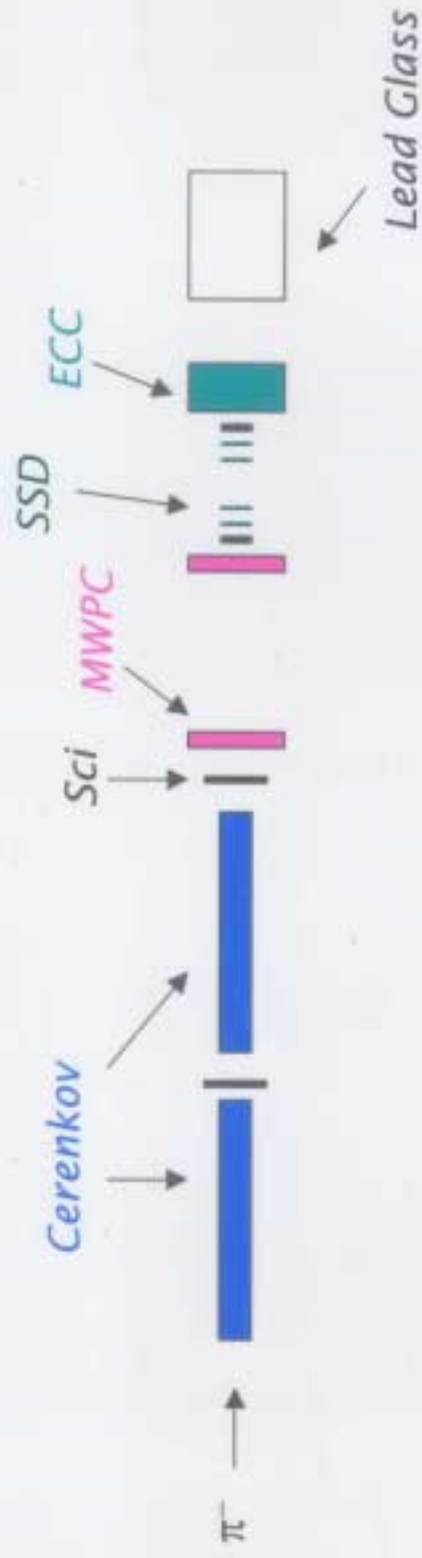


# *Gamma Detection in ECC*

*Analysis of Test Exposure for OPERA*

*Koichi Kodama  
Aichi University of Education  
2nd Emulsion Workshop 2002-Mar-08*

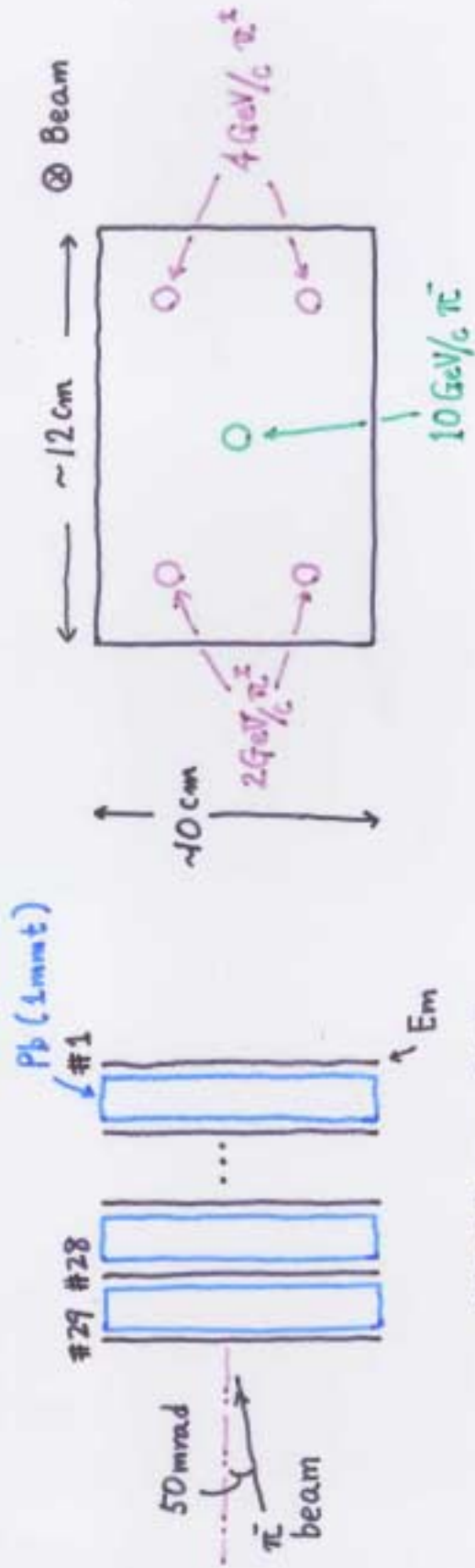
Try to detect  $\gamma$  produced by  $10\text{GeV}/c \pi^-$  interactions



CERN PS T7 beam line ( 2001-May-17 )

# Exposure

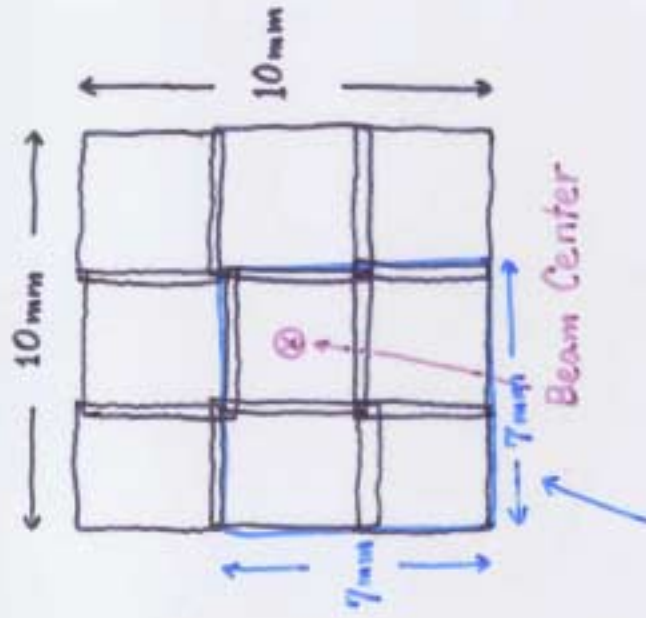
Beam  $\phi \sim 1\text{cm}$   
 $10\text{ GeV}/c\ \pi^-$   
 $\rho \sim 10^3/\text{cm}^2$



OPERA type ECC  
 (but 28 Pb plates)

# Emulsion DAQ

10 mm x 10 mm x 29 sheets

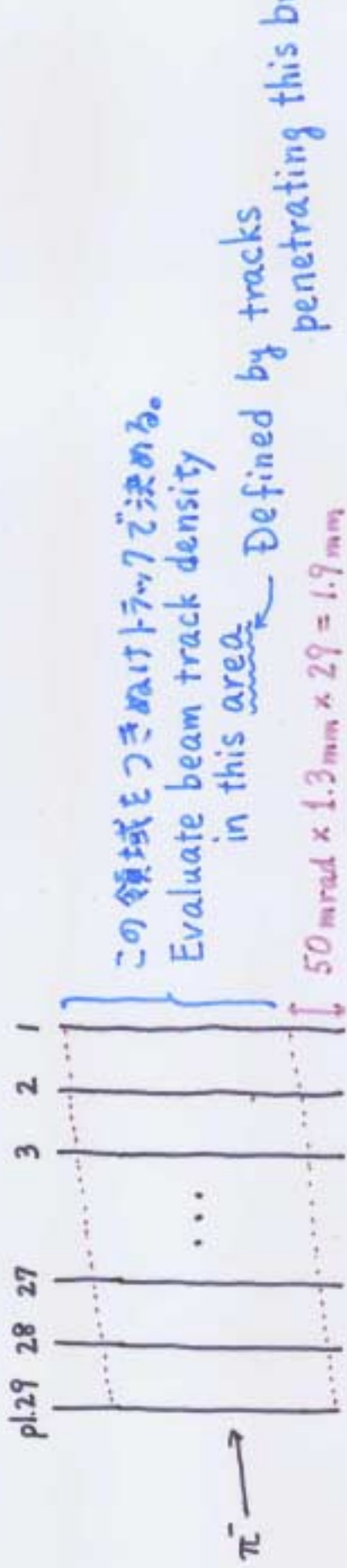


This analysis

Base track density

$$\text{ex. pl. } \phi \approx \frac{1796}{3 \text{ mm} \times 3 \text{ mm}} \sim 2 \times 10^4 / \text{cm}^2$$

