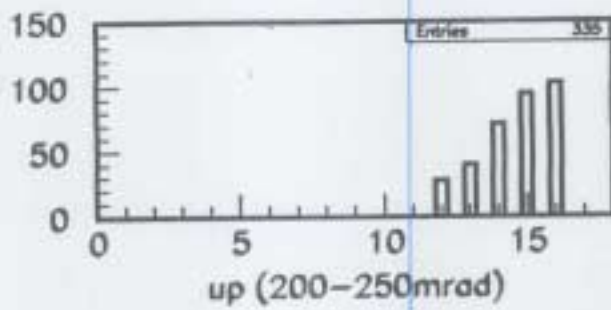
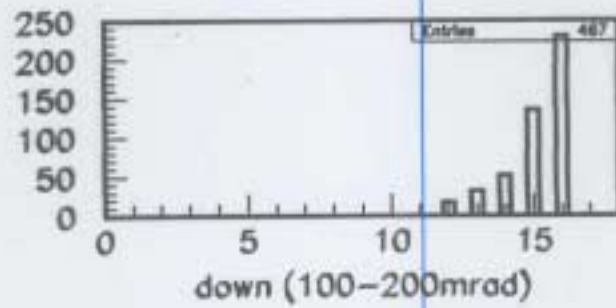
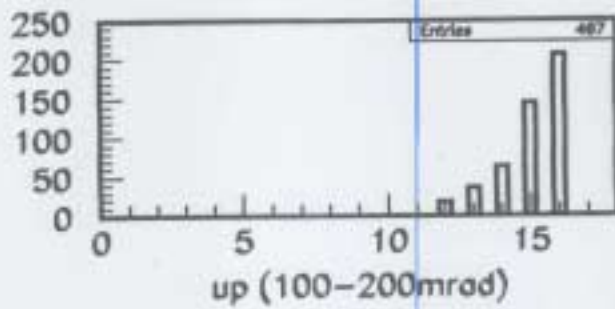
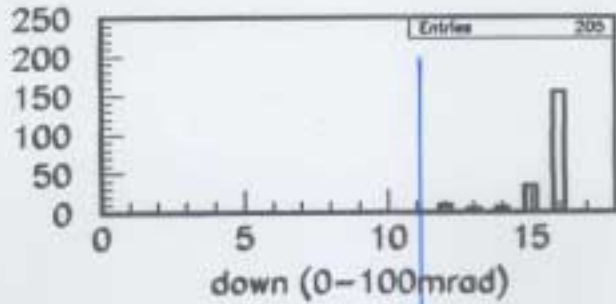
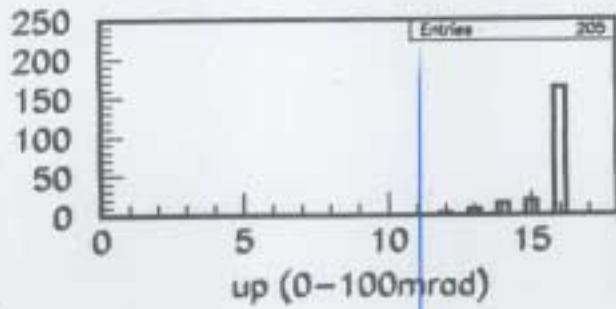


