

The Use of Emulsion
Searching for ν_T Interactions

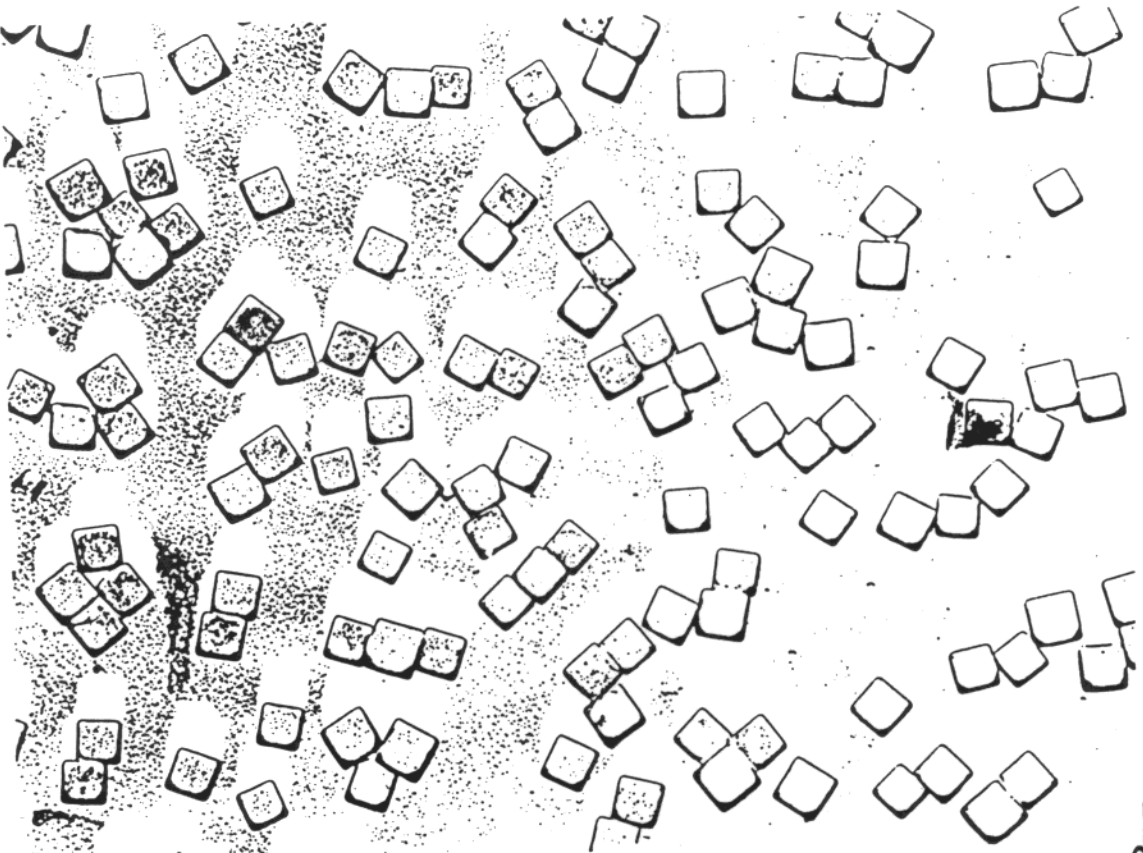
K. Niwa
Nagoya Univ.

4/27/82.

ET-7C

Fuji Film Co.

AgBr cristal



size distribution

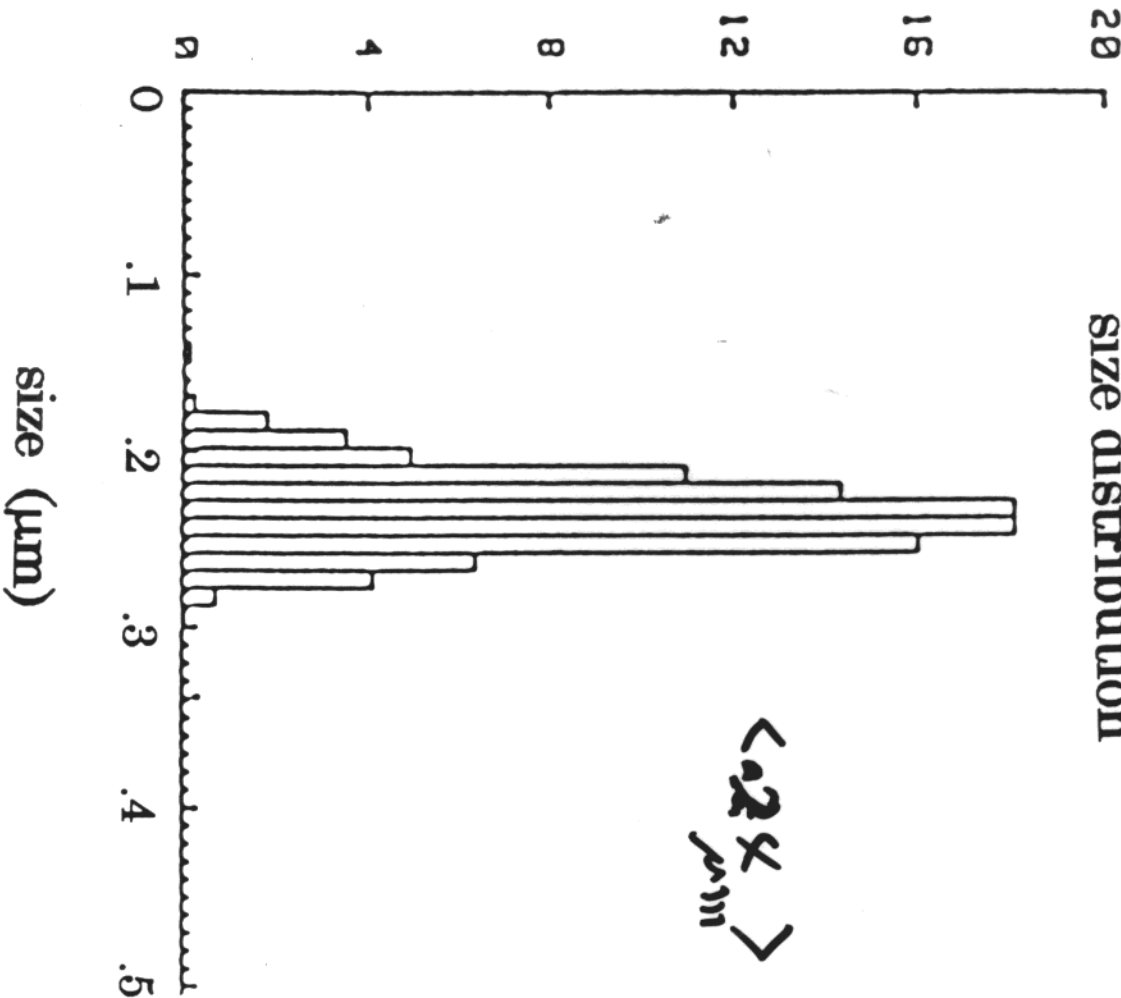
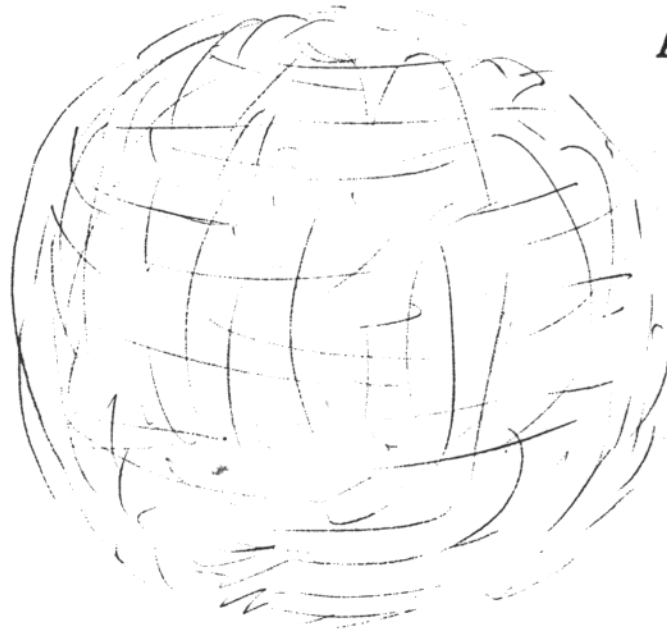


PHOTO by electron microscope



After development

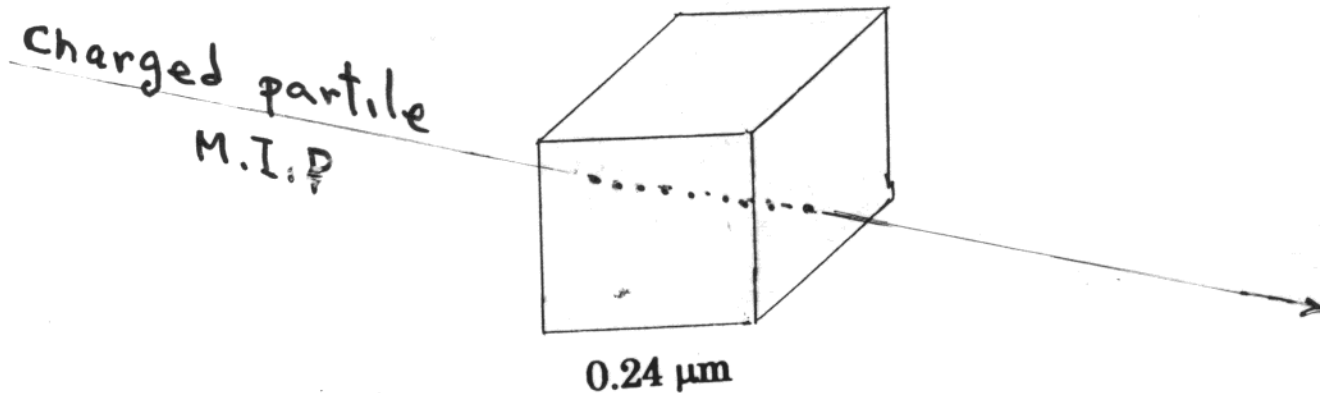
Size $\approx 1 \mu\text{m}$

Development probability 15-30% for MIP
 $\sim 30 \text{ grain} / 100 \mu\text{m}$

EMULSION

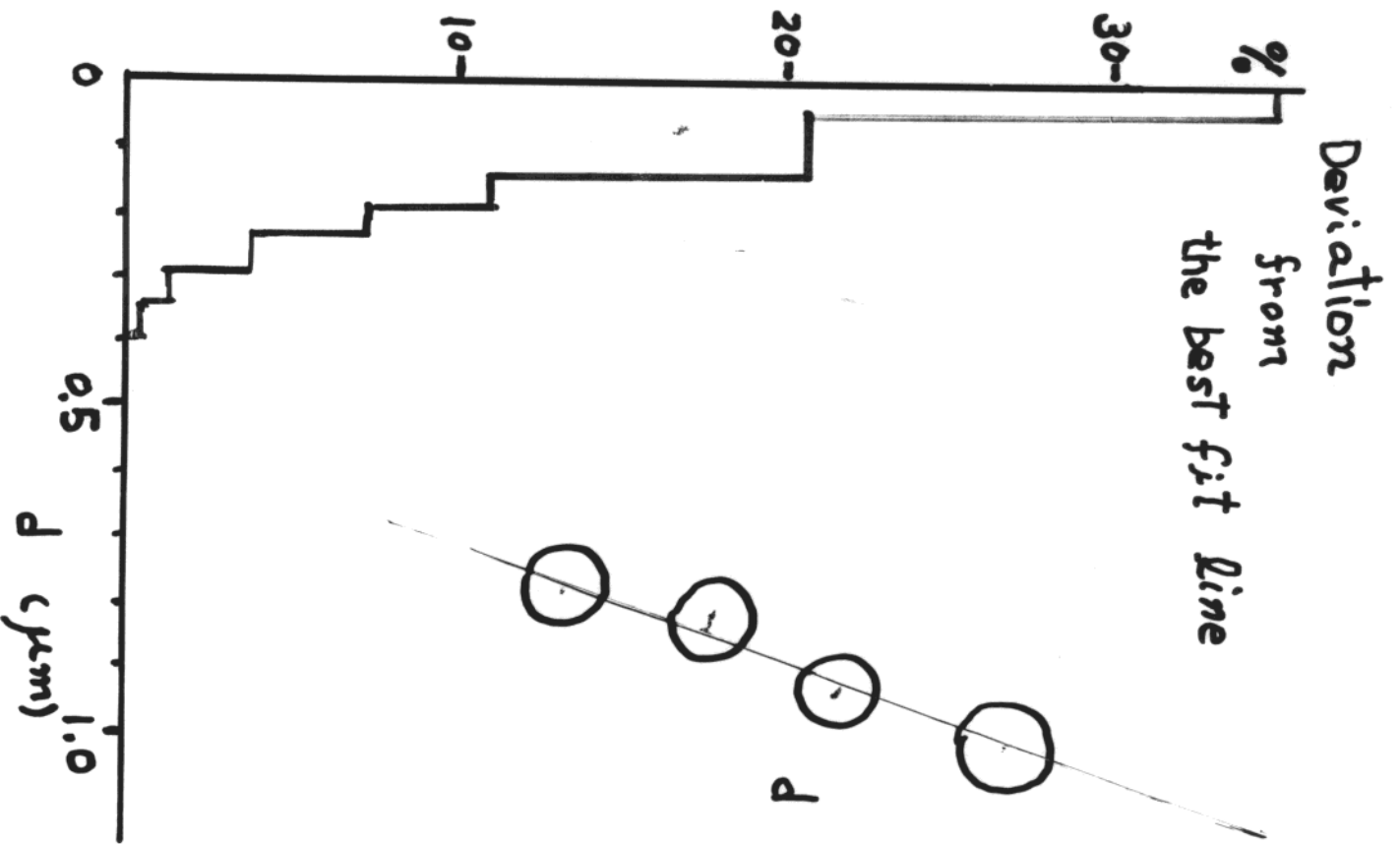
in volume

AgBr cristal	50 %	(20%)
Gelatine	50 %	(80%)
	↑ old	↑ New



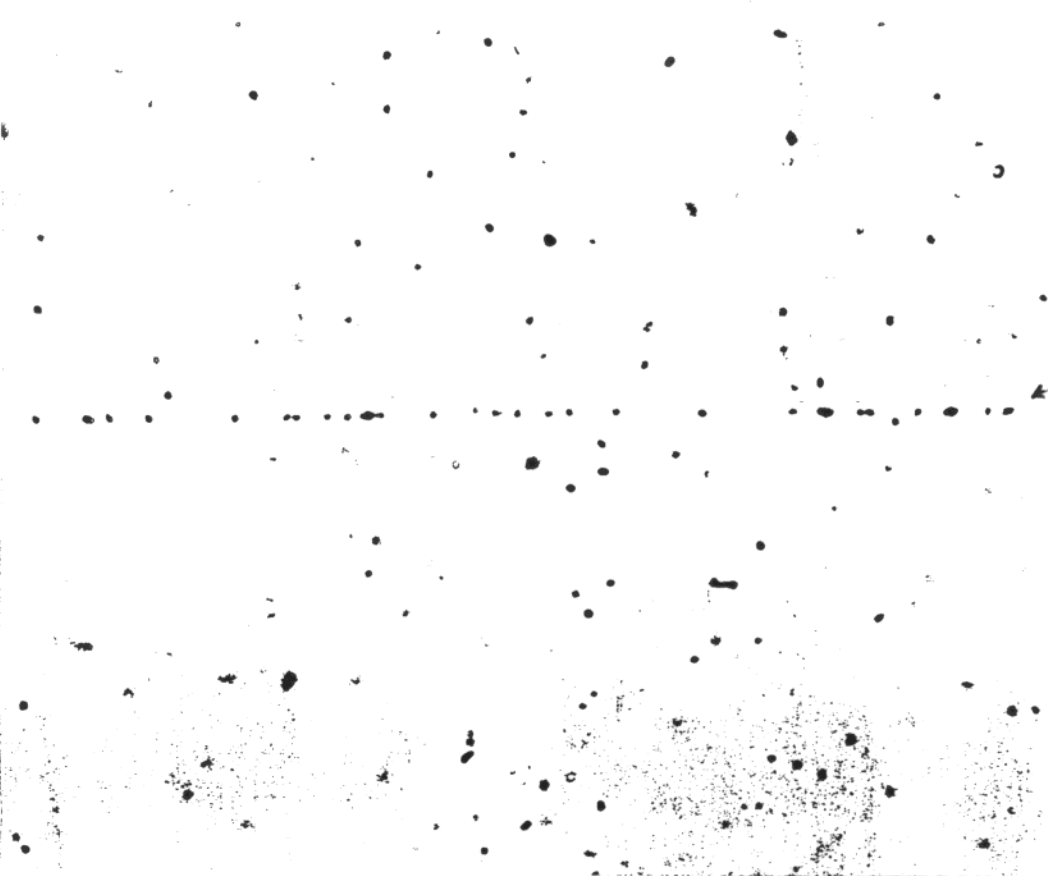
AgBr band gap energy	2.6 eV
Energy loss for MIP	310 eV/cristal