# Measured Beam Density



penetrate tracks

$$\frac{1228}{6 \text{ mm} \times 5 \text{ mm}}$$

||

$$4.09 \times 10^3 / \text{cm}^2$$

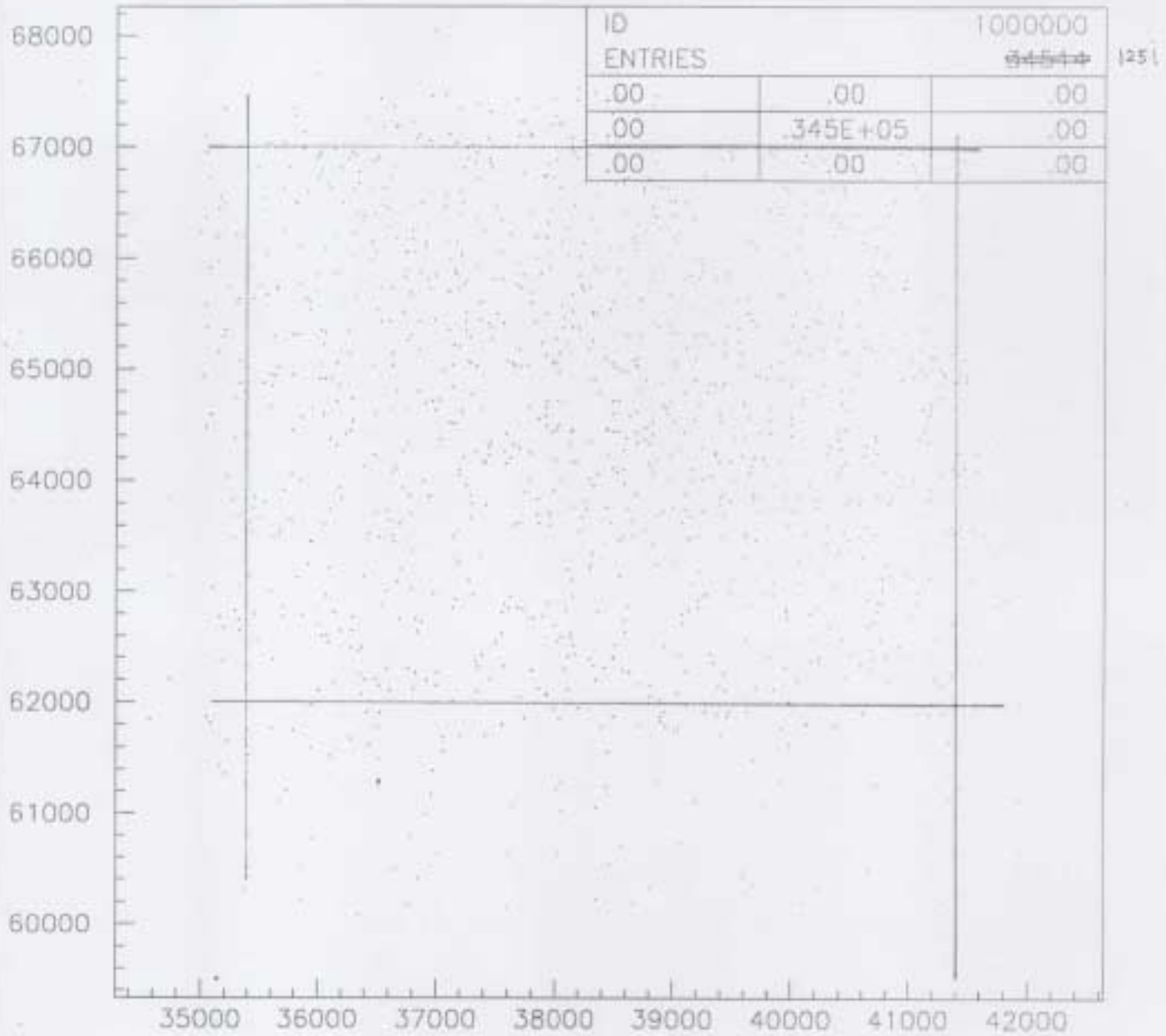
penetrate tracks

$$\frac{1006}{6 \text{ mm} \times 5 \text{ mm}}$$

$$\frac{1228 - 1006}{1228} = 0.184 \quad \longleftrightarrow \quad \lambda_{INT} \downarrow \quad 0.59\% \times (29 - 3) = 0.153$$

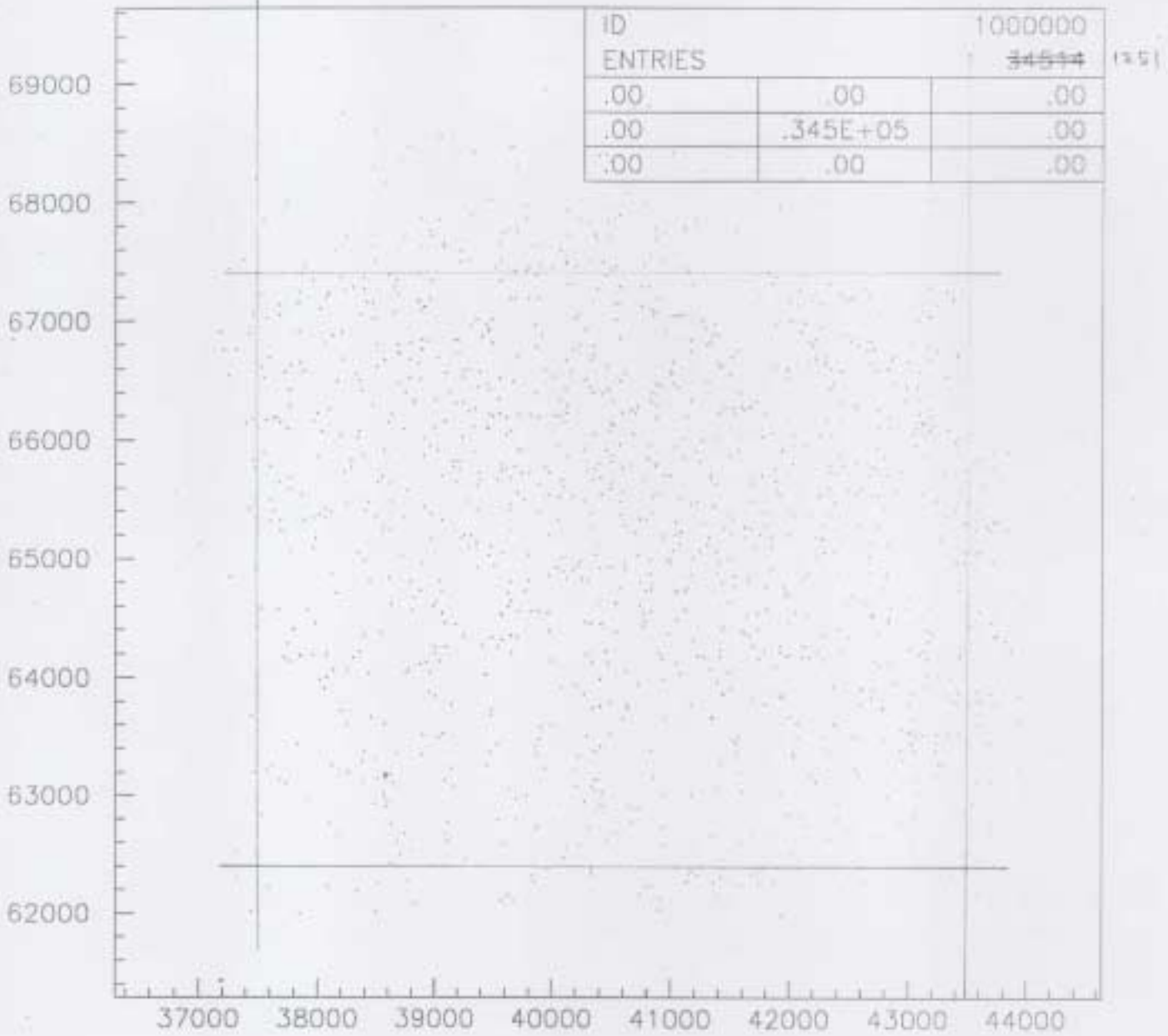
pl. 29

⊗ Beam



Position distribution of tracks  
penetrating a brick  
(pl. 29 - pl.  $\phi 1$ )