$\cos\theta$



$\tan\theta_z$ vs. $\tan\theta_y$

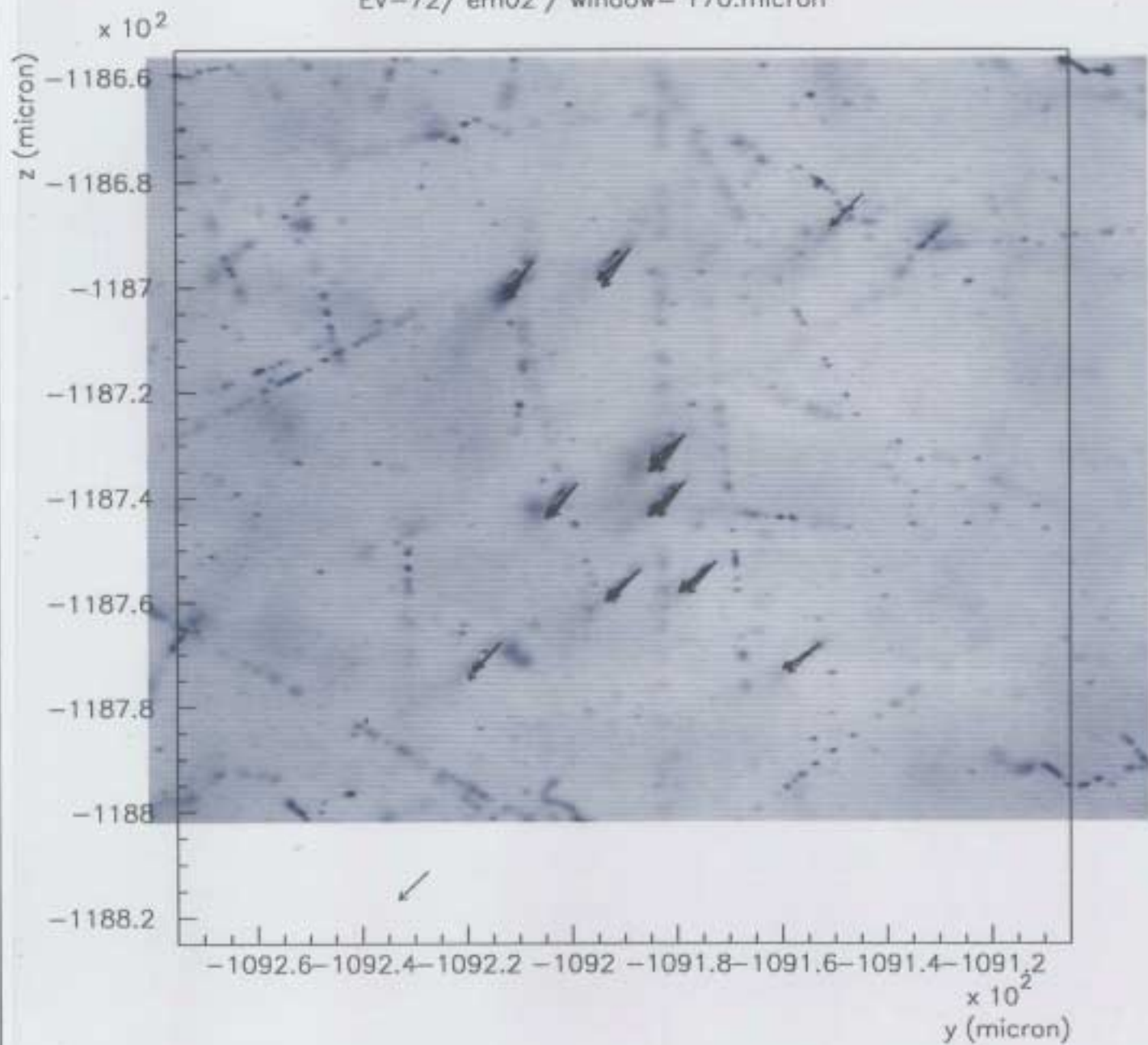
/ BEC01/tpi/gs/ tan θ <0.32 / vw= 1849 /