Tracking



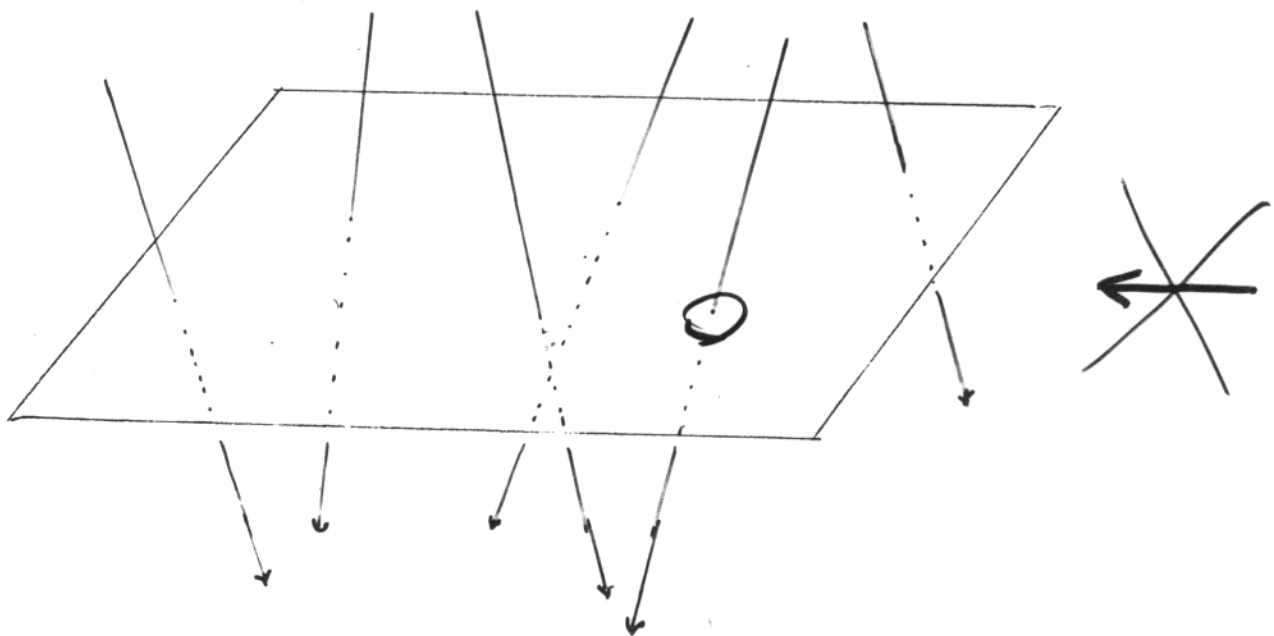
M.I.P

Emulsion ET-9C



Emulsion Tracking Detector

vertical to the beam axis



emulsion plate



Hard backing



Bulk

emulsion film



"Mass productive"

Fuji-film. Co

Angle (θ_x, θ_y)

&

Position (x, y)

$\Delta\theta$

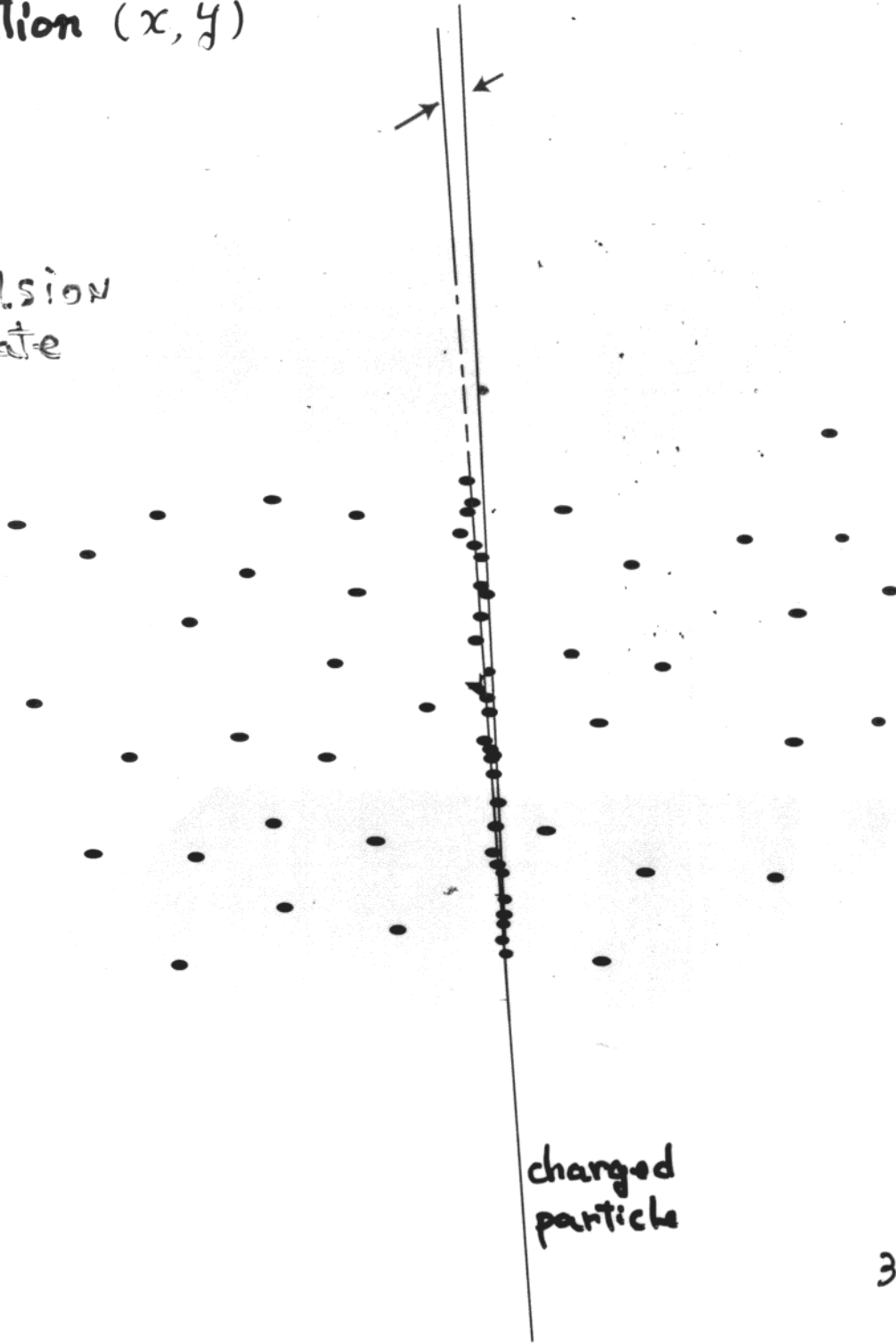
$\Delta\theta \propto \text{Thickness}^{-1}$