pl.  $\phi 1$

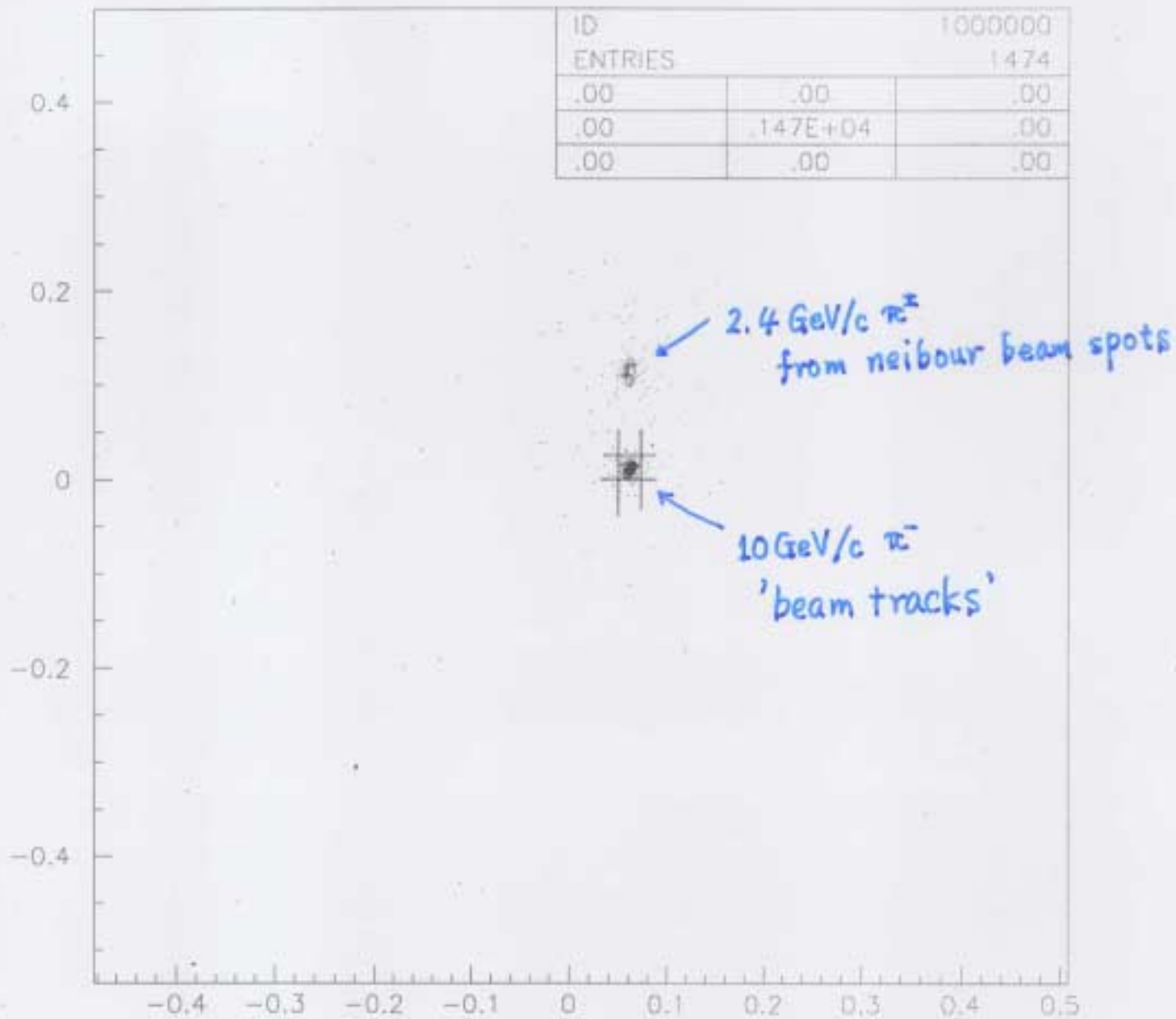


Y1 VS X1

thru tracks

pl. 29

ID	1000000	
ENTRIES	1474	
.00	.00	.00
.00	.147E+04	.00
.00	.00	.00



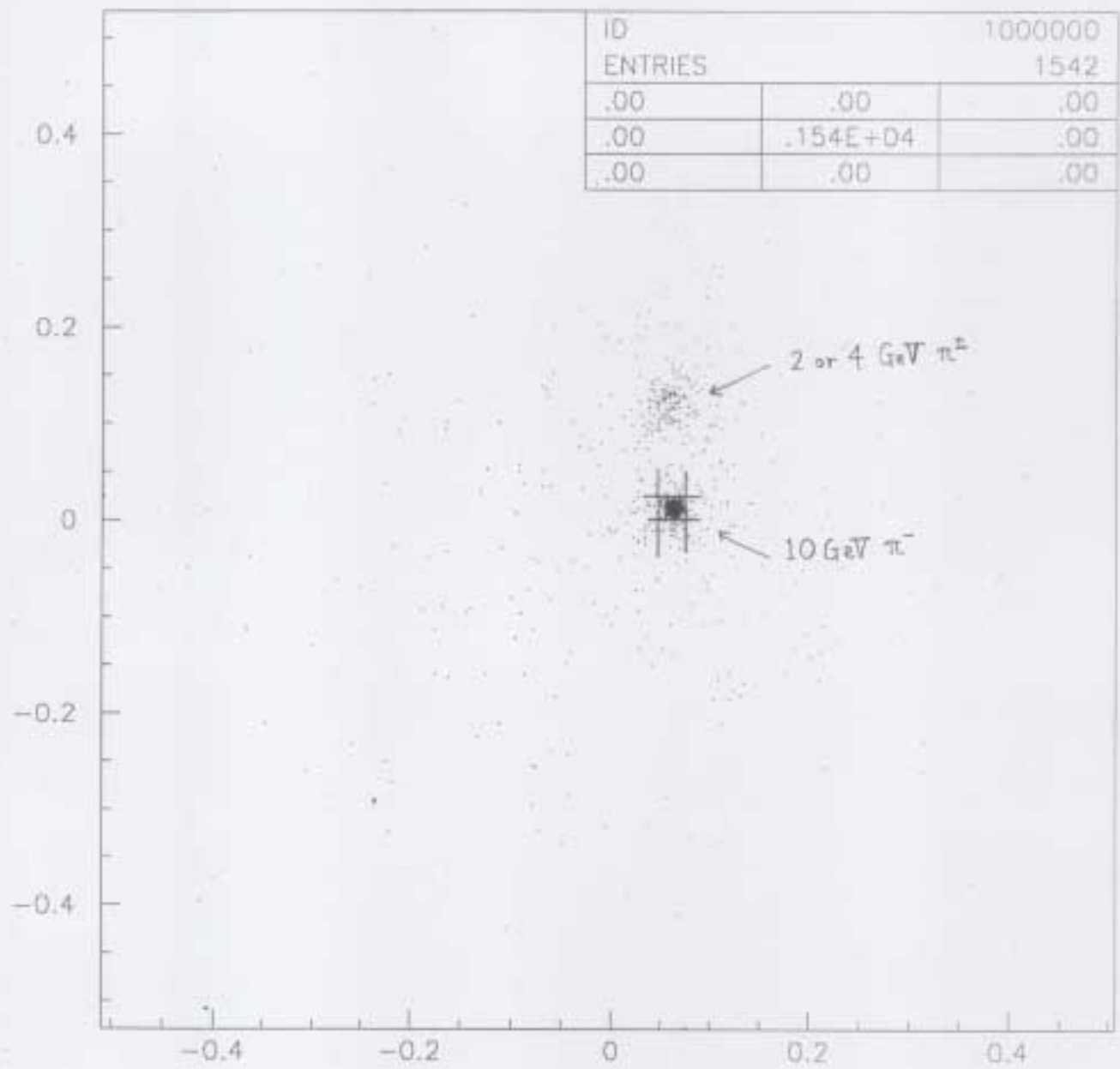
AY VS AX

pl 27 ~ pl 29 230017

Angle distribution of tracks  
penetrating pl. 29 ~ pl. 27