Shower detection

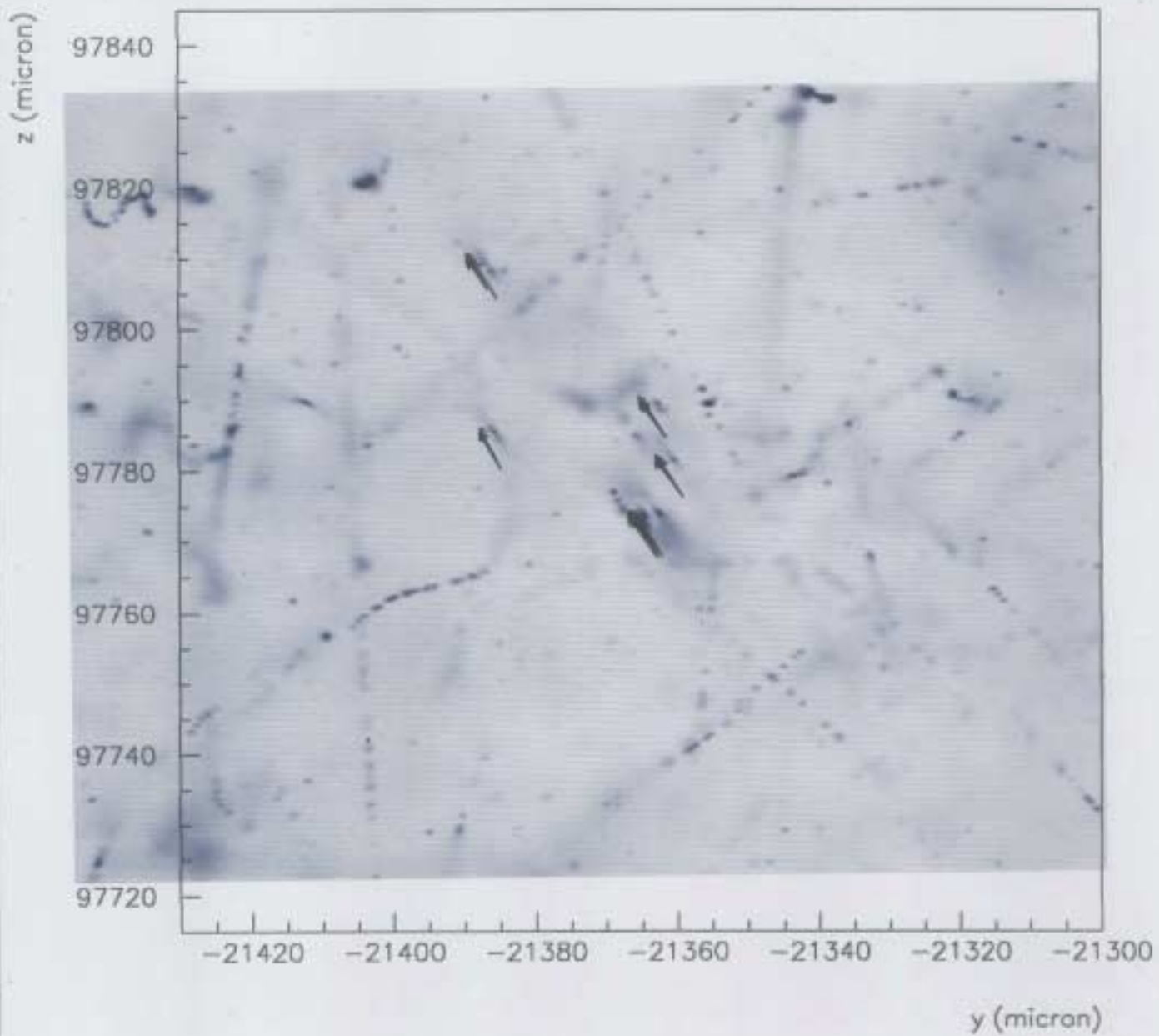
Ev-72-02d-g

EV-72/ em02 / window= 170.micron



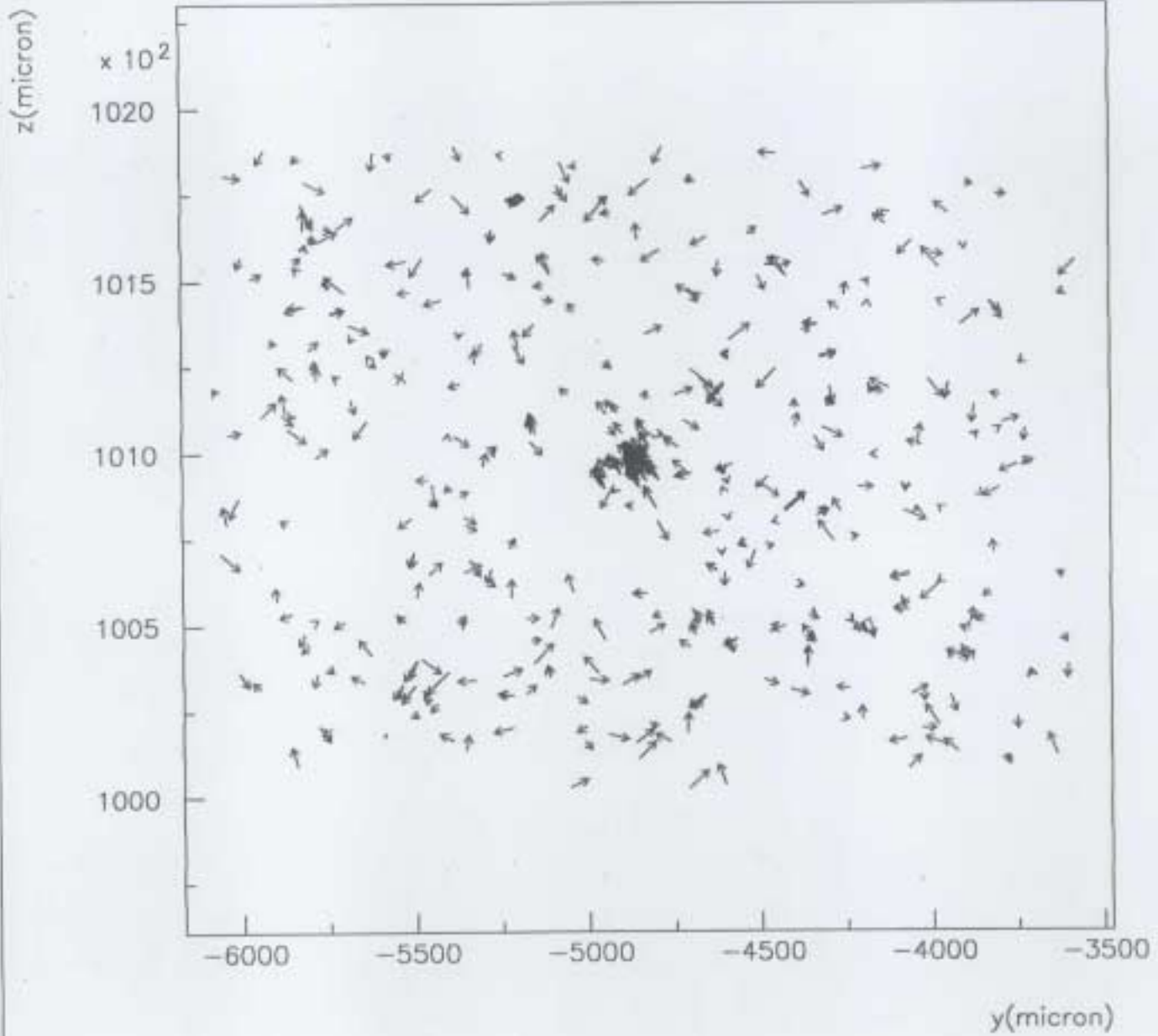
Ev-178-10u-g

EV-178 /em10 / window= 130.micron