Emulsion
plate

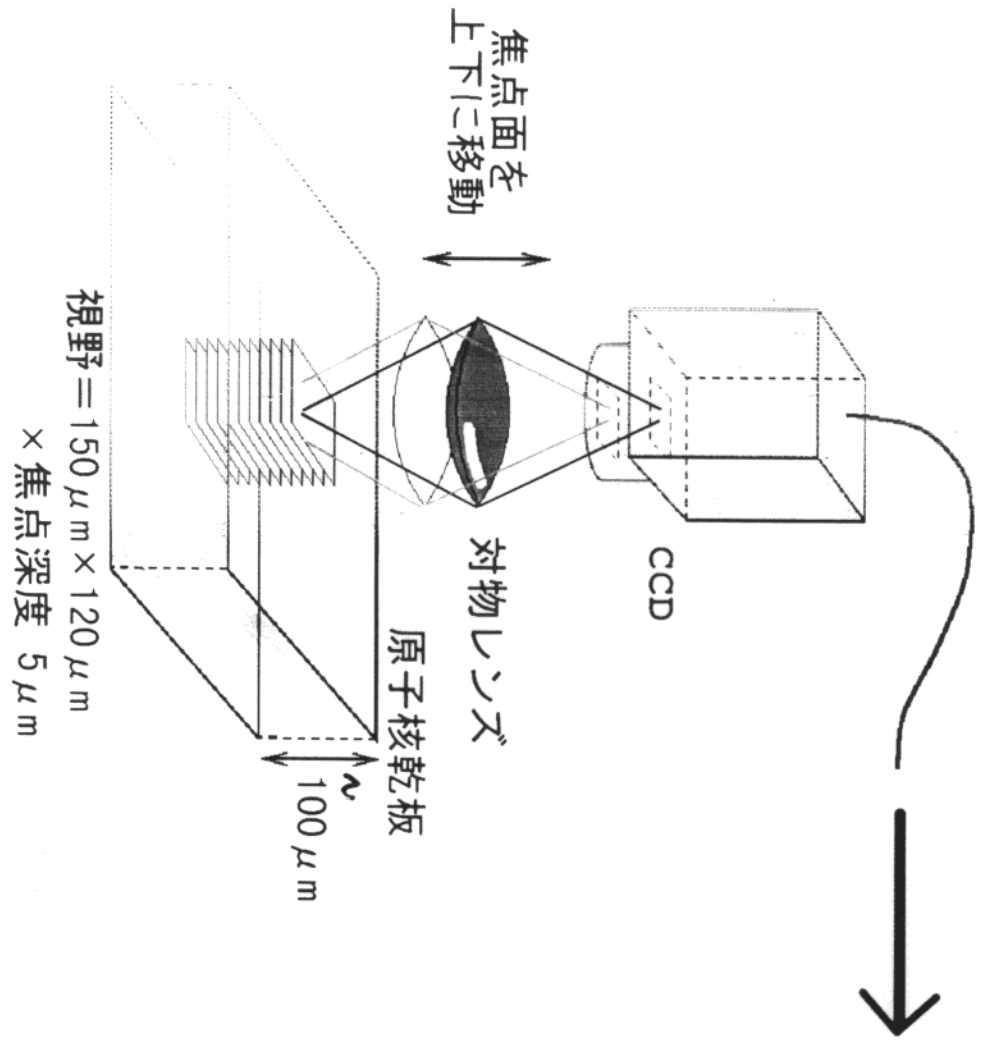
↑
50 μm
S
100 μm
↓

charged
particle

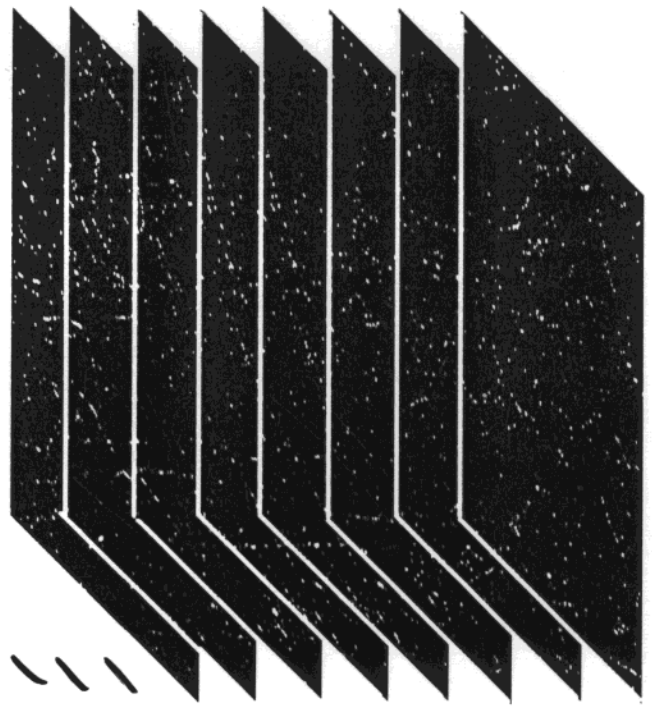
30 grains /
100 μm



Track Selector



512pixel \times 512pixel \times 16frameの
 デジタル情報として
 frame memoryに取り込む



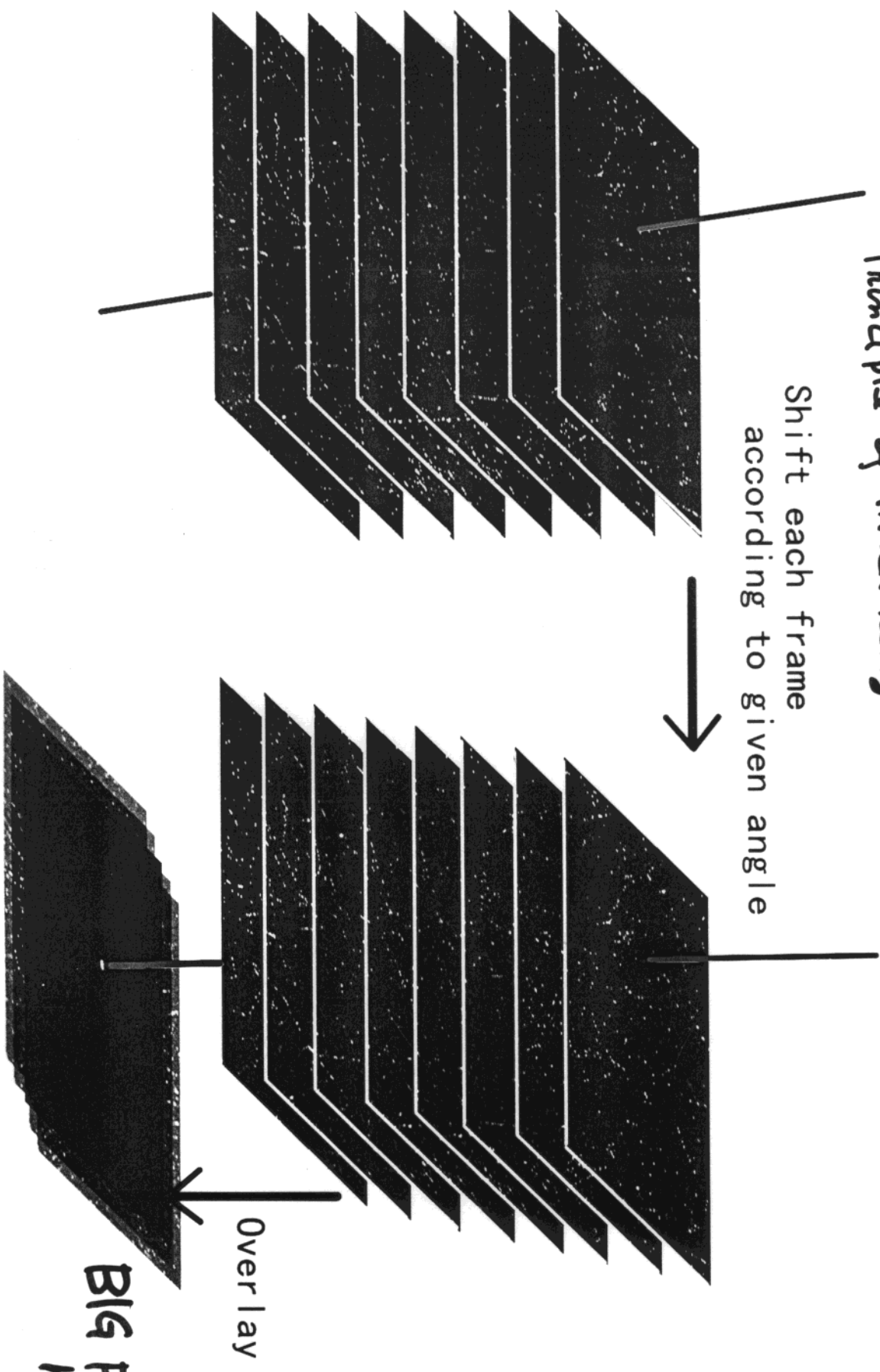
Digitized Image

16 layers

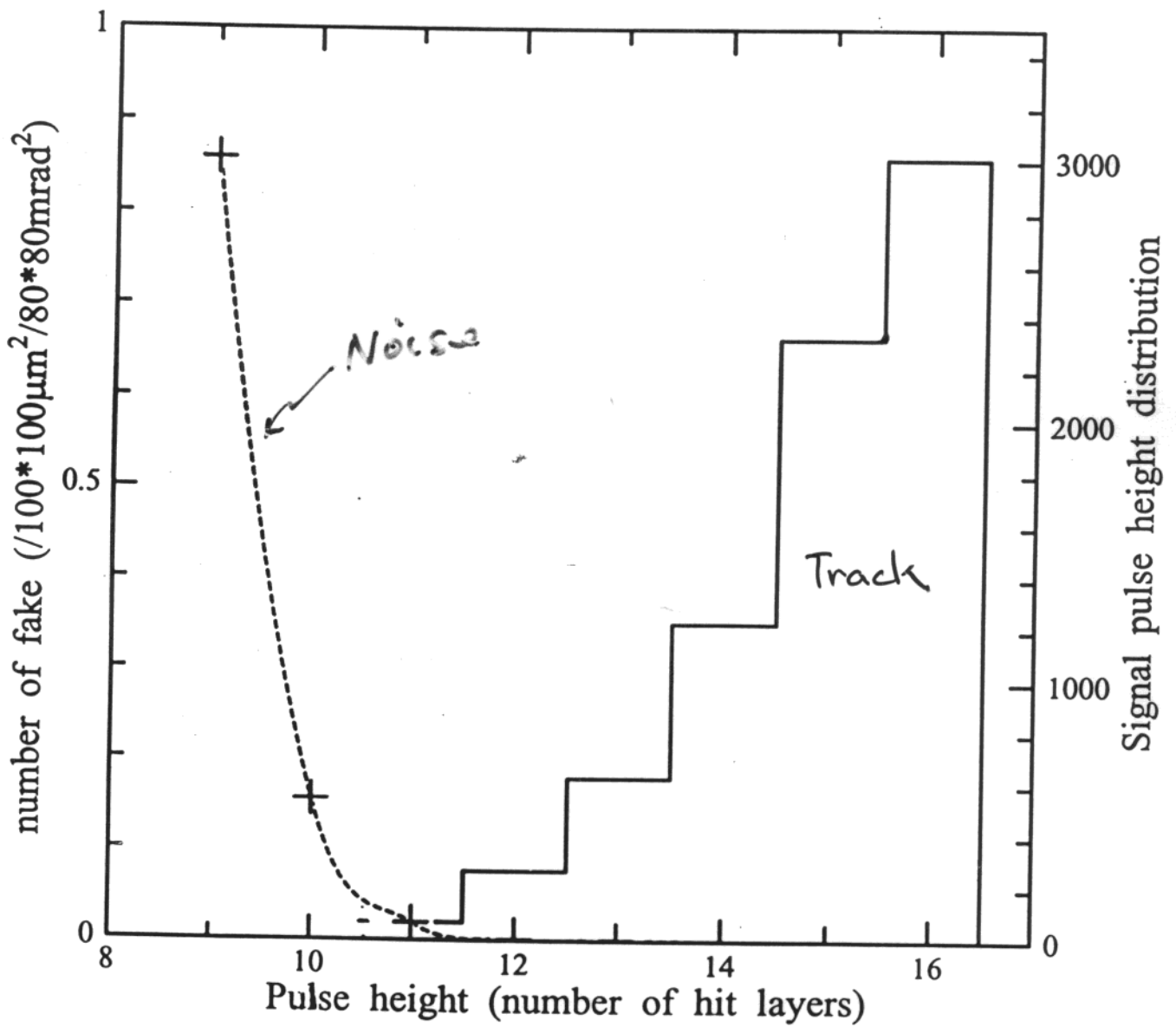
Track Selector

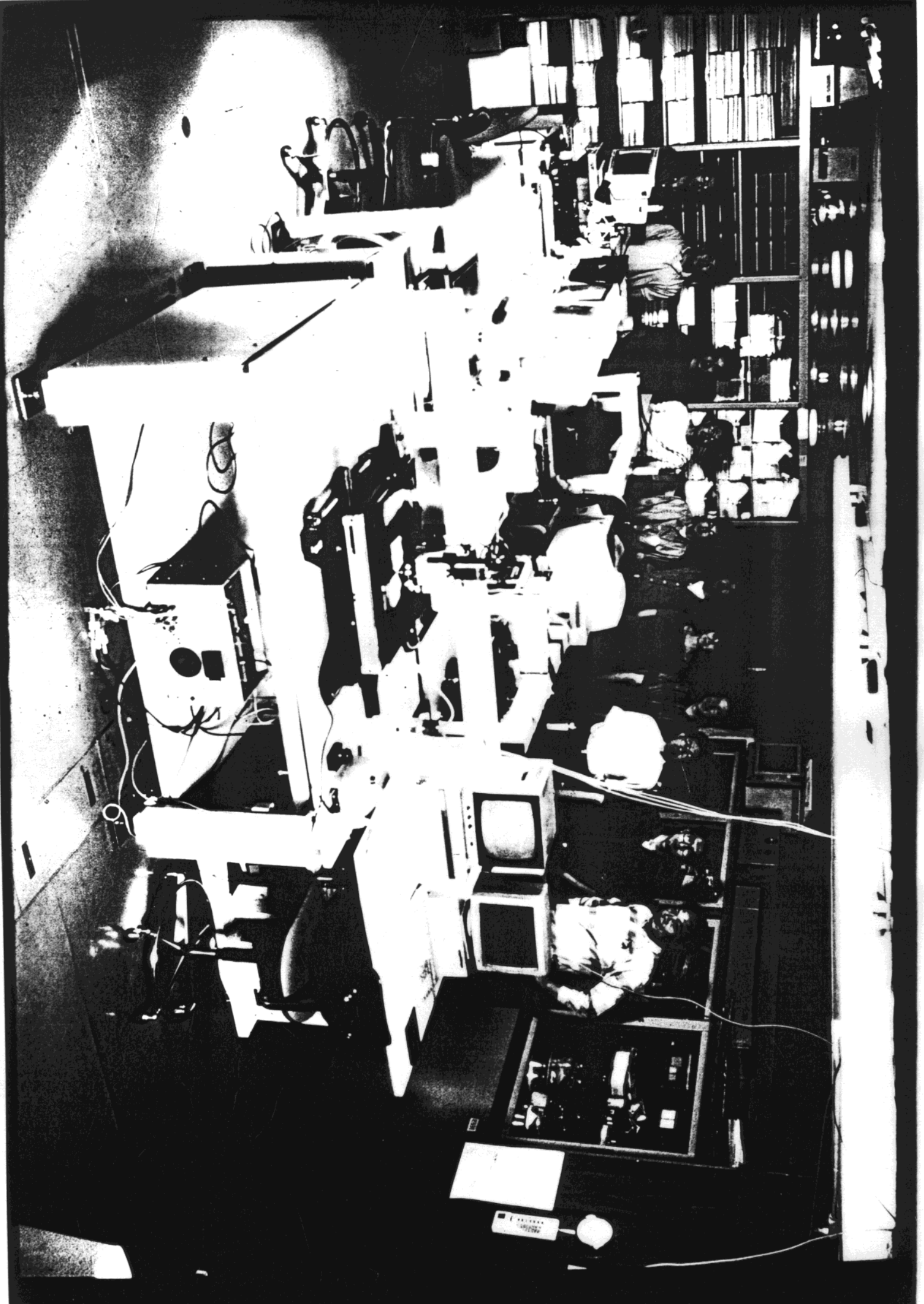
Principles of Track recognition

Proc. of International Cosmic Ray Symposium, Tokyo 1974 (1974)