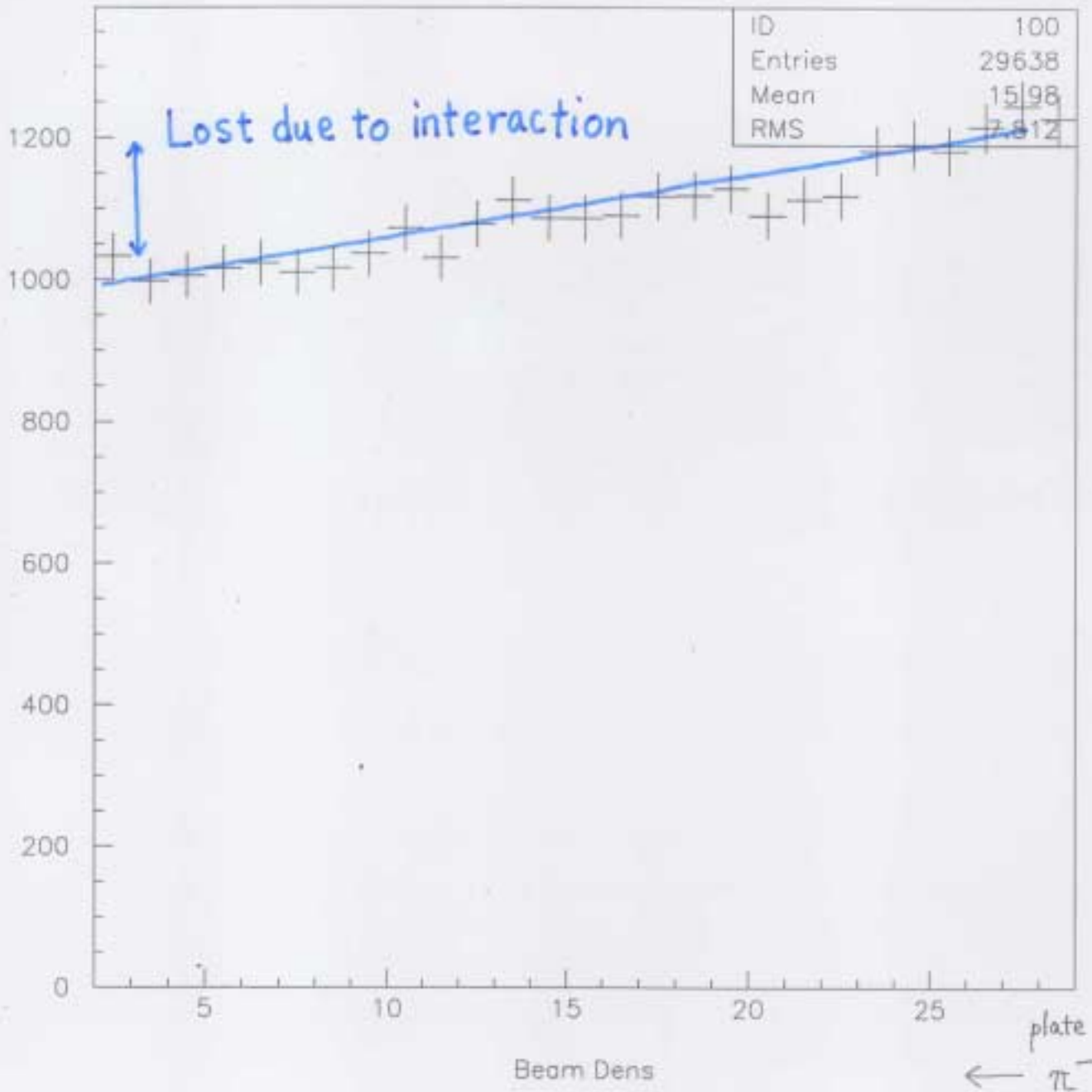
p1.φ1



AY VS AX

p1φ1 ~ p1φ3 につきぬけ

# Beam track density



Beam Tracks / 5 mm × 6 mm

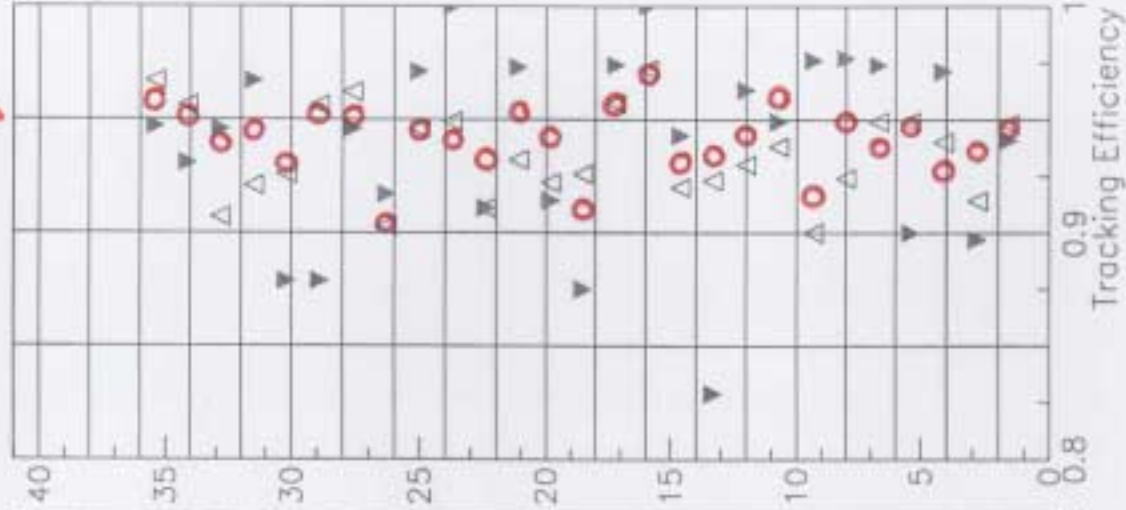
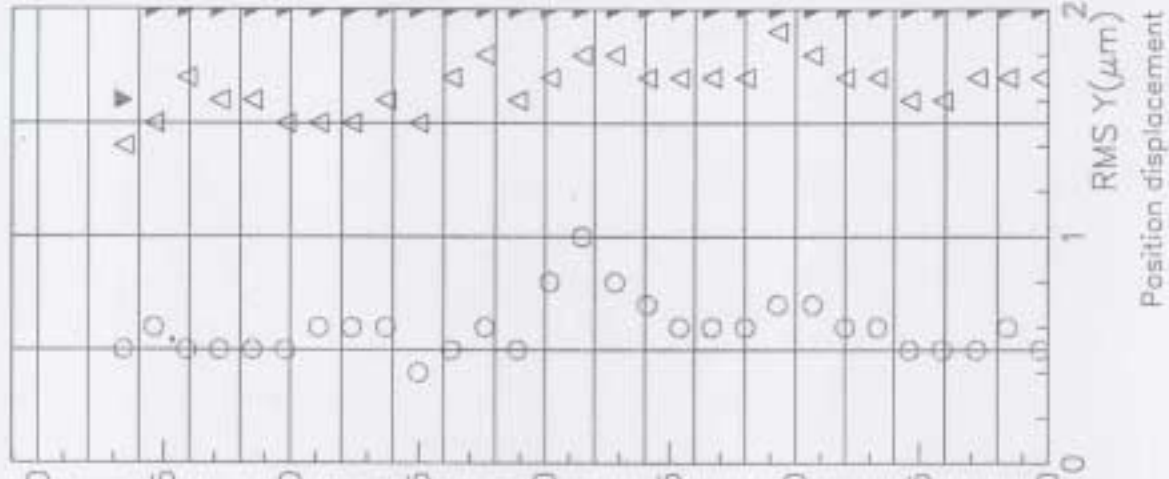
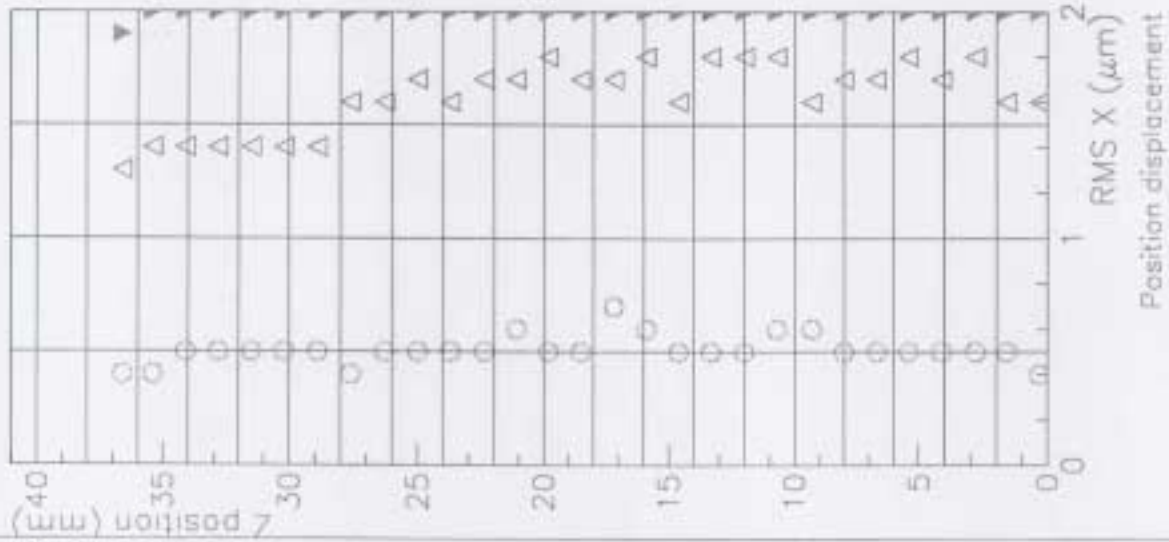
# Tracking Characteristics (Summary)