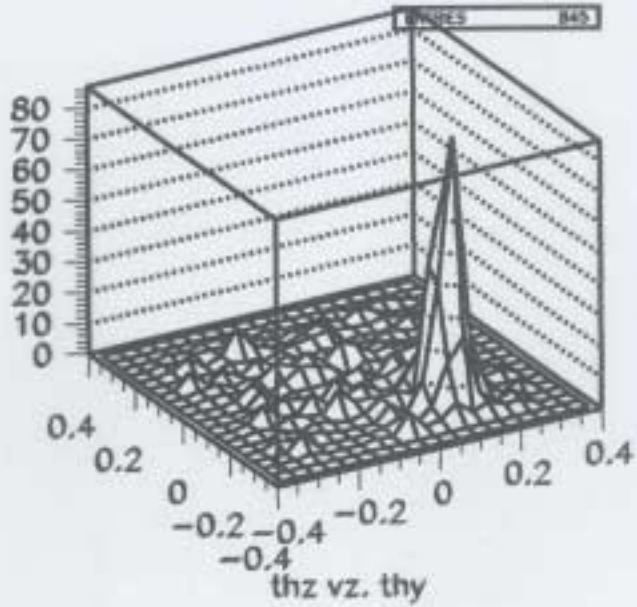
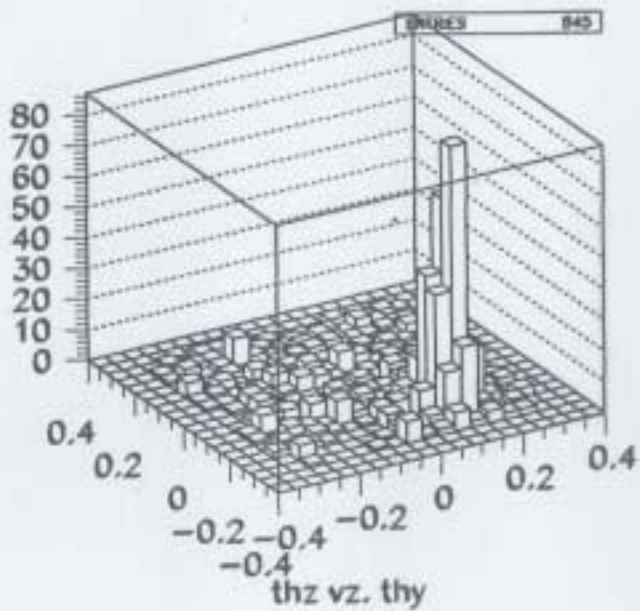
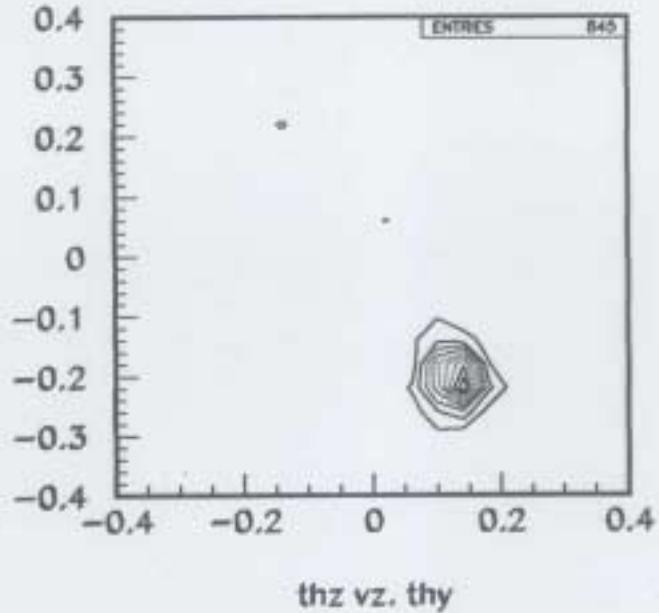
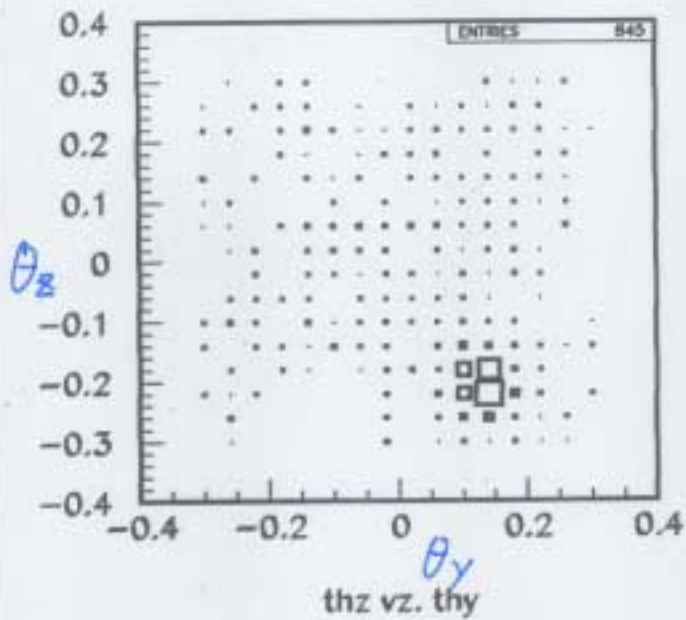