Pulse height distribution of super-imposed video image

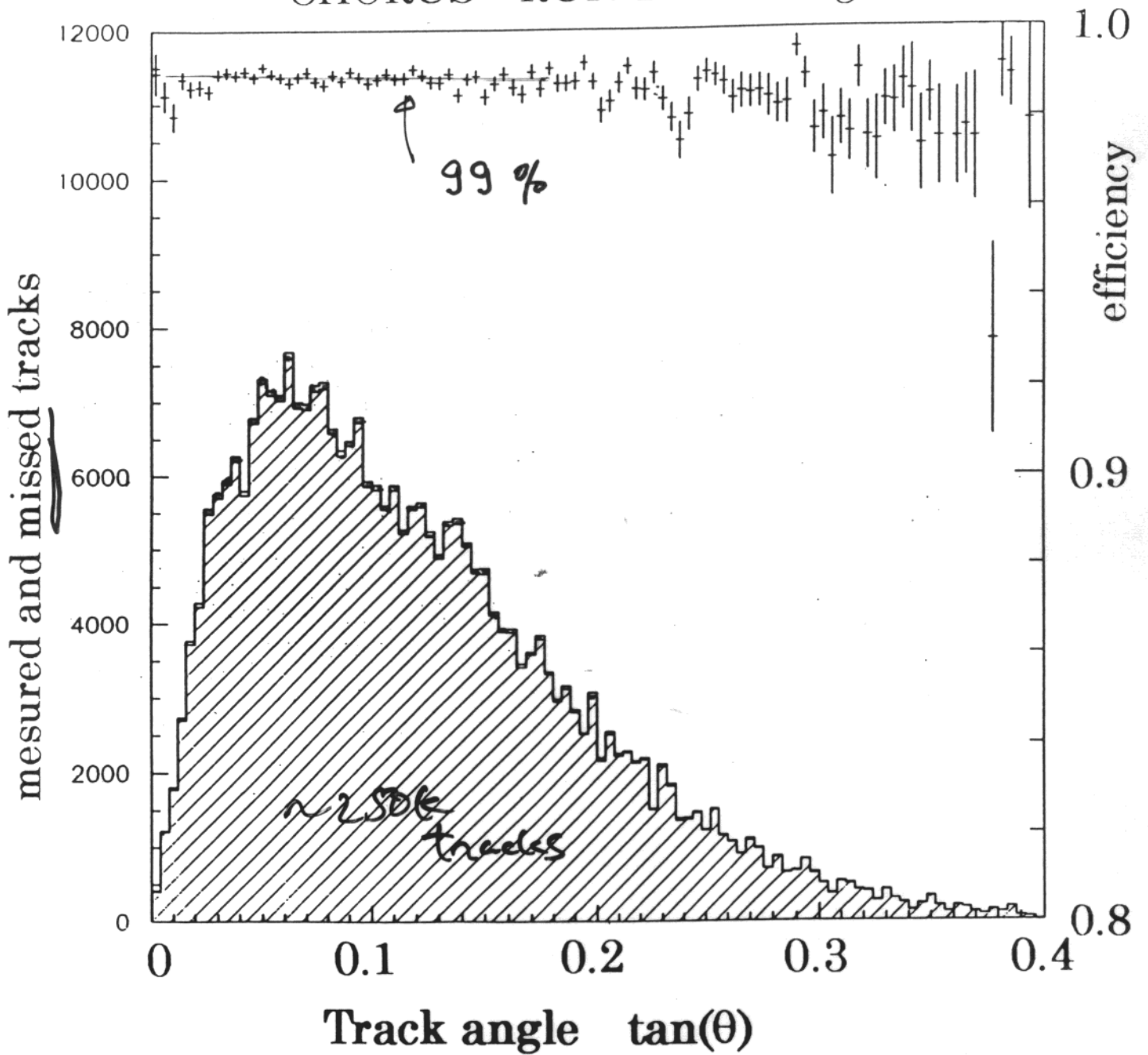




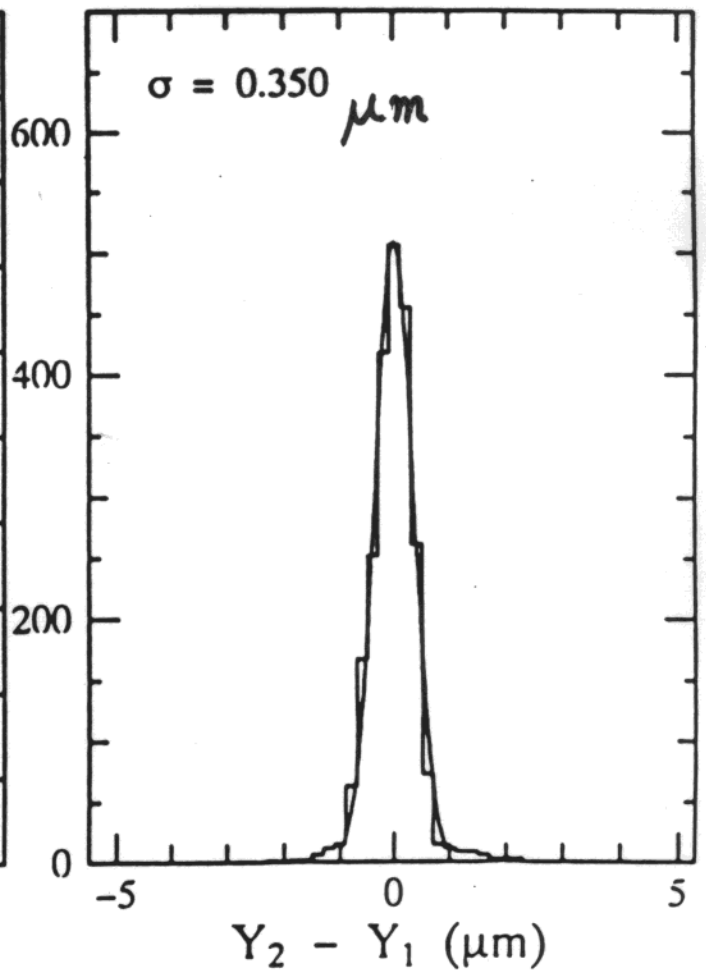
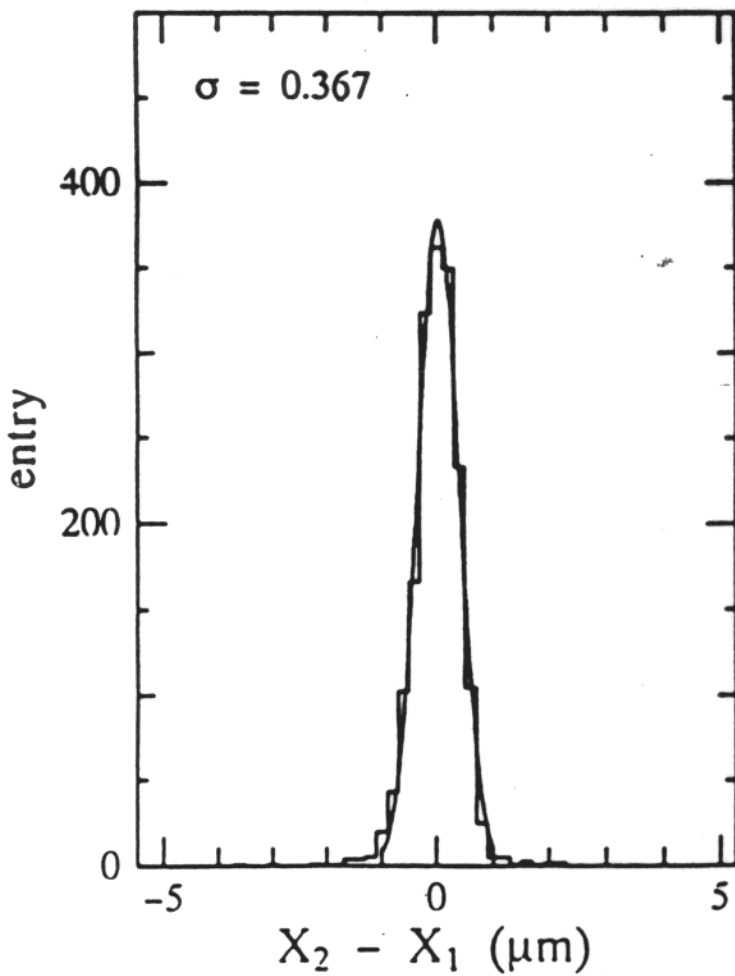
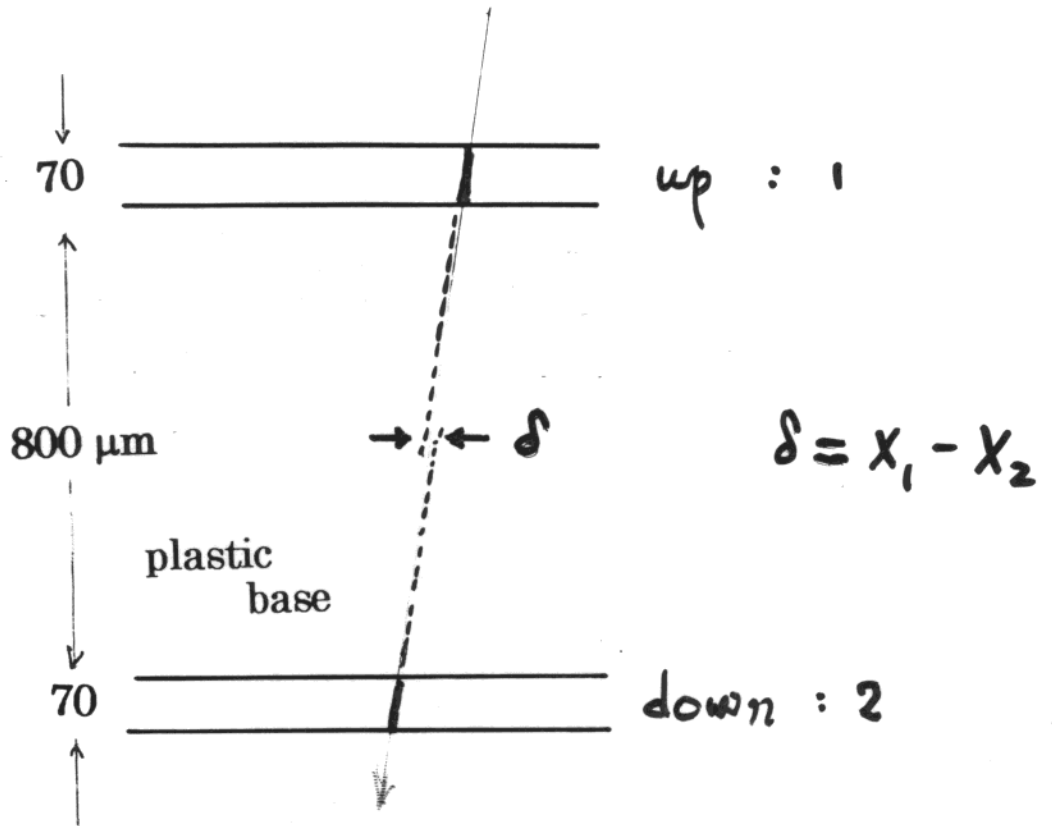
Automatic track read out efficiency

> 98%

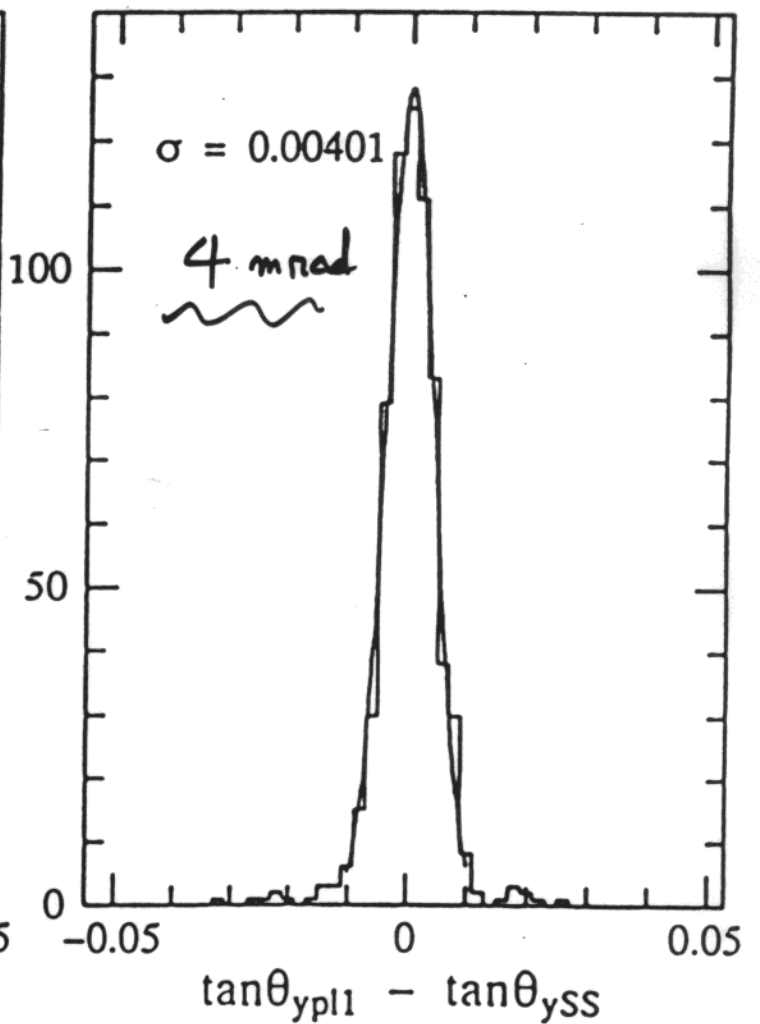
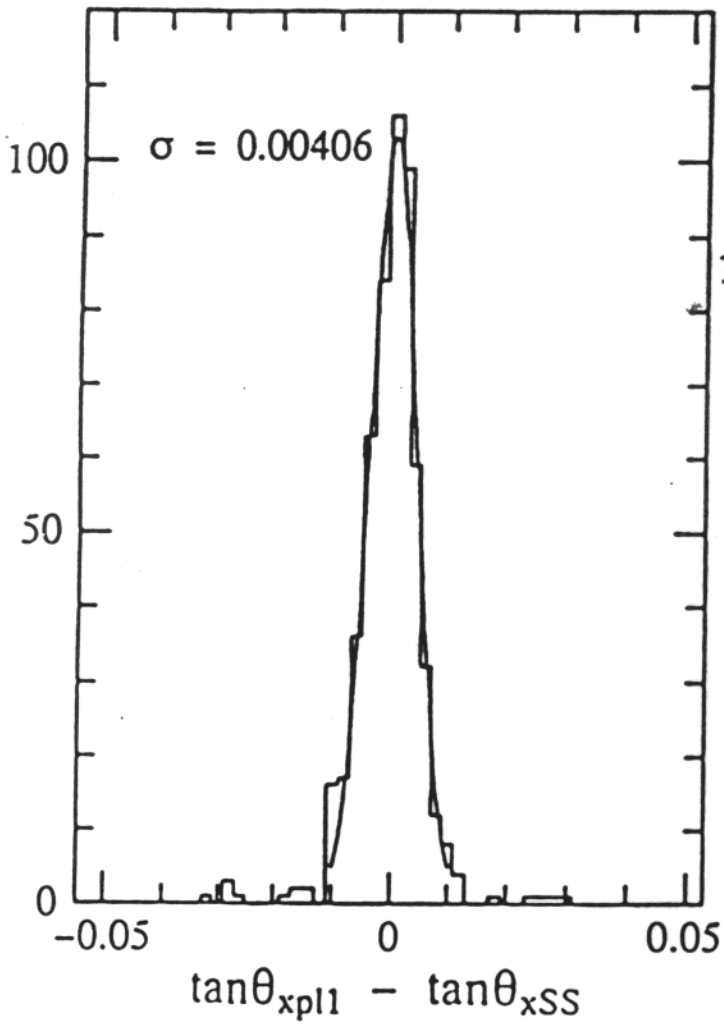
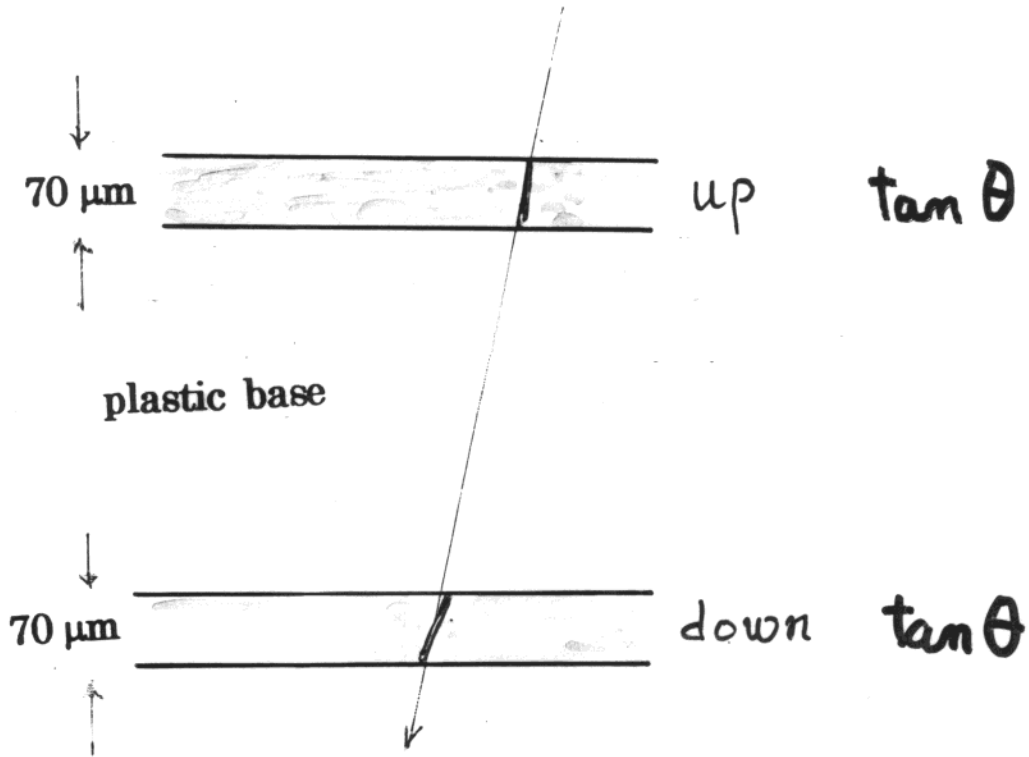
CHORUS RUN-1 FUJI-gel



Position resolution



Angle resolution



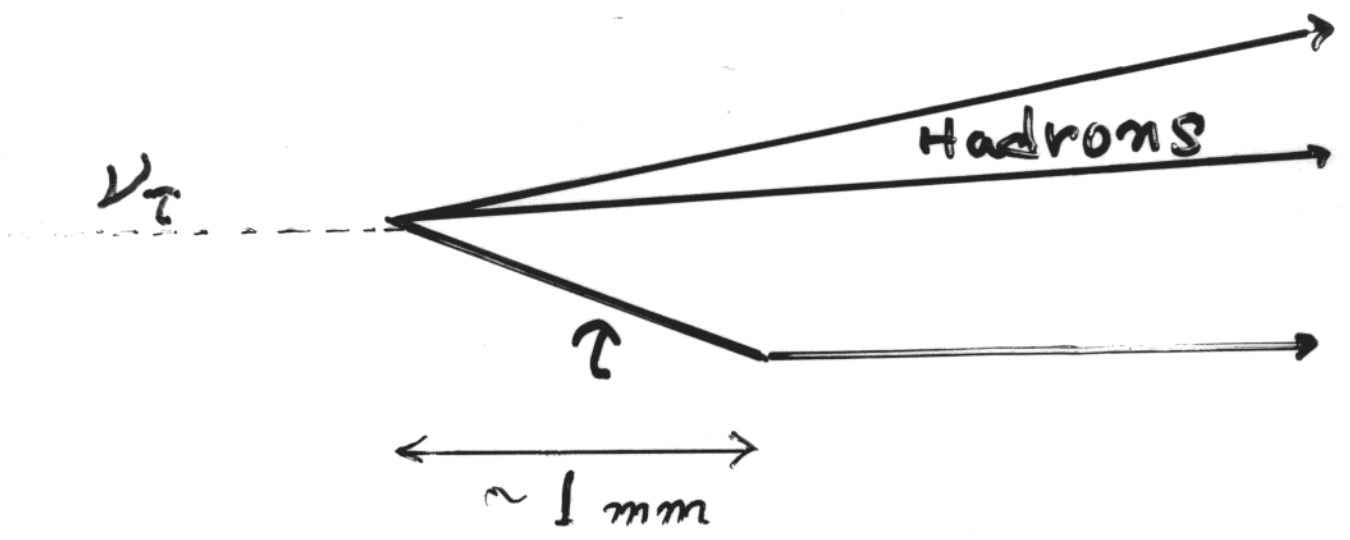
ν_τ detection

Requirement.