test

RUN=5555 EVENT=01111 MODULE=1

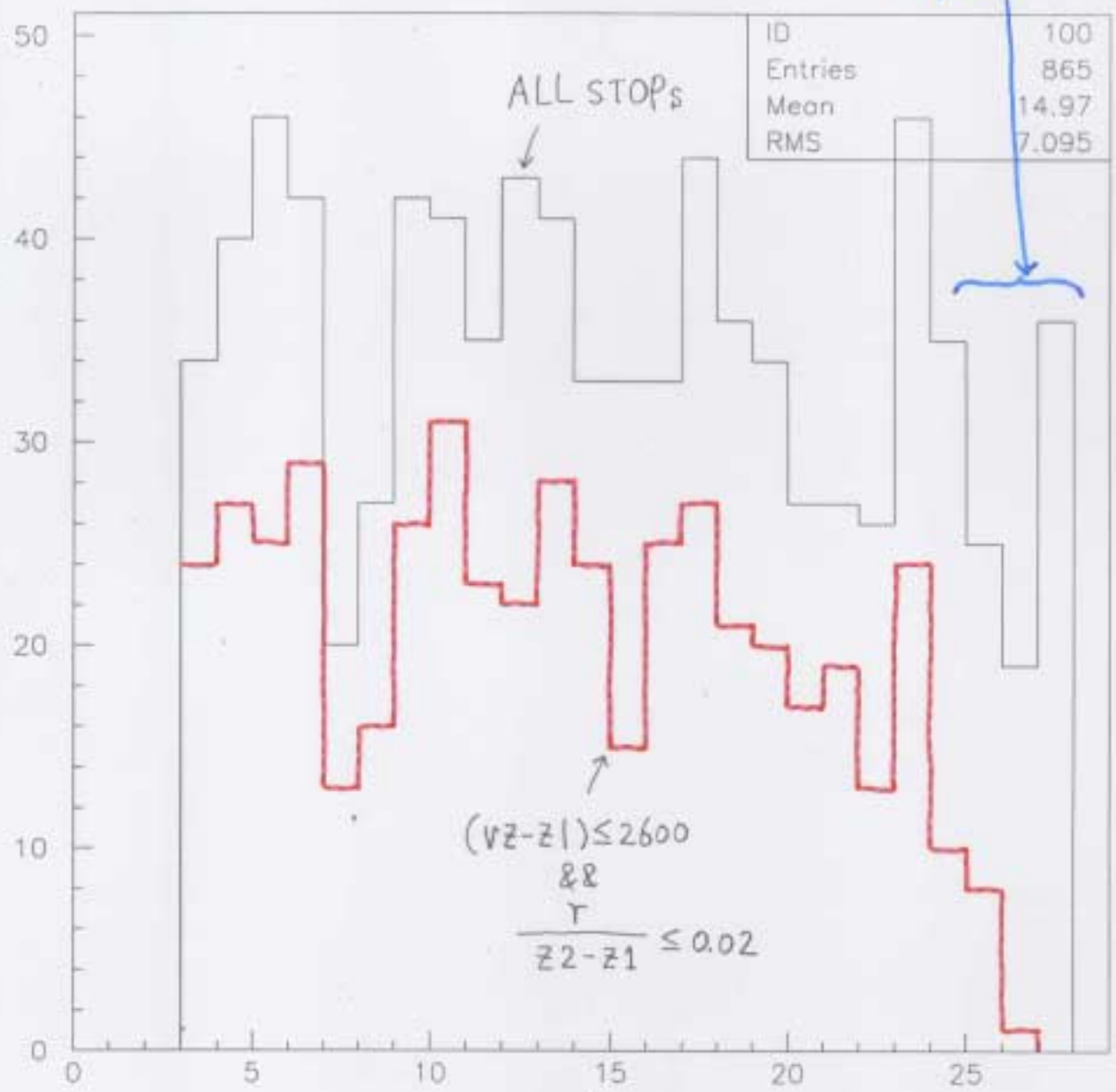
95% (base track) ↓

- $\phi < 0.1 \text{ rad}$
- △  $0.1 < \phi < 0.2 \text{ rad}$
- ▽  $\phi > 0.2 \text{ rad}$



Position (mm)	○	△	▽	mm
29-1	1.6k	239	19	7.4
28-1	1.7k	273	29	7.4
27-1	1.6k	280	37	7.4
26-1	1.7k	277	33	7.4
25-1	1.8k	296	33	7.4
24-1	1.7k	296	33	7.3
23-1	1.7k	290	37	7.3
22-1	1.7k	310	36	7.2
21-1	1.6k	297	34	7.3
20-1	1.7k	293	39	7.2
19-1	1.7k	292	45	7.1
18-1	1.6k	280	37	7.1
17-1	1.6k	281	35	7.1
16-1	1.6k	283	42	7.2
15-1	1.6k	300	36	7.1
14-1	1.6k	285	36	7.1
13-1	1.6k	288	35	7.1
12-1	1.5k	274	35	7.1
11-1	1.5k	272	27	7.1
10-1	1.5k	258	30	7.1
9-1	1.5k	261	32	7.1
8-1	1.4k	249	43	7.2
7-1	1.4k	253	36	7.1
6-1	1.3k	256	41	7.0
5-1	1.3k	252	35	7.1
4-1	1.3k	257	32	7.0
3-1	1.2k	233	34	7.0
2-1				7.0
1-1				7.0

$\gamma_s$  from  
up stream int.