2.94 mm x 2. / mm

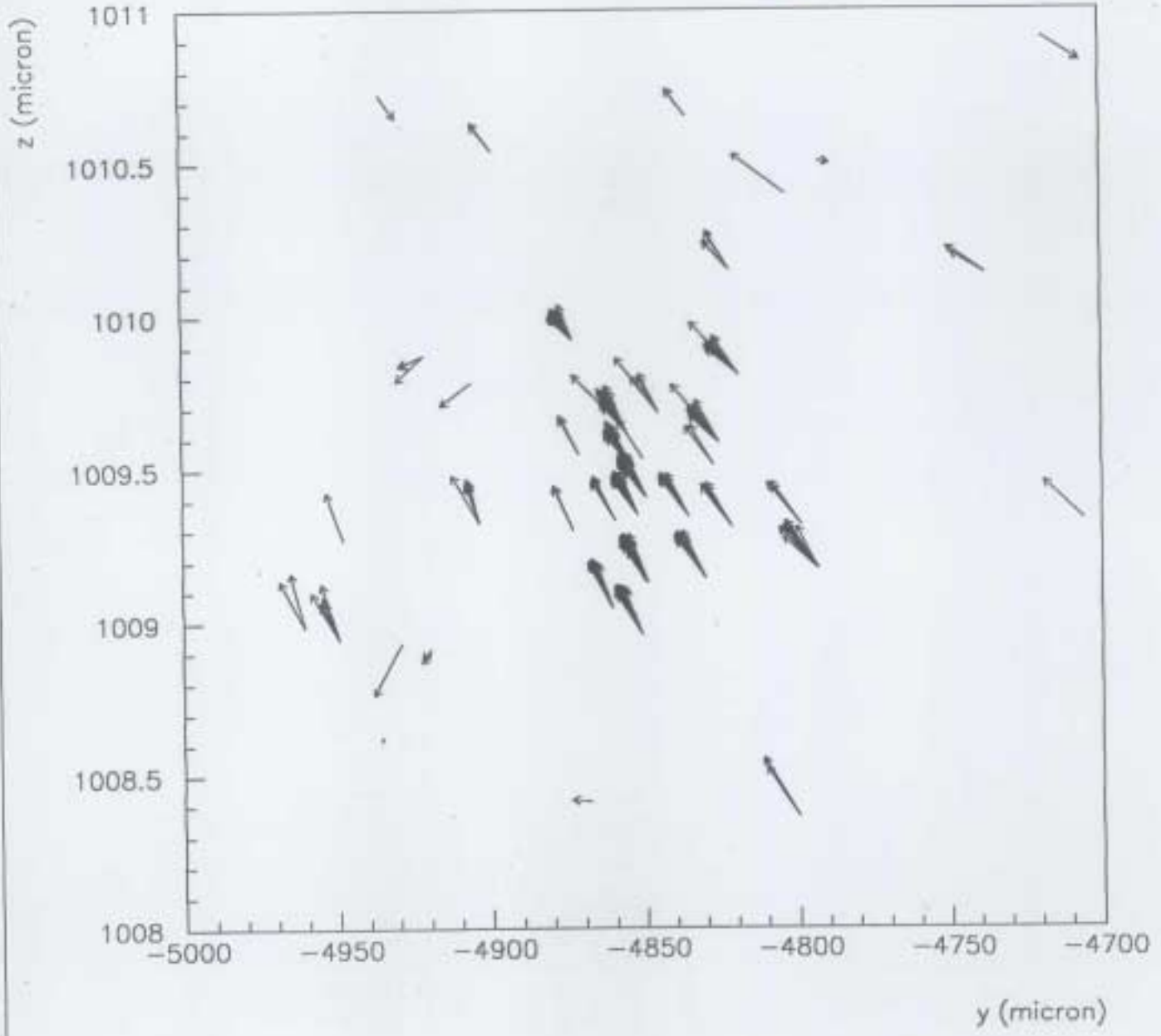
/ BEC01 / em13 / gs / vw=441 / track= 845