① ^{Big} Target Mass

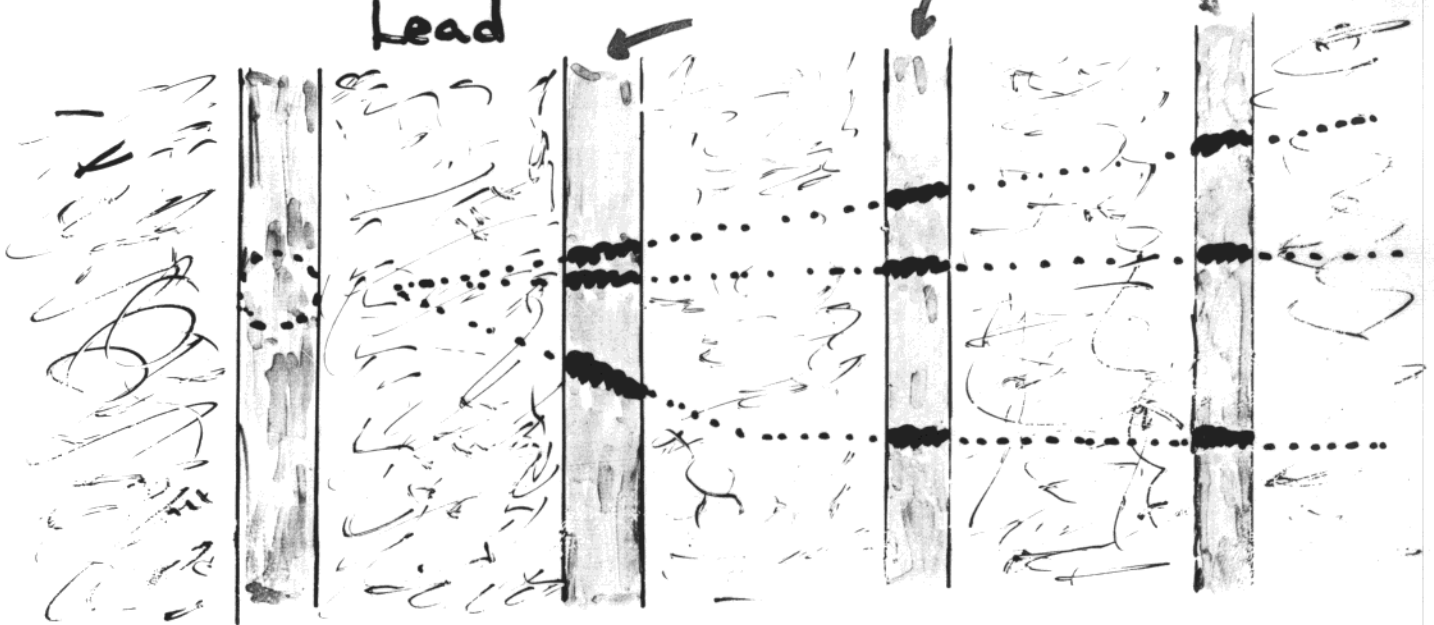
- short base line ν osci. ~ 1 ton
- long base line ν osci. $\sim > 100$ t
1 Kt.

② Precise tracking with good granularity.