## Primary track selection

Down going stop tracks  $\rightarrow$  233 tracks /  $7_{\text{mm}} \times 7_{\text{mm}}$

- $\geq 3$  segs (i.e. 23 em. sheets)
- not reconnected with  $P_{\text{min}} = 1 \text{ GeV}/c$

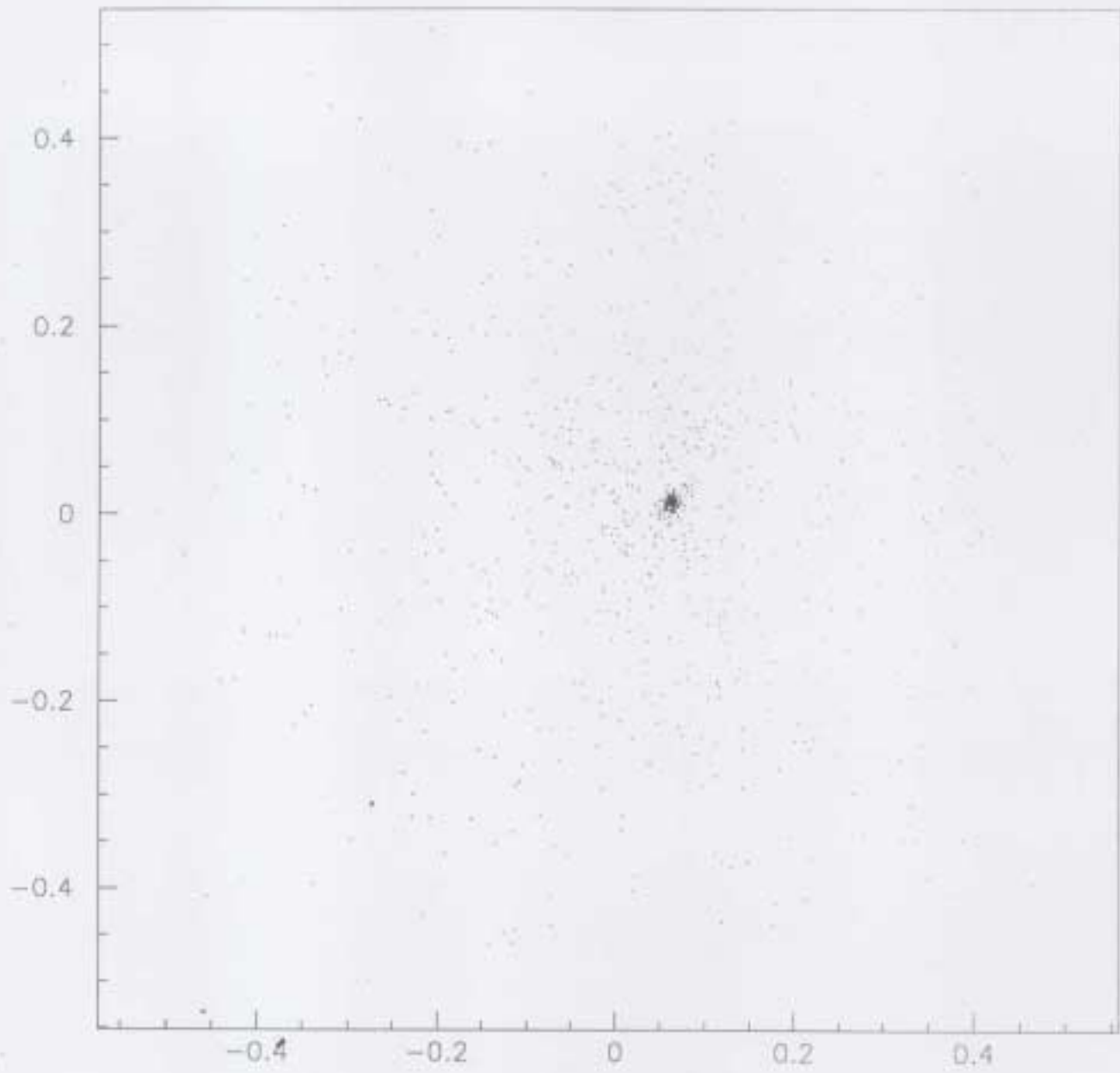
$$\circ \left\{ \begin{array}{l} \theta_x = 0.060 \pm 0.020 \\ \theta_y = 0.010 \pm 0.010 \end{array} \right.$$

## Charged secondary & electron selection

Up going stop tracks  $\rightarrow 865 \text{ tracks} / 7_{\text{min}} \times 7_{\text{min}} \times (29-4)$

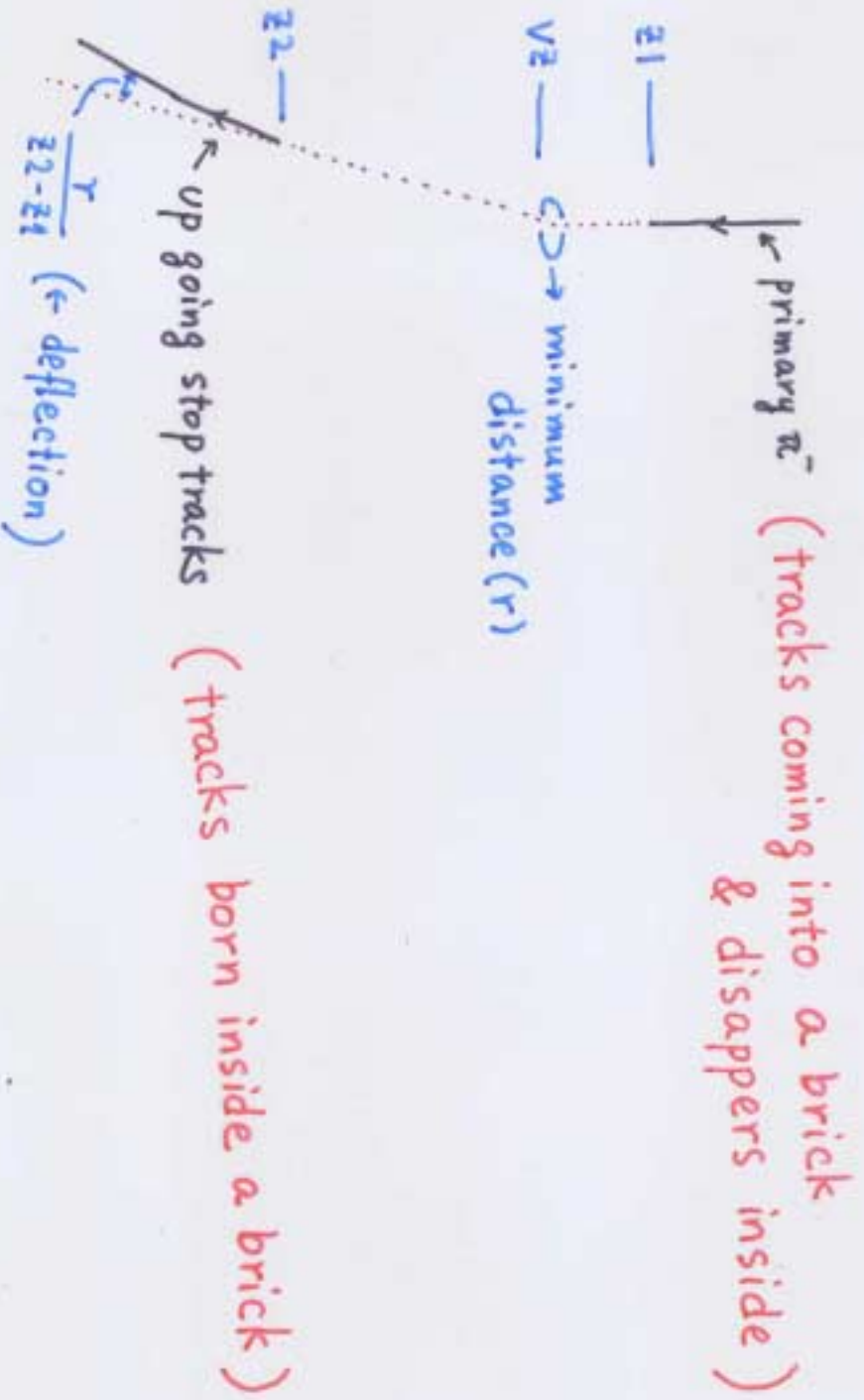
- $\geq 3$  segs (i.e. 3 em. sheets)
- not reconnected with  $P_{\text{min}} = 1 \text{ GeV}/c$