/em13 / ev178 / view=441 /



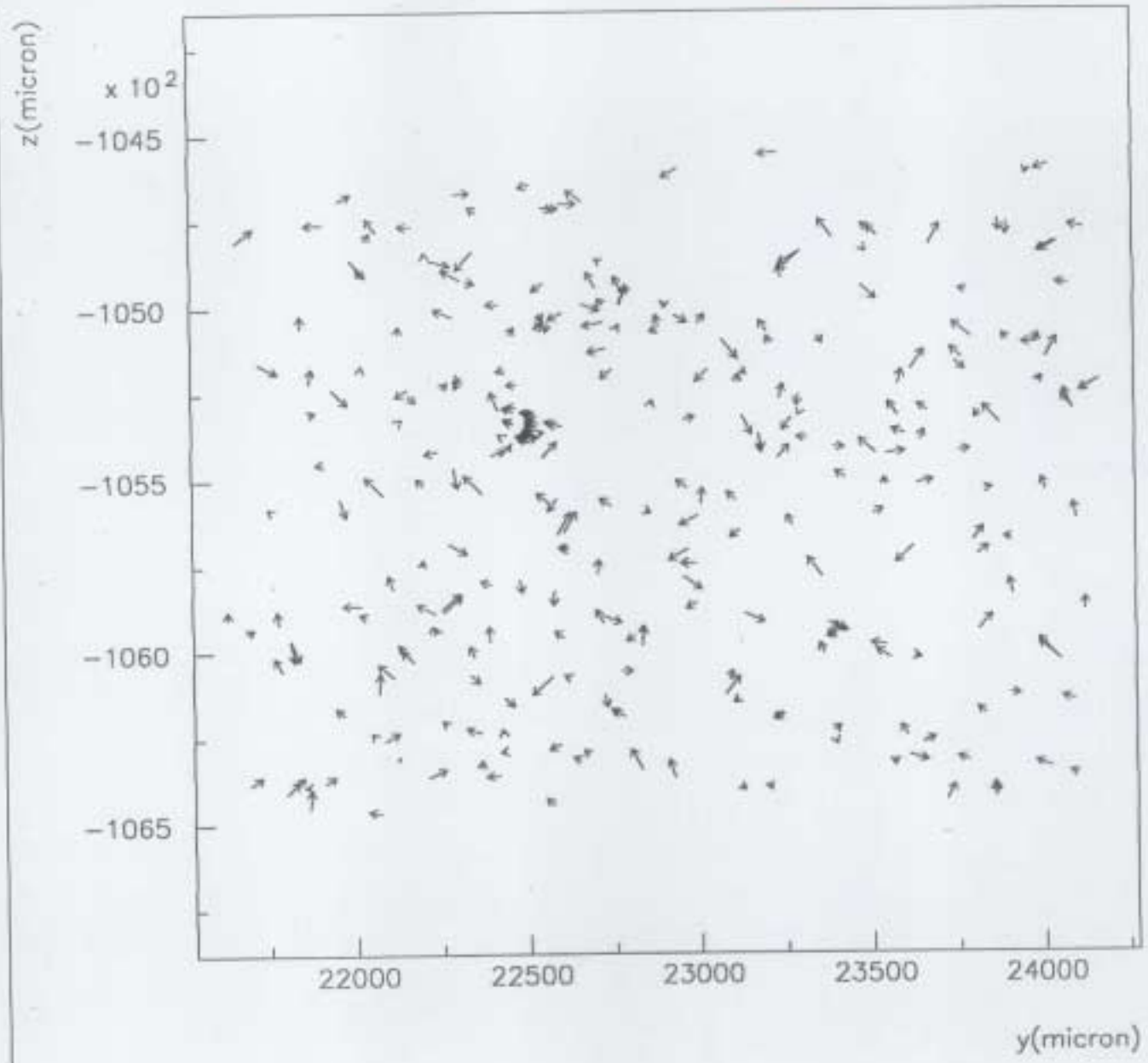
/em13 /ev178/ window=300. *flow*



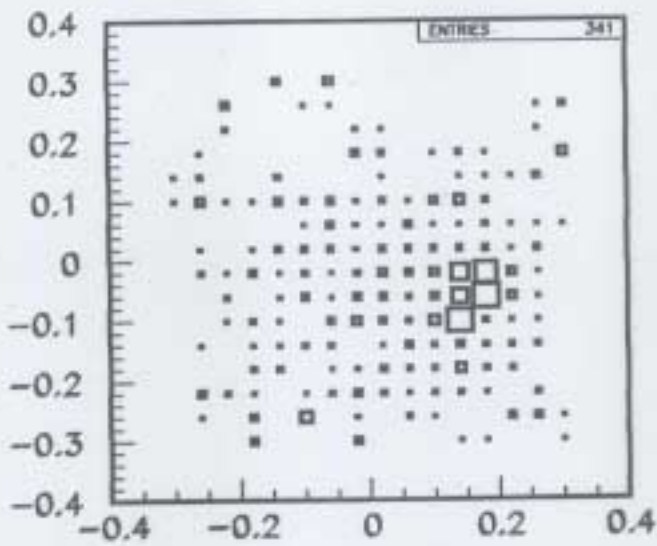
2.94 mm x 2.1 um

z2/03/08 02.53

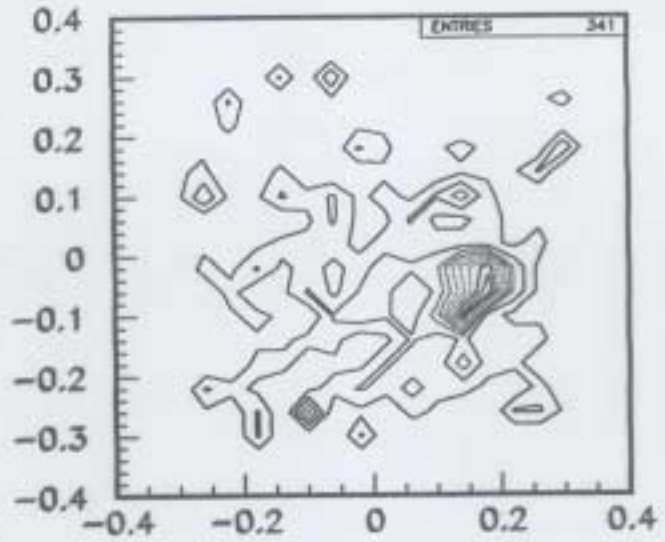
/em02 / a307 / gs / vw=441



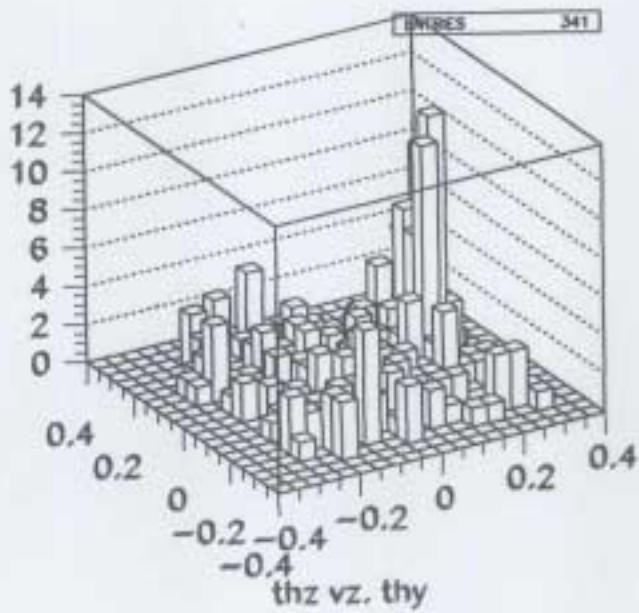
/em02/ a307 /gs/ view=441 /



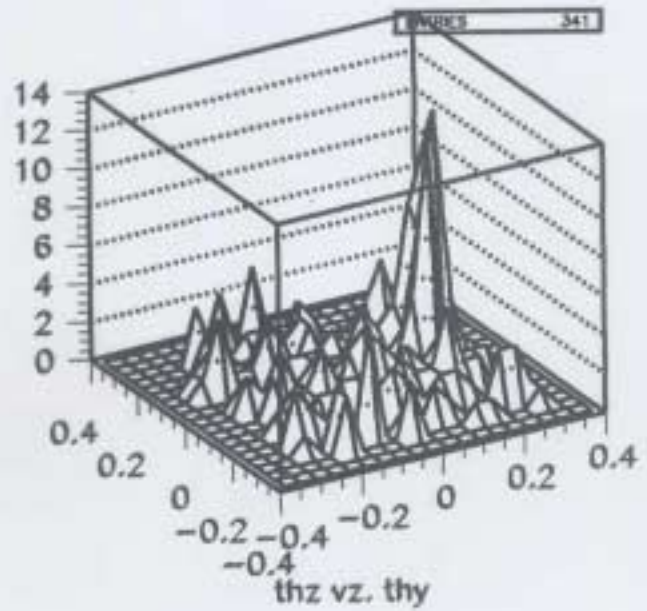
thz vz. thy