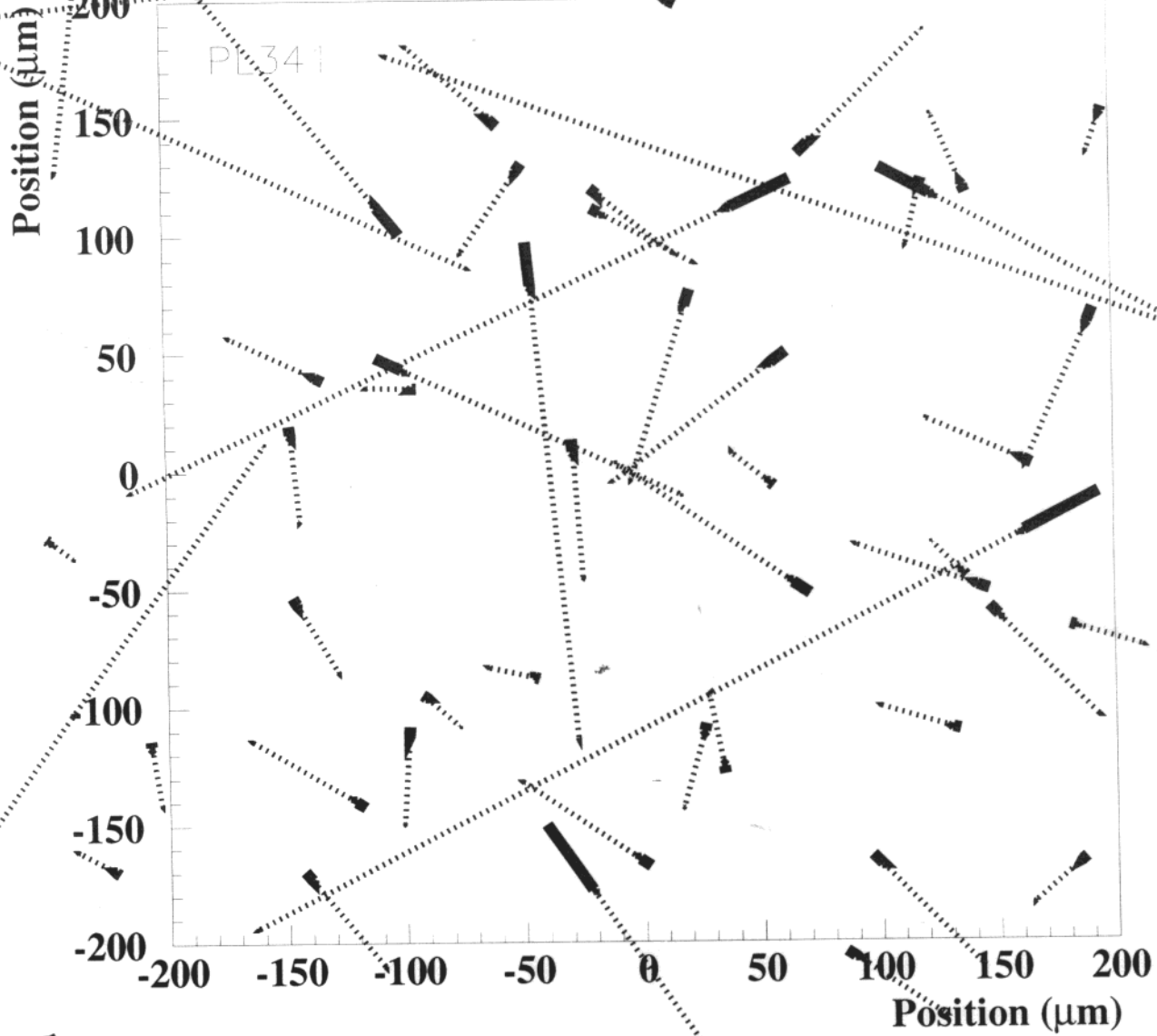
Absorber
Lead

Emulsion

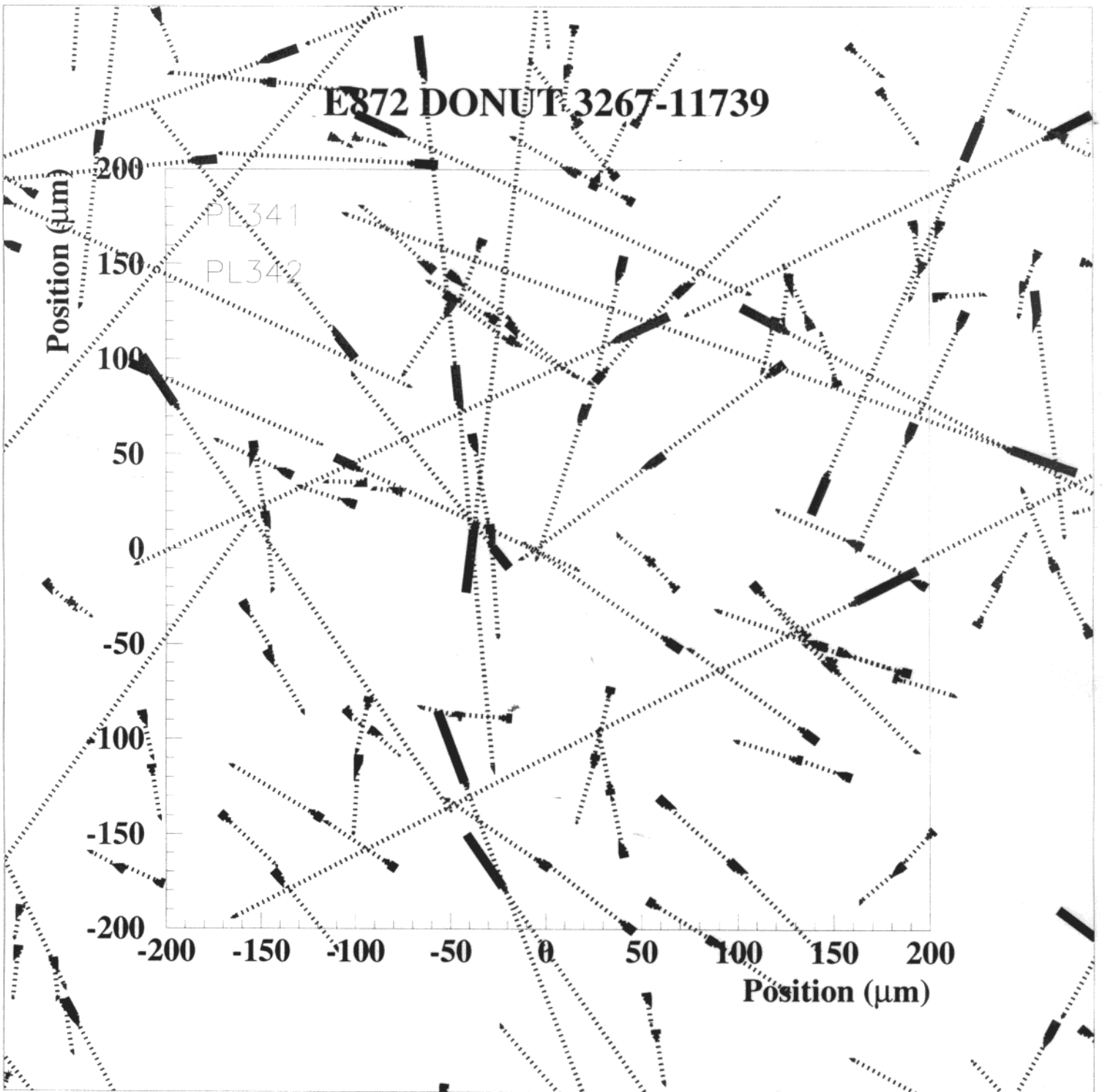


E872 DONUT 3267-11739

PL341



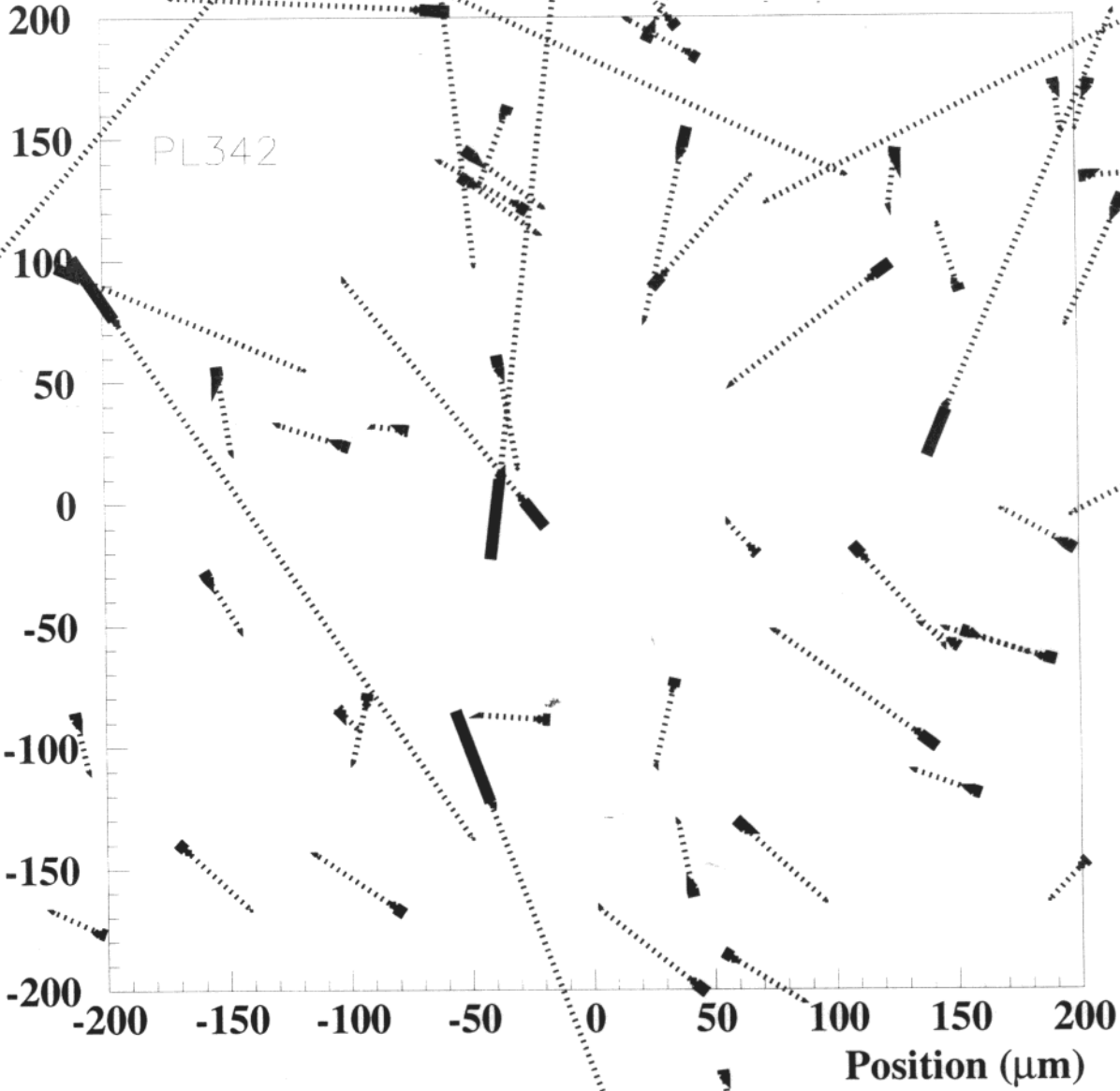
E872 DONUT 3267-11739



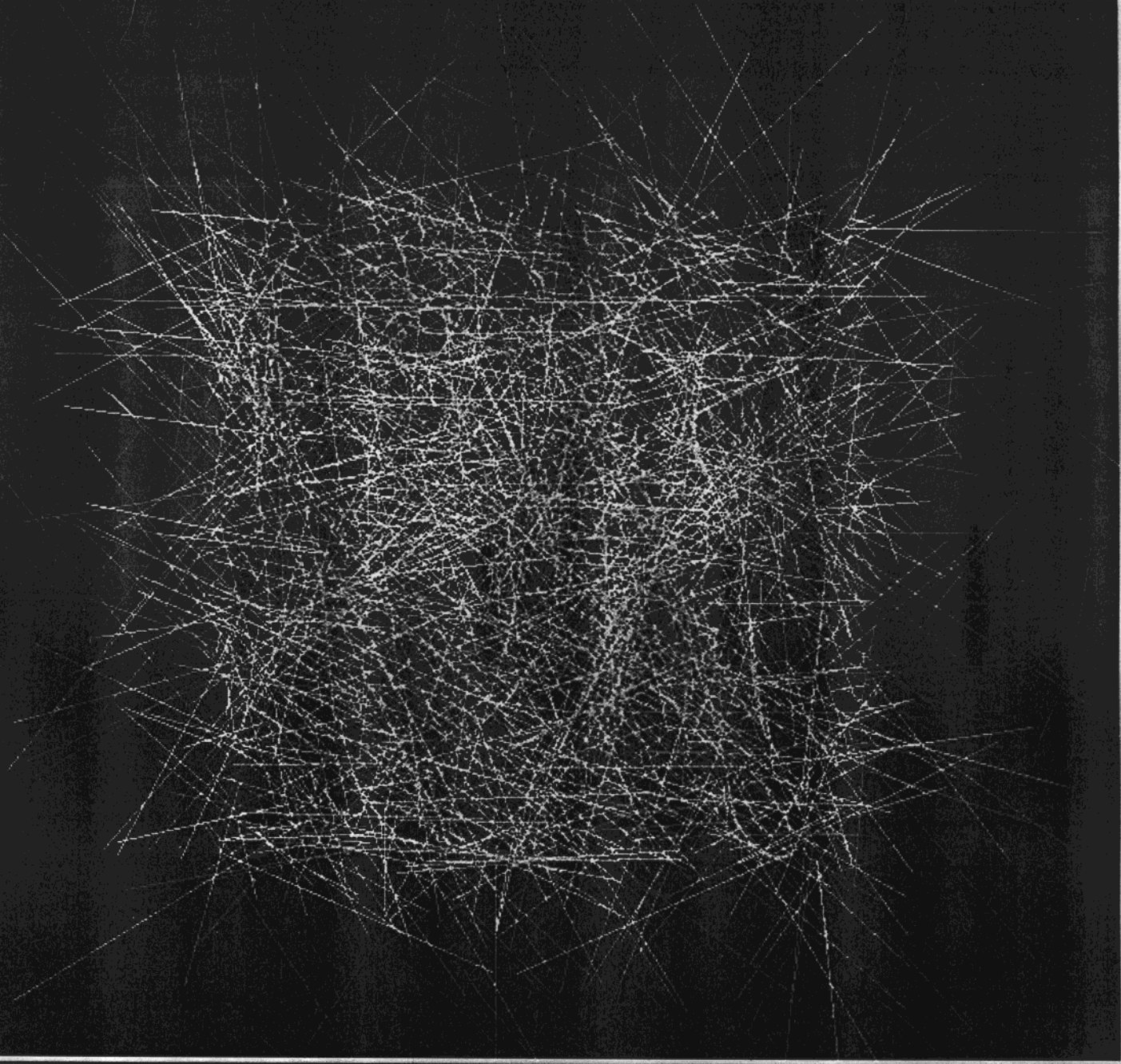
E872 DONUT 3267-11739

Position (μm)

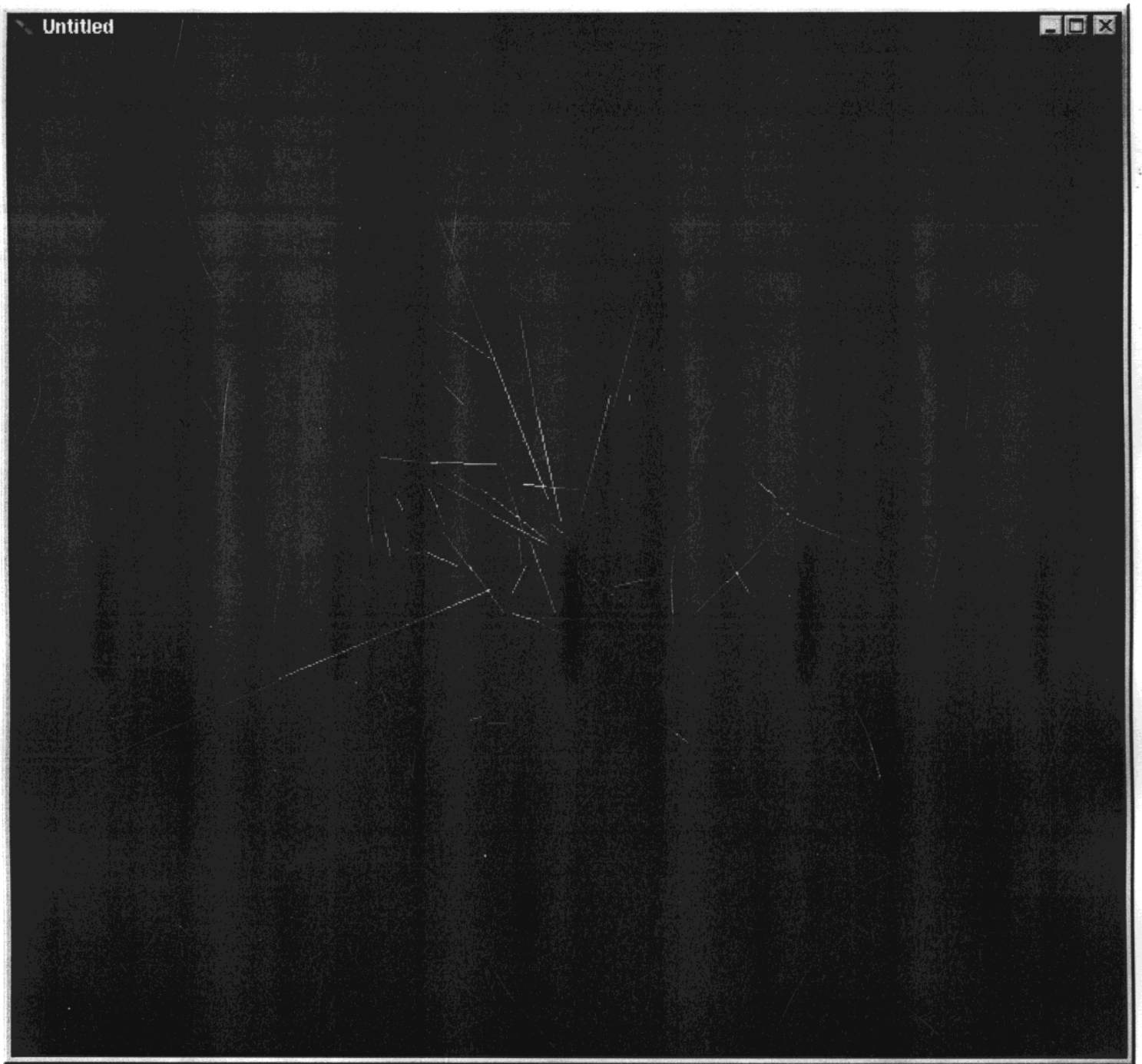
PL342



Untitled

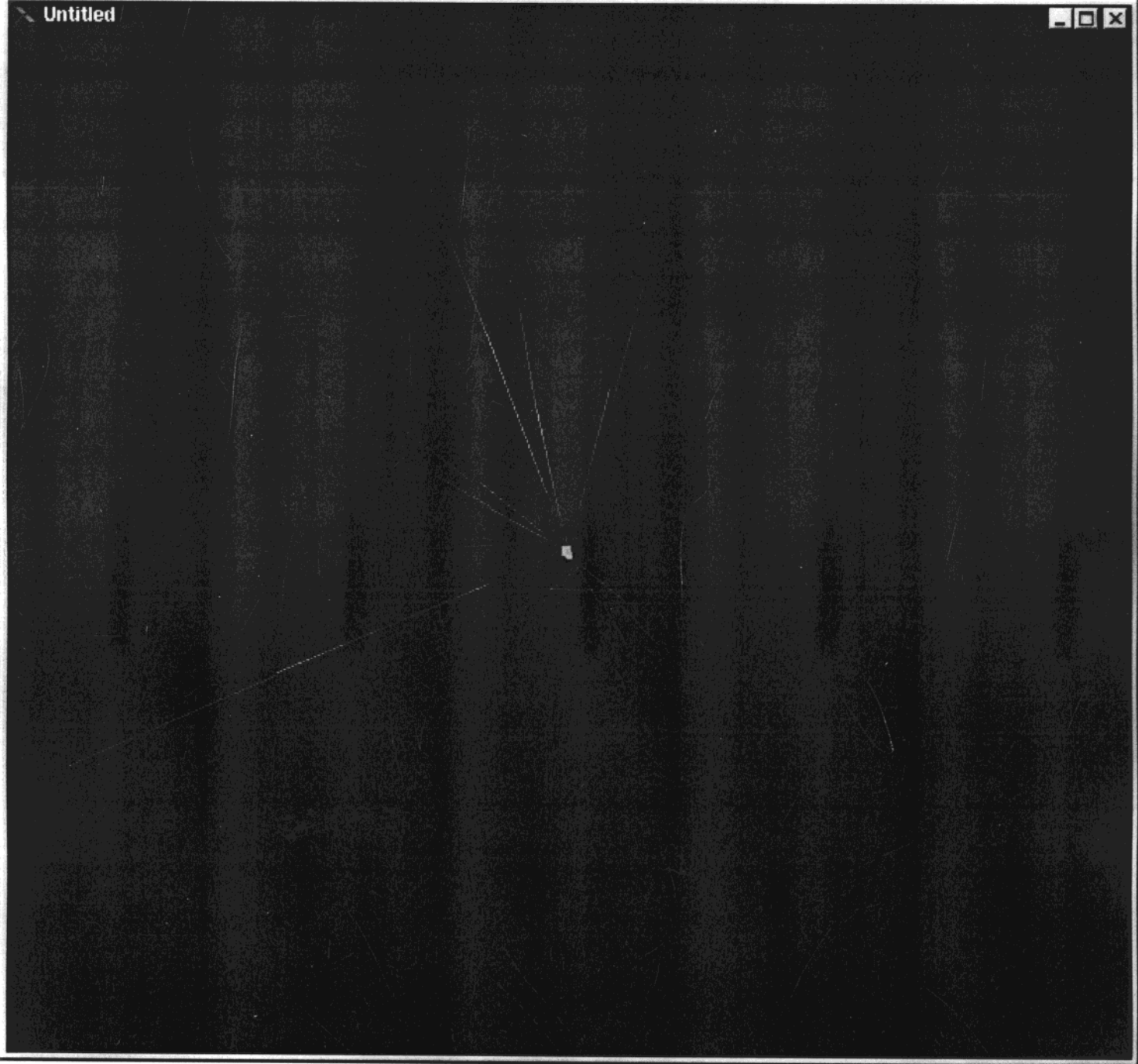


Track density $\sim 1000 / 1.2 \times 1.2$ (→)