# Up Going Stop Tracks



AY VS AX

Search for Interactions with  $\gamma$  (e-pair) and/or charge secondary





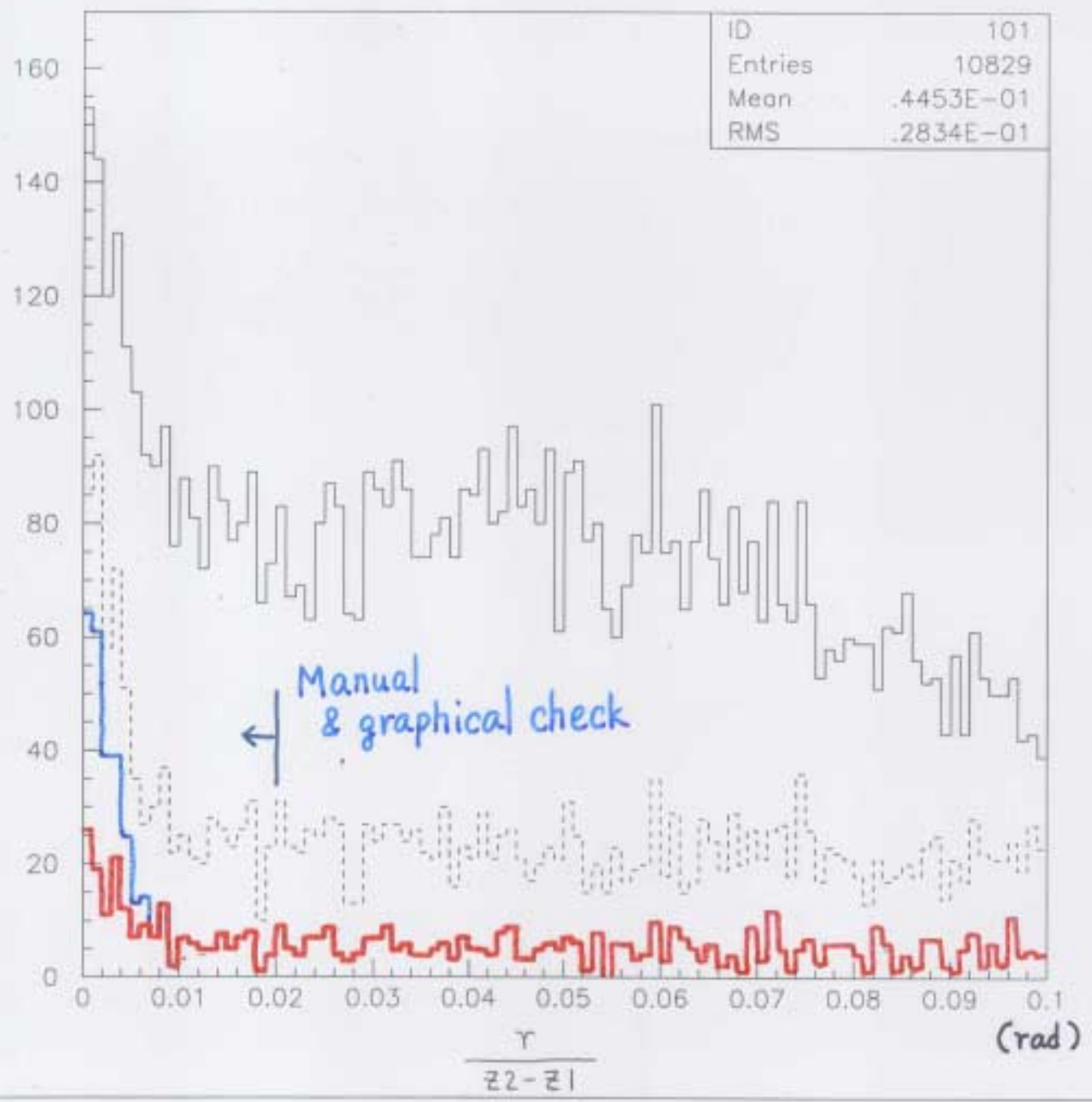
Secondary  
included also...

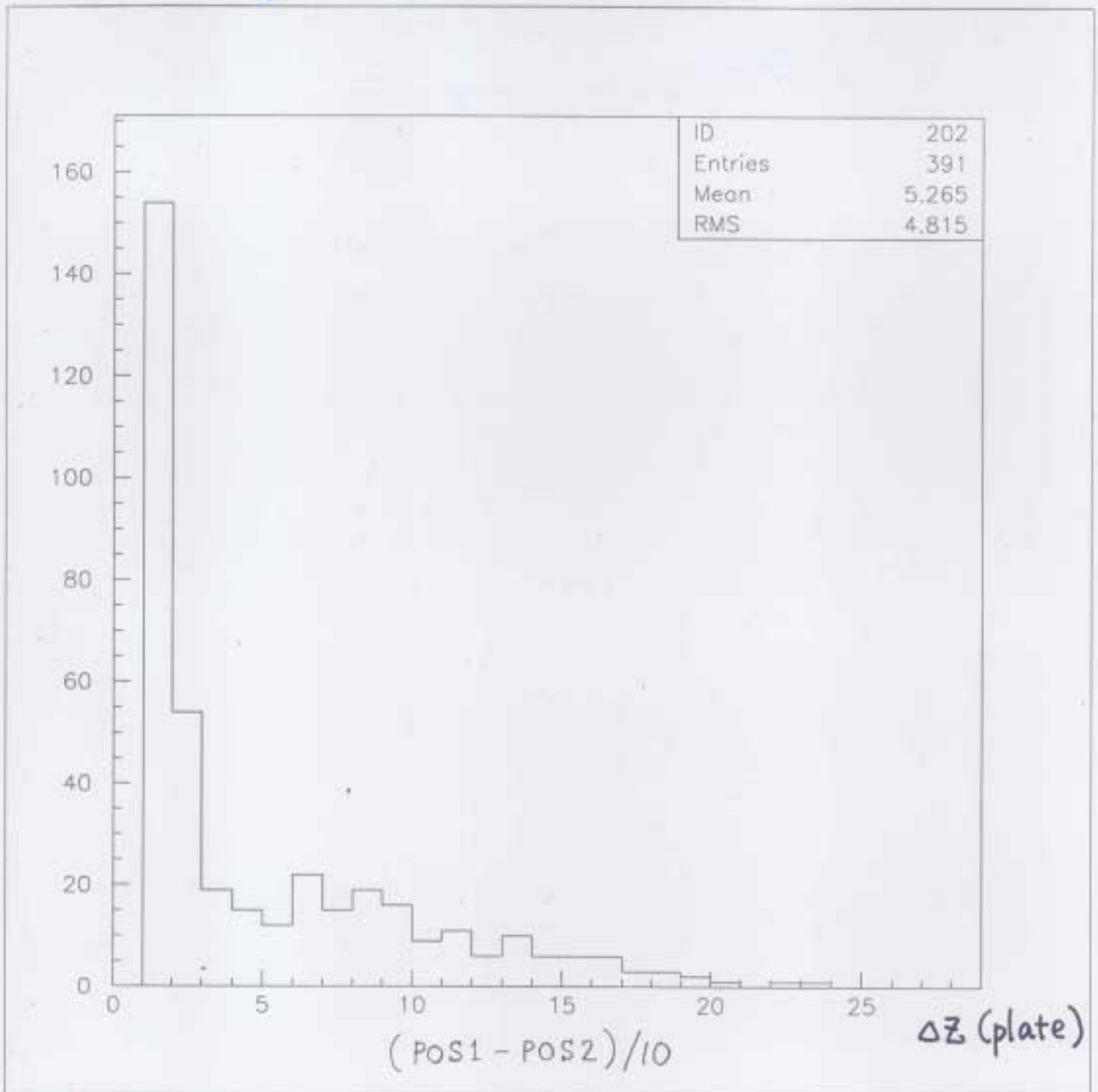
$z_2 - z_1 \leq 14000$  &&  $v_2 - z_1 \leq 2600$