thz vz. thy

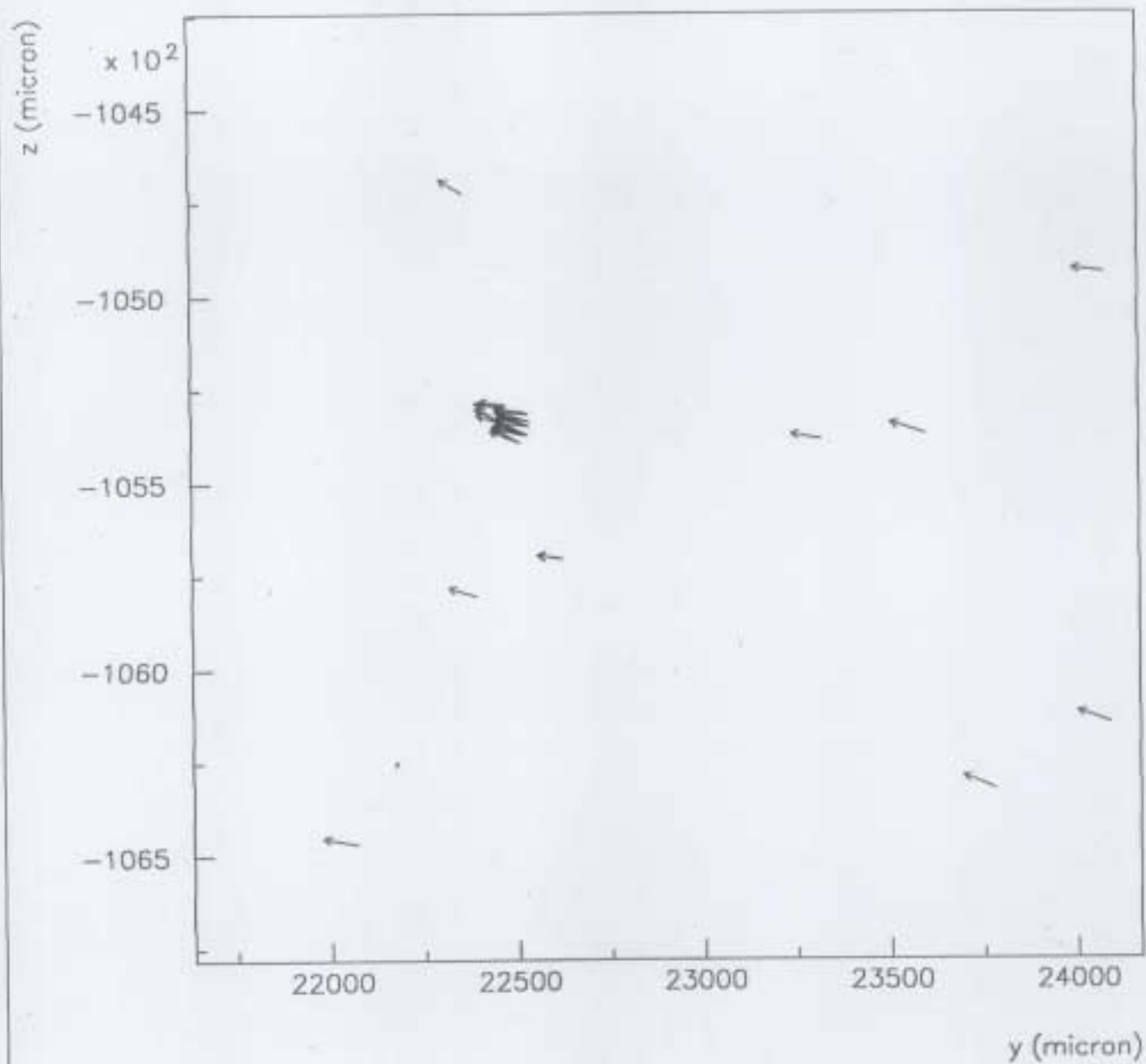


thz vz. thy



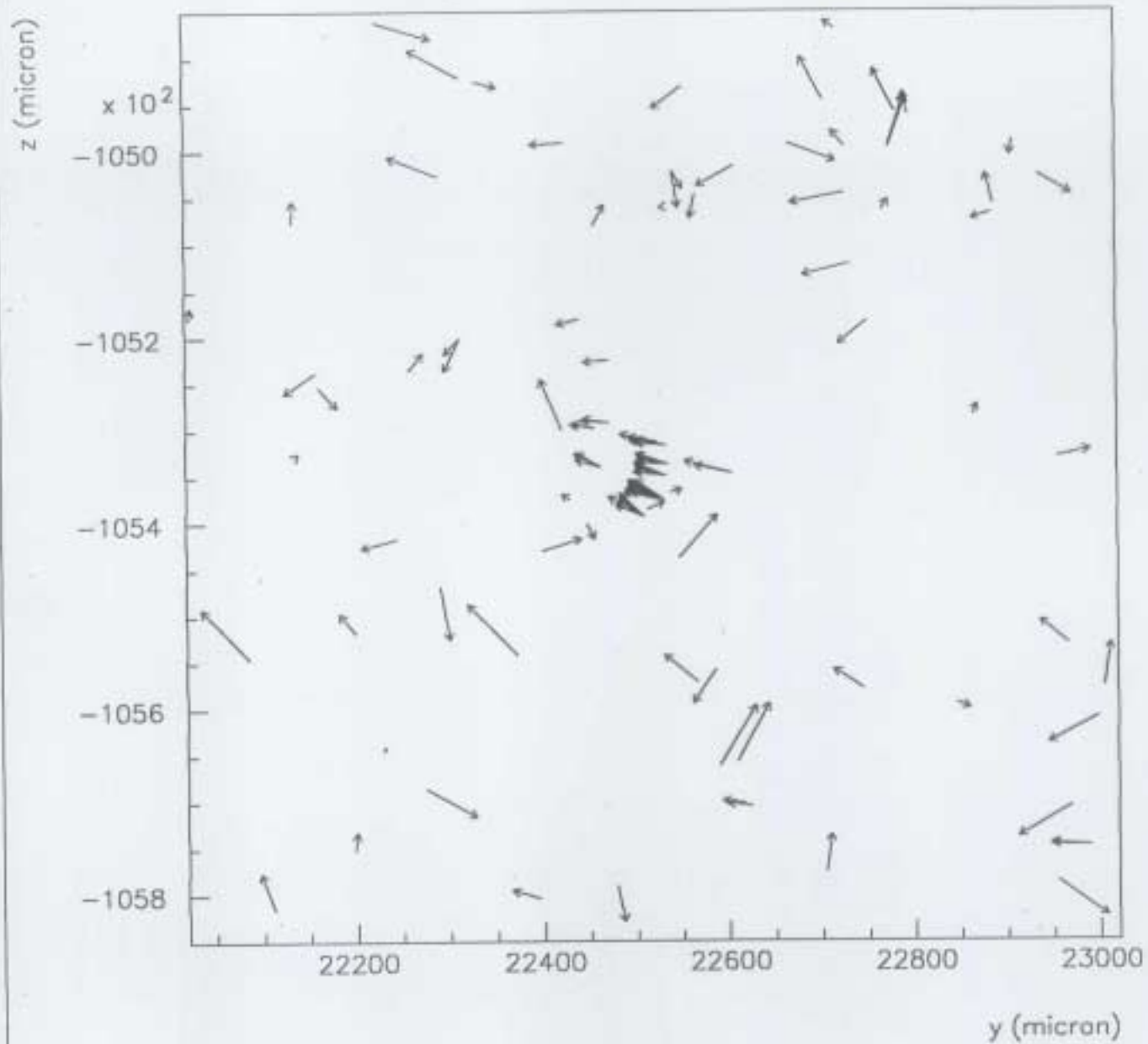
thz vz. thy

em02 / a307 / qs / $\phi_y = .15$ $\phi_z = -.05$ $\Delta\theta = .04$



z2/03/08 02.54

/em02 / a307 / gs/ window=1000. *mu*



Summary and Outlook

- Automatic scanning for cosmic electron observation looks promising through study of NTS characteristic and pilot scanning balloon ECC.
- Expected electron number with $E > 10 \text{ GeV}$ is $2/\text{cm}^2$ ($\tan \theta < 0.3$) from flight time. *$S \approx 2000 \text{ cm}^2$
chamber*
- Jobs to be done :
 - (1) alignment of emulsion plates:
 - global alignment: using heavy tracks and high energy showers
 - local alignment: using high energy single tracks
 - (2) precise parameter tuning of NTS