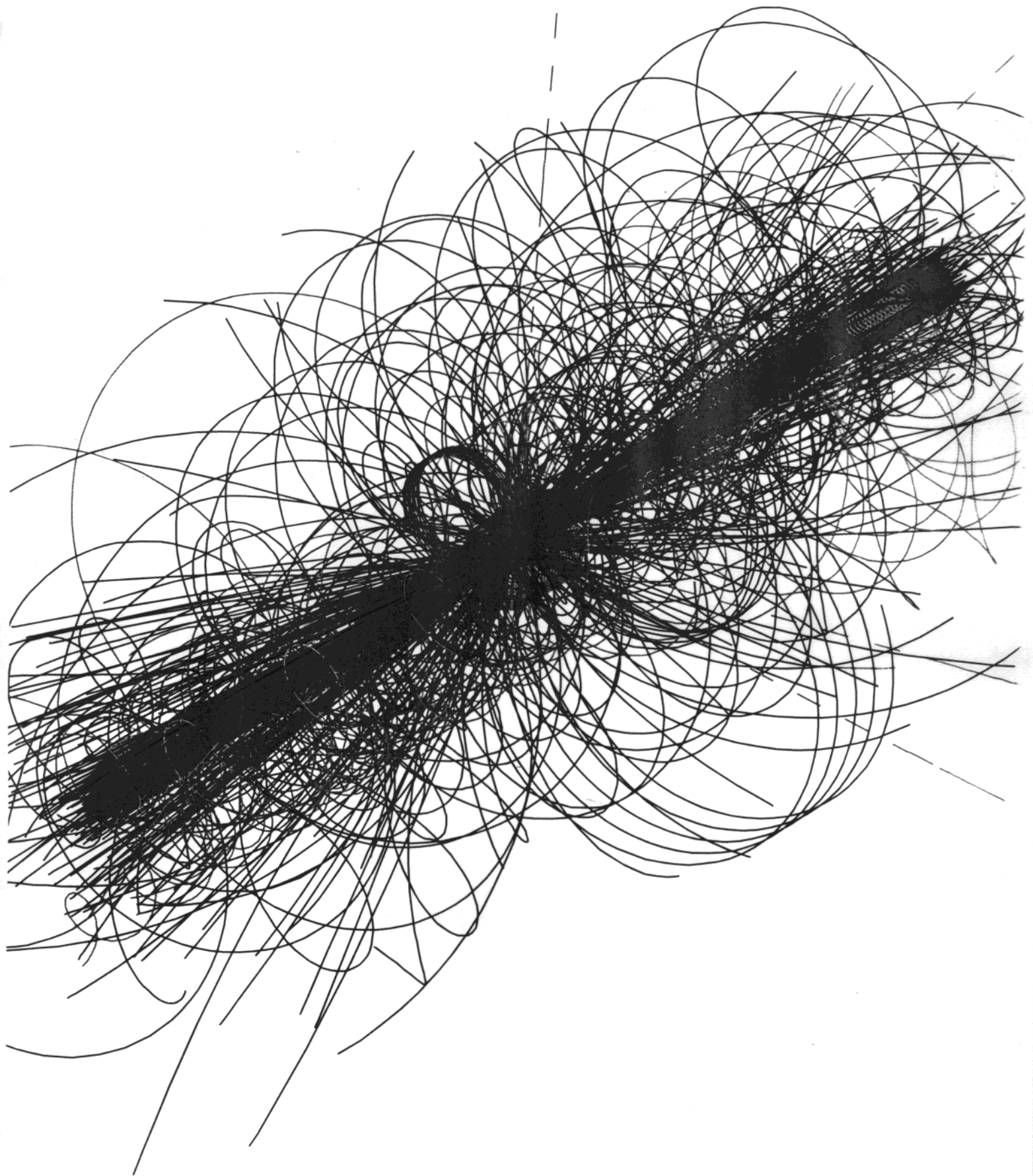


Stop Track ~ 36 tracks

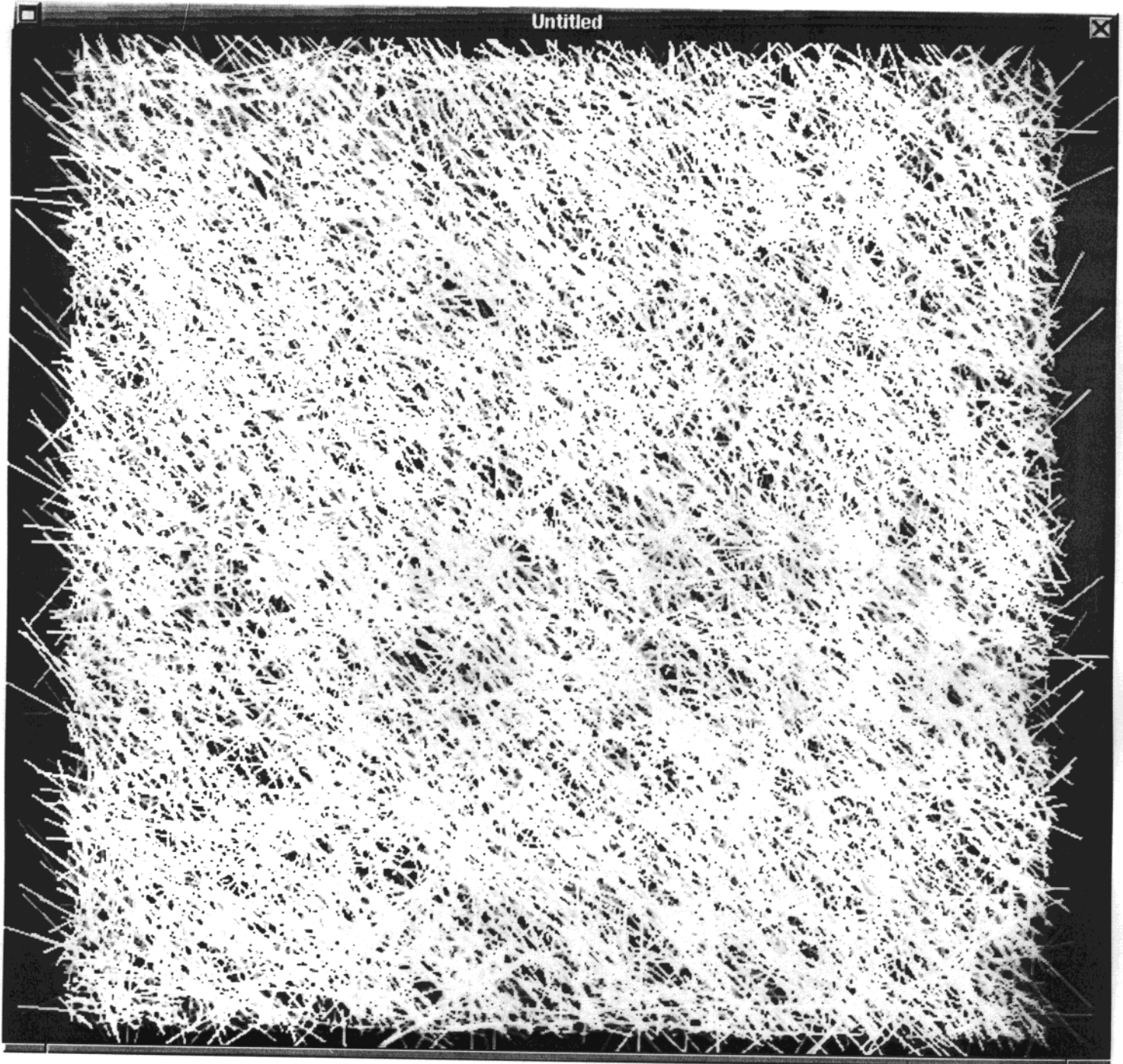
Untitled



LHC



RUN 3267 EVENT 24207



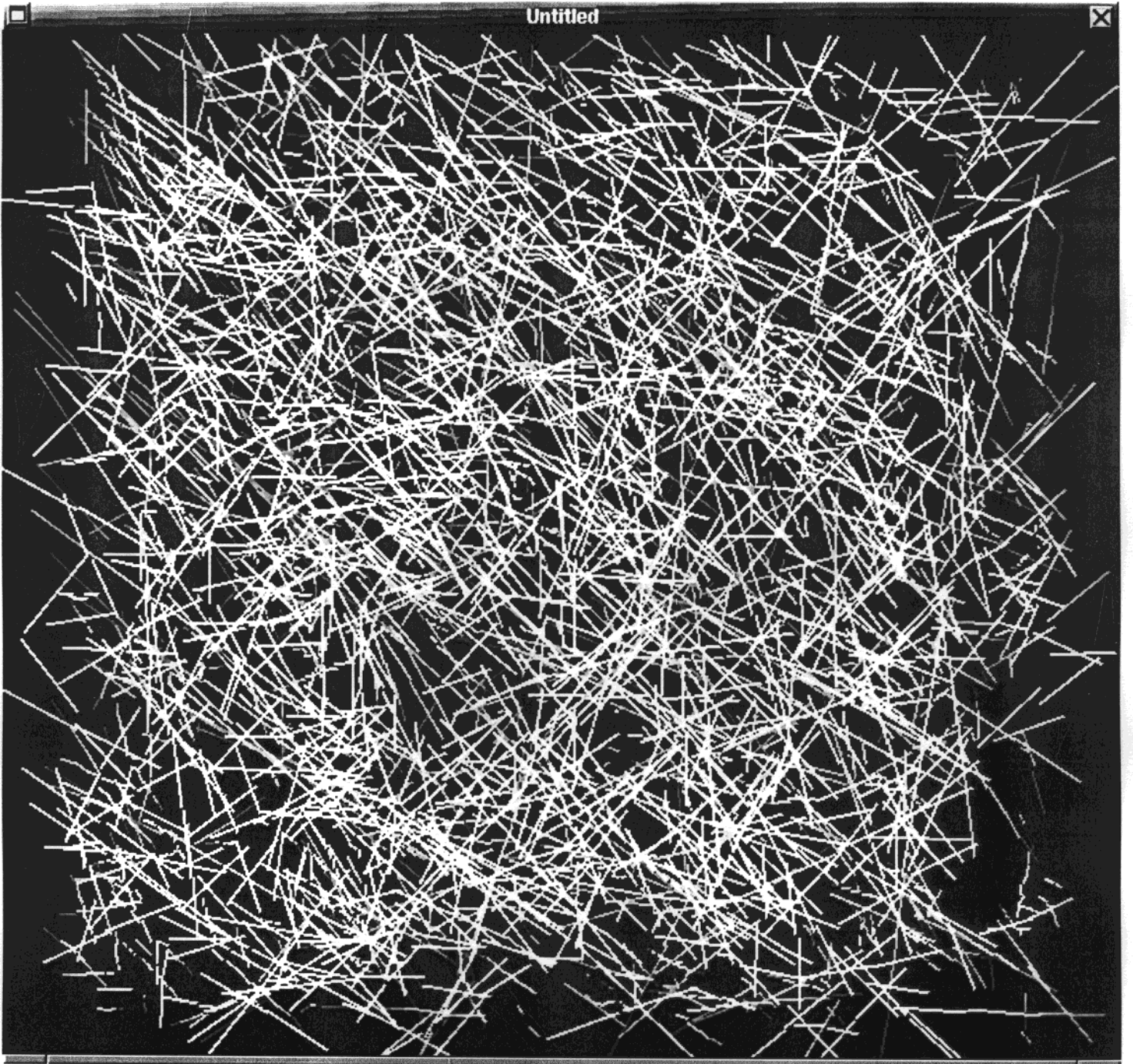
$5 \times 5 \text{ mm}^2$ x 7 layers

~ 20 K tracks

($\sim 10^5 / \text{cm}^2$)