Y candidate  
selection

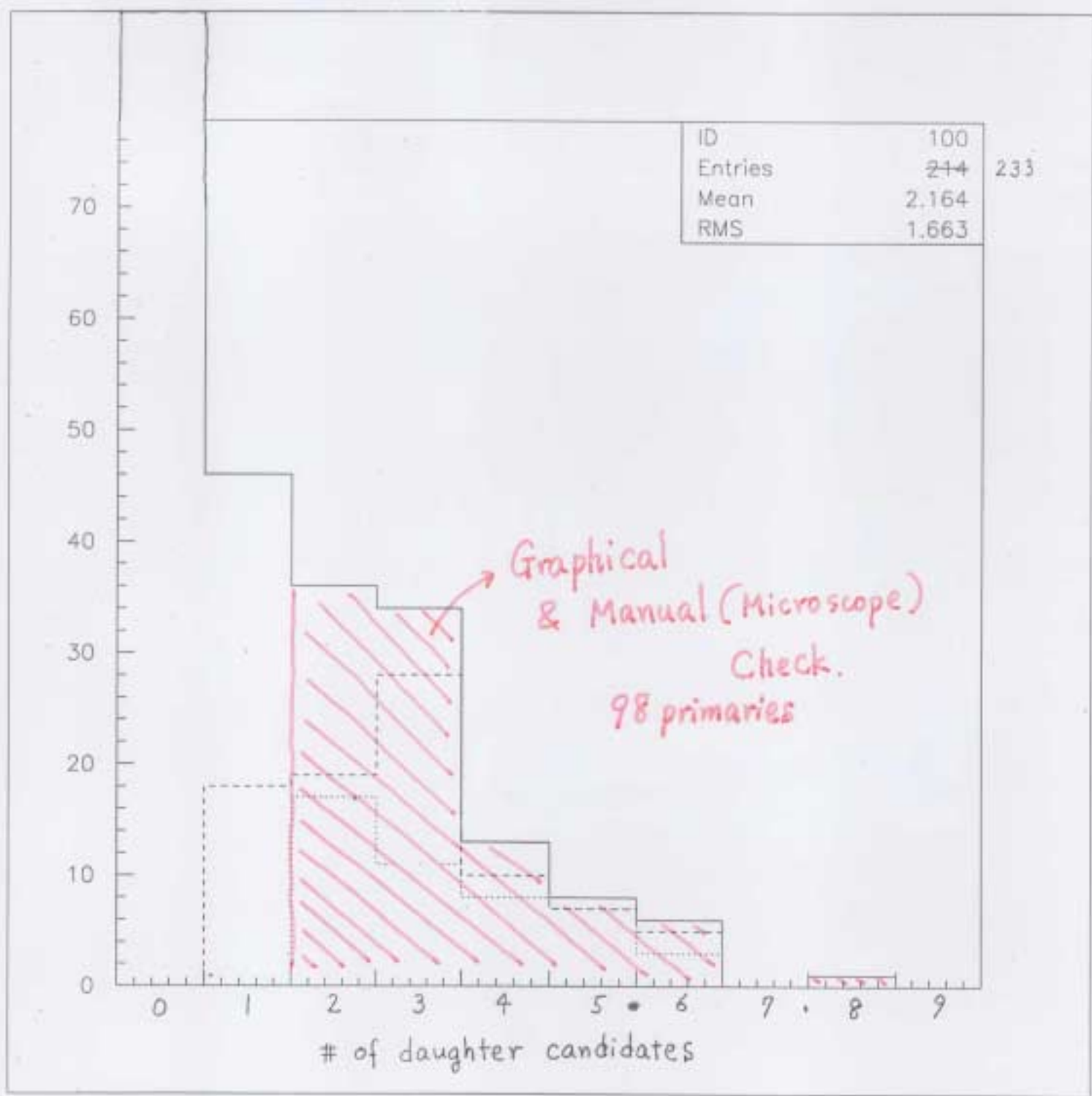
→  $z_2 - z_1 \geq 2000$

ID	101
Entries	10829
Mean	.4453E-01
RMS	.2834E-01



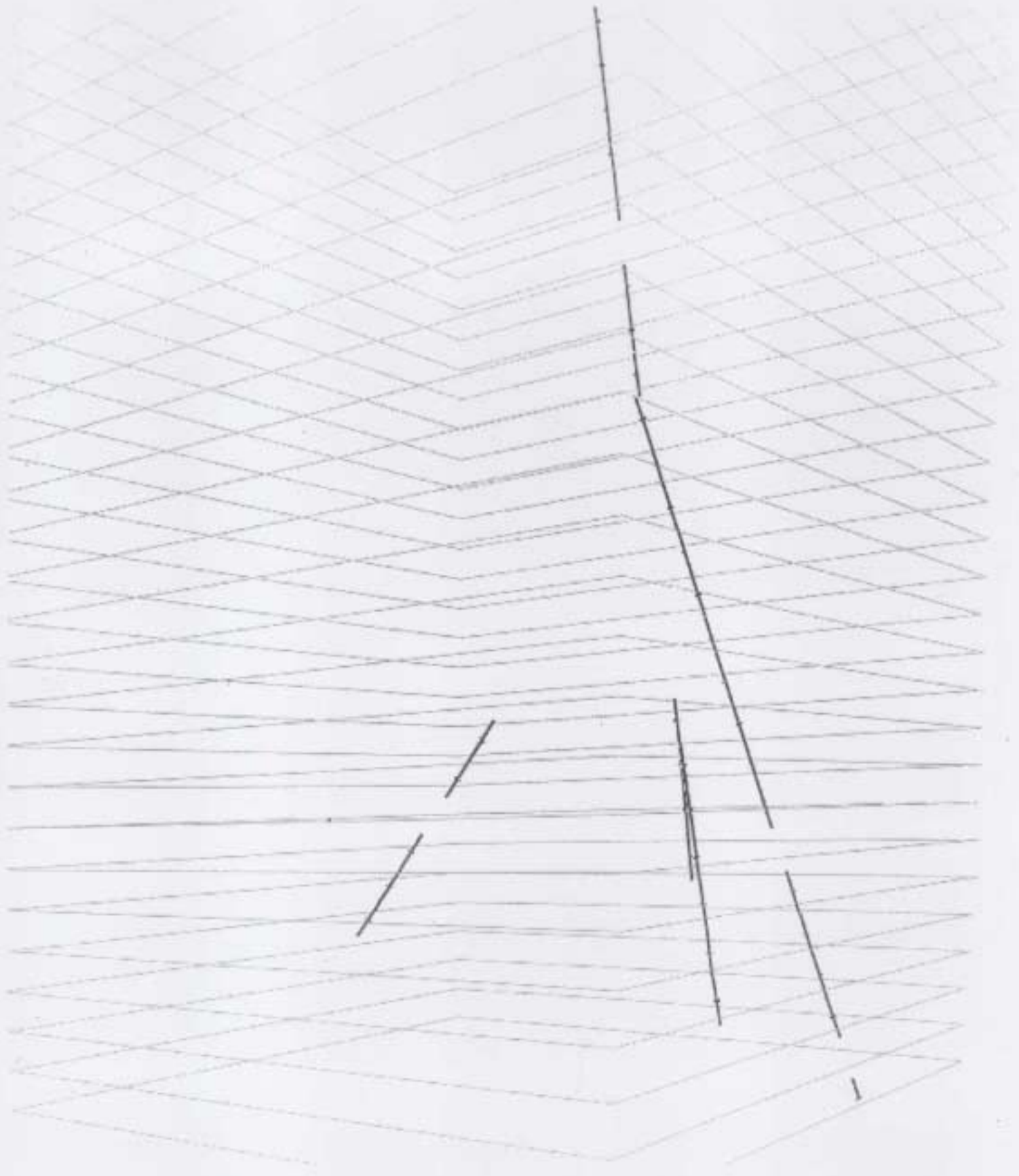
$\Delta z$ electron ( $r$ ) candidate

$$(vz - z1) \leq 2600 \ \&\& \ \frac{r}{z2 - z1} \leq 0.02$$



~0.04





## Summary

- Gamma detection in  $10\text{GeV}/c$   $\pi^-$  interactions is being tested for OPERA type ECC brick
- So far,
  - 1 event with 2 electron pairs
  - 2 events with 1 electron pair ← — not confirmed by eyewere detected among 98 interactions

## Next

- More statistics ( larger fiducial volume for  $\gamma$  detection )
- Energy determination by MCS to evaluate invariant mass