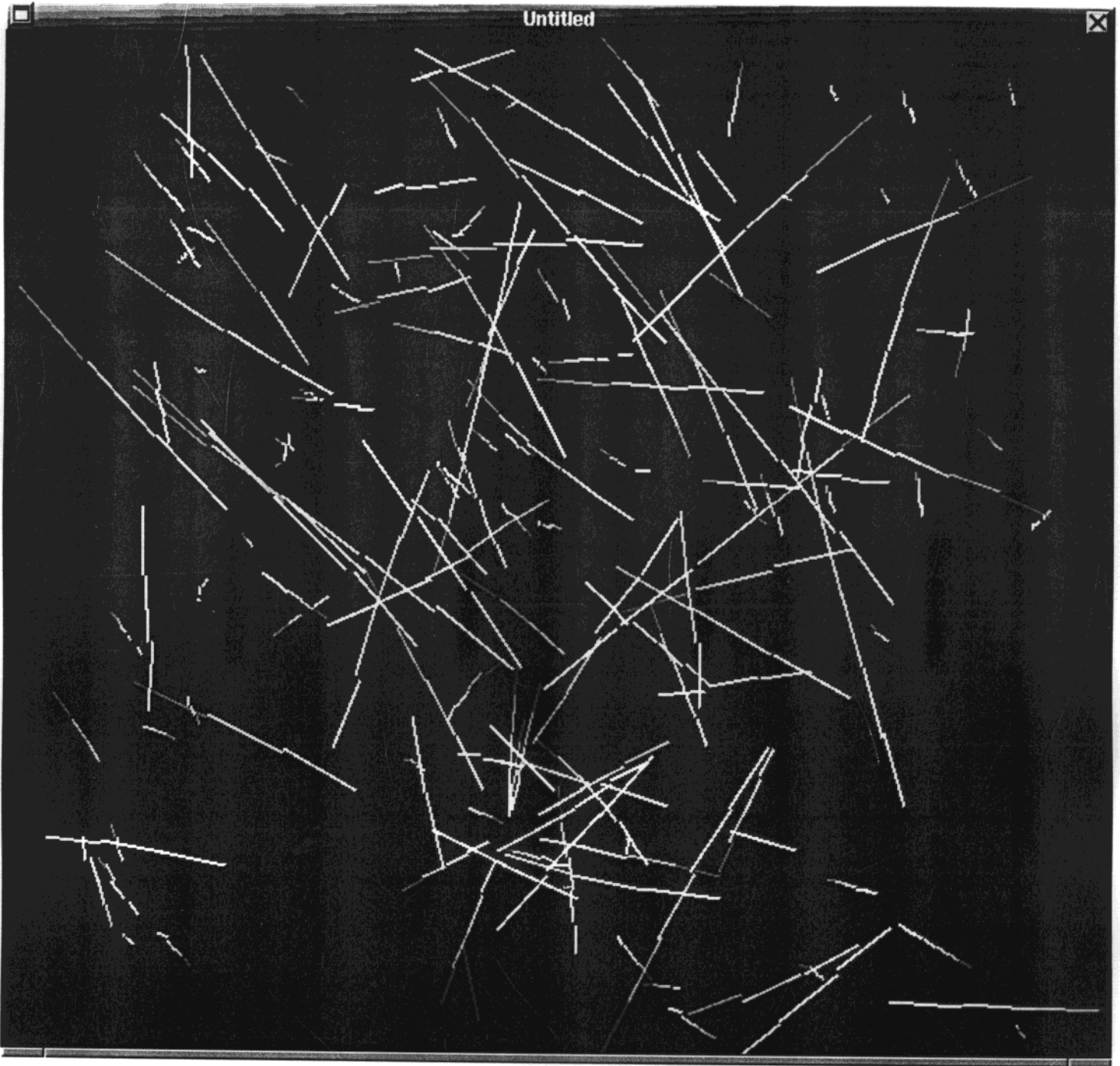
RUN 3267 EVENT 24207

Untitled

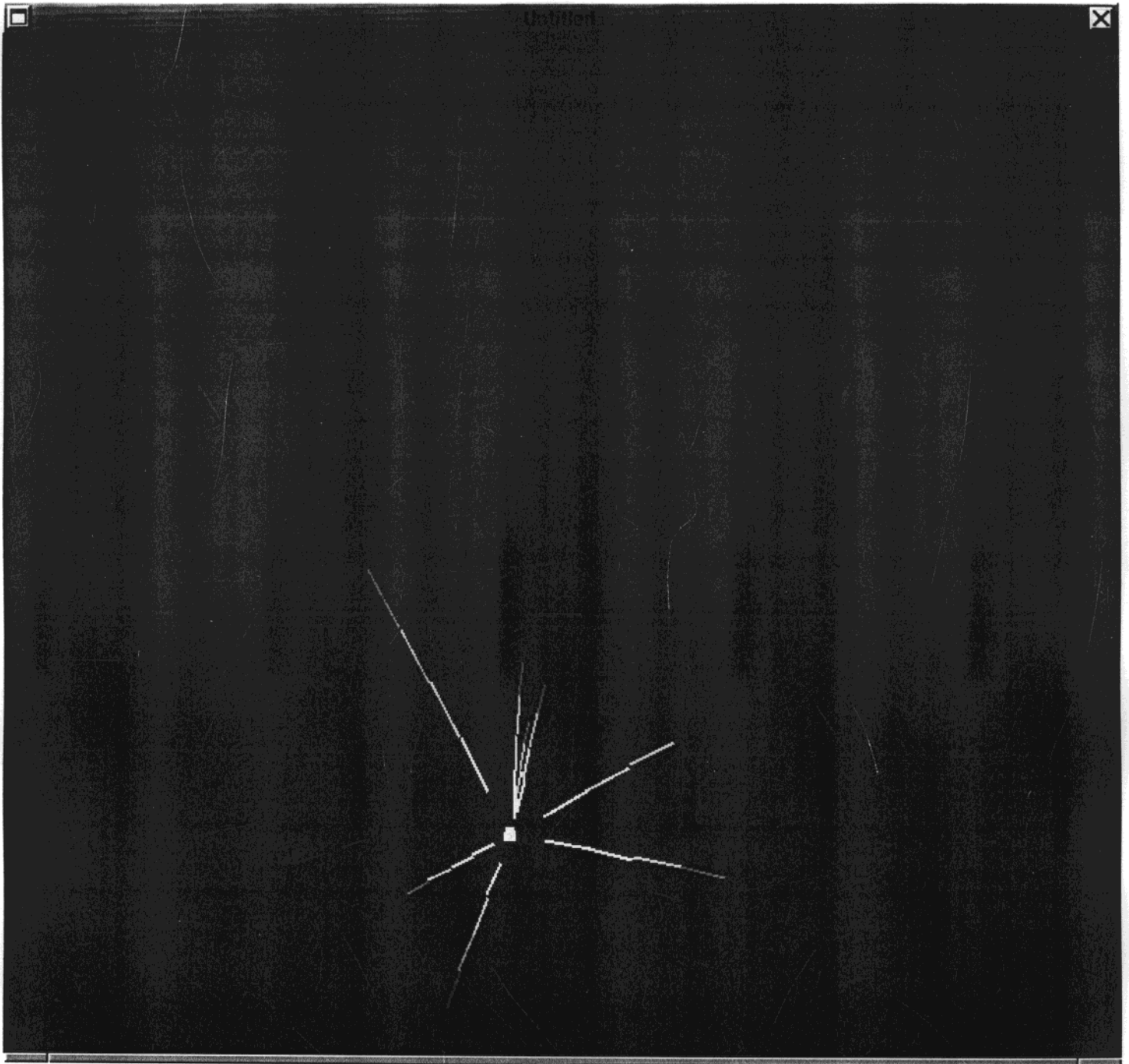


RUN 3267 EVENT 24207

Untitled

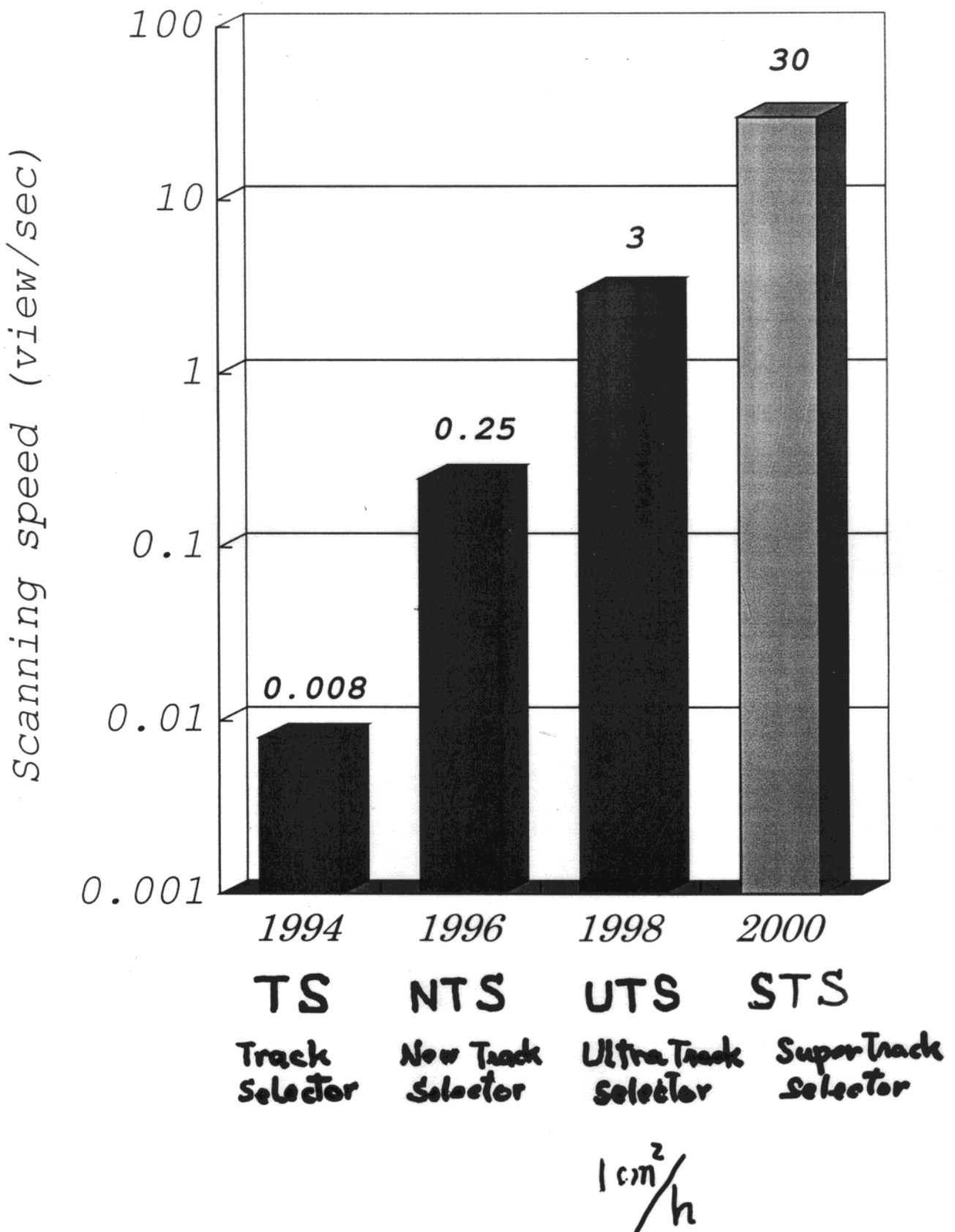


RUN 3267 EVENT 24207

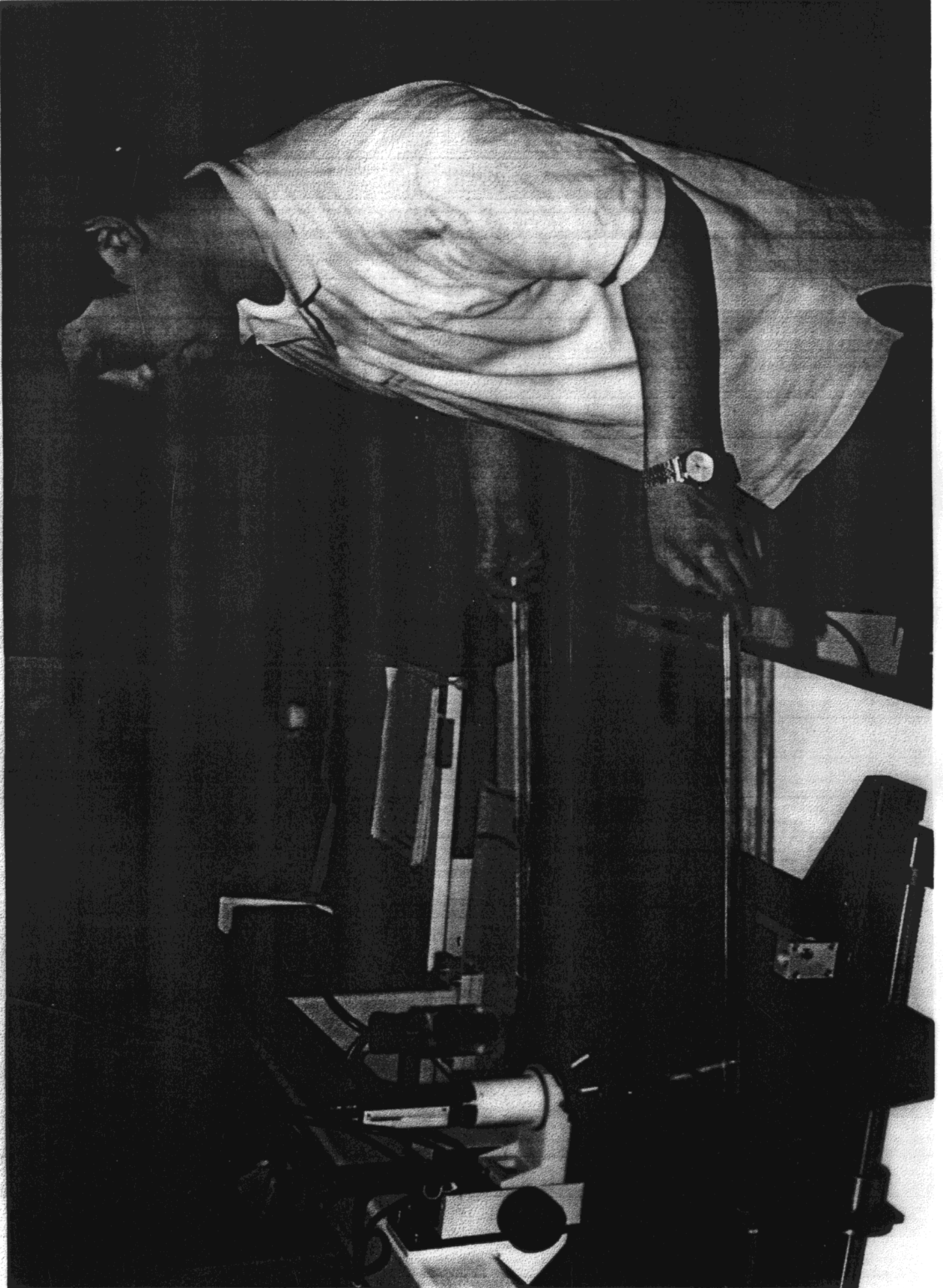


Track Selector developed by Nagoya Univ.

Scanning Power Roadmap

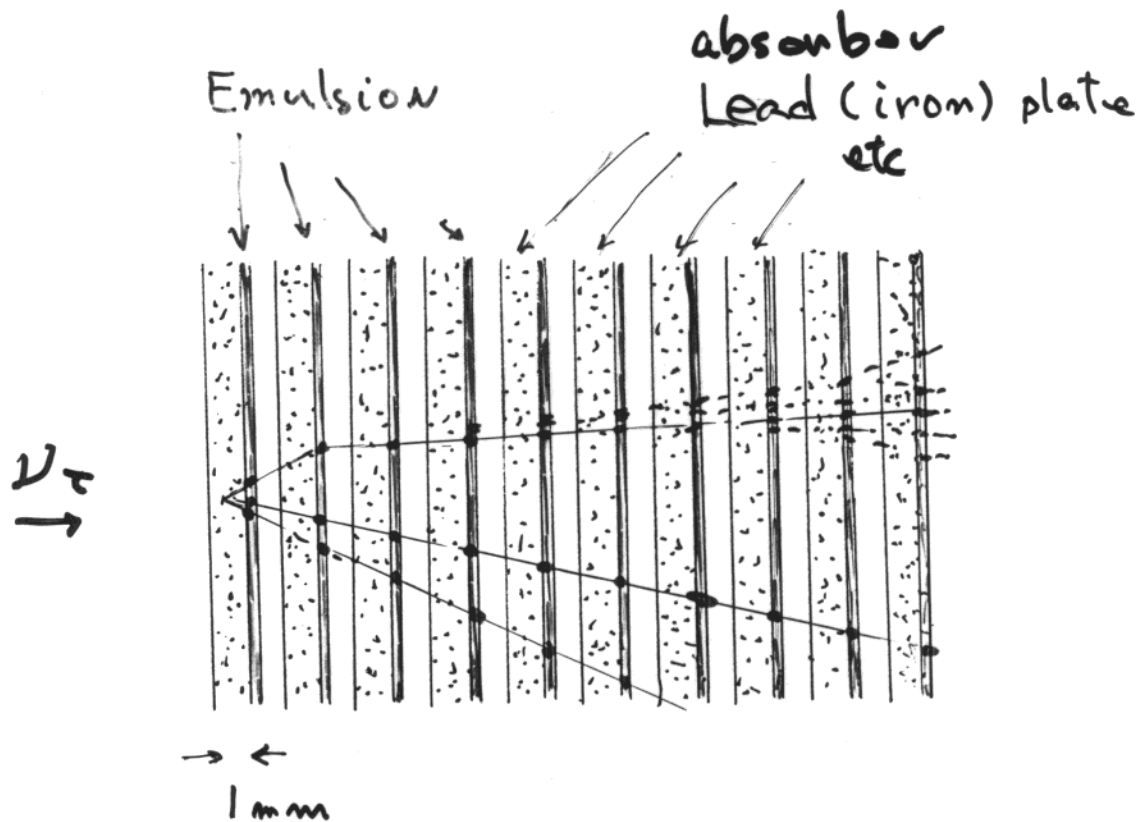


1961 / Na goga / Ona.



ECC

Emulsion Cloud Chamber



Tracking reso. $1\ \mu\text{m}$ (big area)
 $0.1\ \mu\text{m}$ (small area)

- momentum measurement by multiple scattering
- electron and γ -ray detection

Emulsion Experiments

Search for

ν_T interactions

		Target Mass	
①	CHORUS CERN	~ 1 ton	100k D
↑ E e c	DONUT FNAL	400 kg	13k D

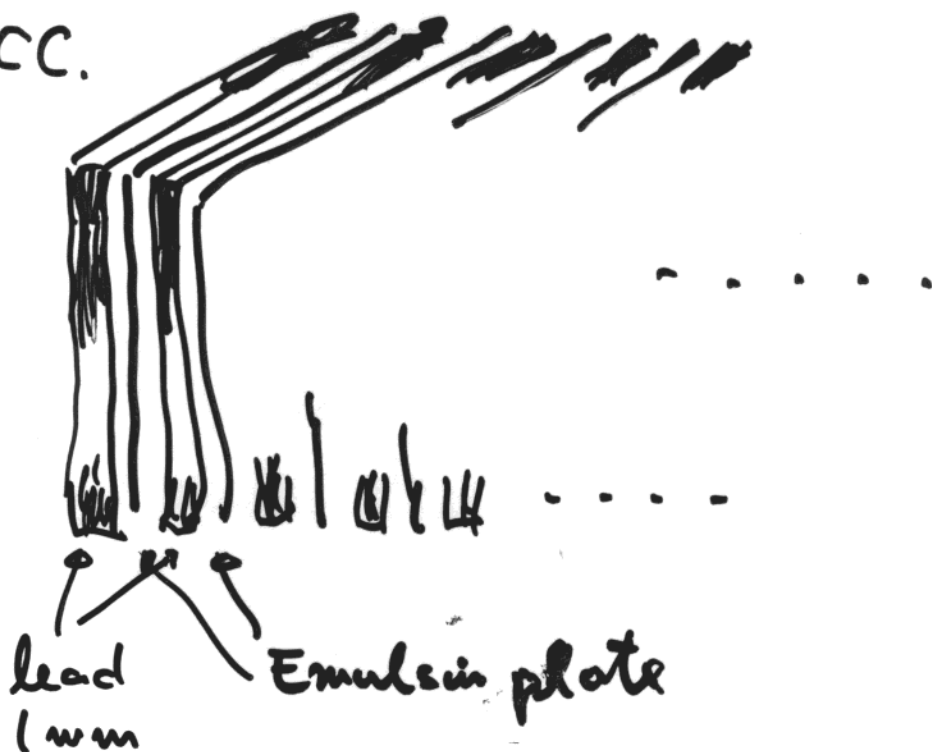
	TOSCA	~ 3	
	OPERA	700	Tons
	MINOS'	100 ~ 1K	

Mass production & cost.

Emulsion film

Fuji film Co. $100 \text{ km}^2 / 2 \text{ months}$
cost $\sim 100 \text{ \$} / \text{m}^2$

ECC.



$10 \text{ kg} / \text{m}^2 \cdot \text{layer.}$

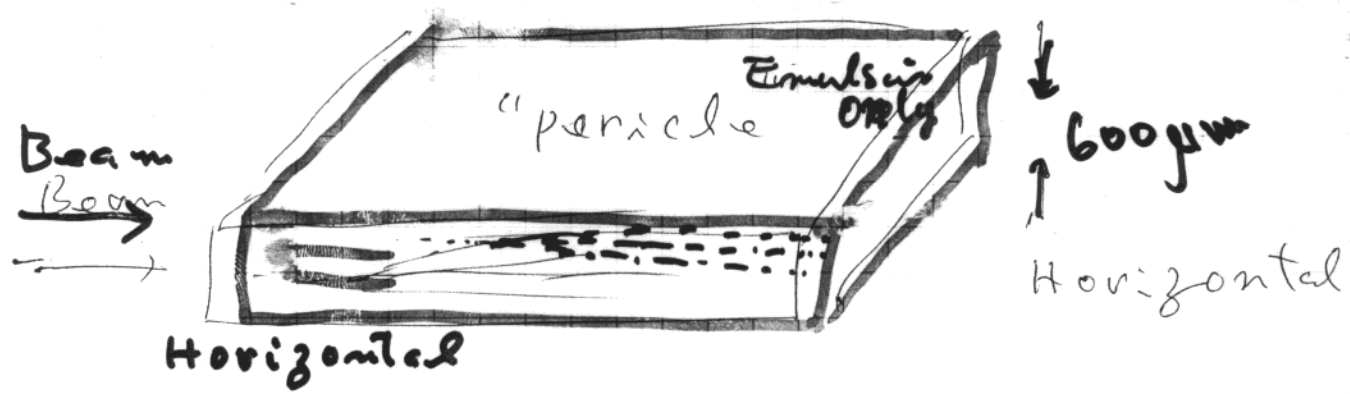
↓

$1 \text{ km ton} \sim 10^5 \cdot 100 \text{ \$} \approx \underline{10 \text{ M\$}}$

Summary / conclusion

(1) 1960 ~ 1990

Emulsion was used as a
 Super high res. "cloud chamber"



(2) NOW

Emulsion is a
 Super high res. "tracking detector"

- Automatic read out (Track Selector)
 On-line
- FCC (Big mass target)
- Cost of film Emulsion production
 (Fujifilm Co.)

Emulsion is a good
 candidate for ν_τ detection
 or $(\nu_\mu \rightarrow \nu_\tau \text{ oscillation})$