# Recent Results from DONUT

NAKAMURA M.
(Nagoya Univ)

( 2000 APRIL 3 )

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1. Overview of DONUT
2. New Scanning Strategy "NET SCAN"
3. Σ Candidates Selection
4. Candidates (We have 5.)
5. Summary

# AIM of ĐONUT

Đirect Observation of $\nu_\tau$ Interactions

# Method

$\nu_\tau$ enhanced Beam
(Prompt $\nu$ Beam)

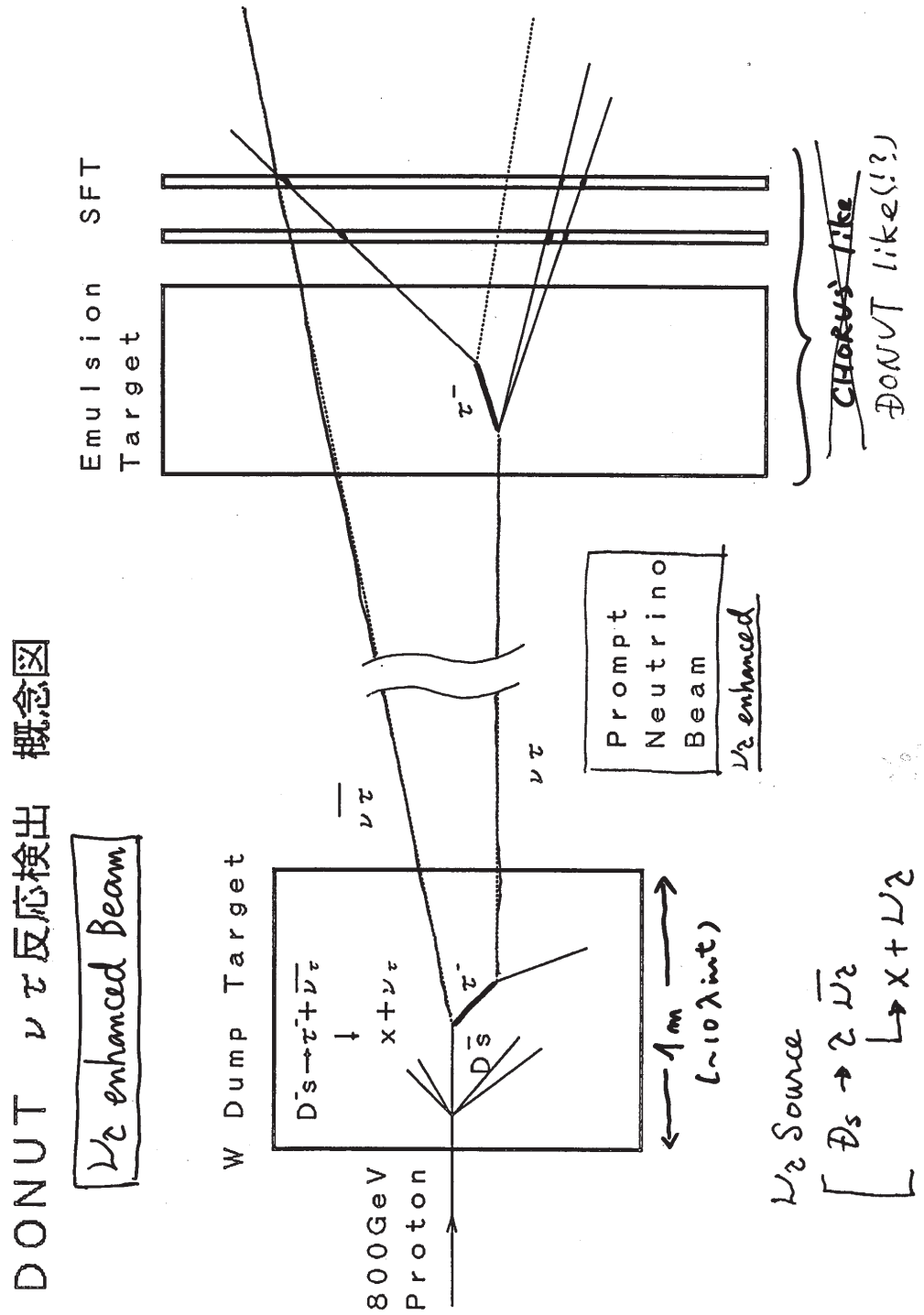
+

Emulsion Cloude Chamber

+

~~CHORUS Type Event Analysis~~

NETScan


DONUT νt 反応検出 概念図
νt enhanced Beam
Emulsion SFT
Target
W Dump Target
800GeV
Proton
Prompt
Neutrino
Beam
νt enhanced
~1m
(~10λint)
Chorus like
DONUT like(!?)
νt Source
Ds → τ νt
↳ X + νt

# Pre-History of DONUT

1992 First Observation of $D_s \to \mu\nu$
in CERN WA75 Collab. (Dr. M. KOBAYASHI)
(Prog. Theo. Phys. 89 (1993) 131-138)

$$\frac{Br(D_s \to \tau\nu_\tau)}{Br(D_s \to \mu\nu_\mu)} = \left(\frac{m_\tau}{m_\mu}\right)^2 \times \left(\frac{1-\left(\frac{m_\tau}{m_{D_s}}\right)^2}{1-\left(\frac{m_\mu}{m_{D_s}}\right)^2}\right) \sim 9.2$$

$Br(D_s \to \mu\nu_\mu) \sim 0.8\%$
$\Rightarrow Br(D_s \to \tau\nu_\tau) \sim 3.7\%$

1993 First Observation of $D_s \to \tau\bar{\nu}_\tau$
$\hookrightarrow \mu\bar{\nu}_\mu\nu_\tau$
in FNAL-E653 Collab. (Dr. M. KOMATSU)

$$\Rightarrow \frac{\nu_\tau^{cc} + \bar{\nu}_\tau^{cc}}{(\nu_{all}^{cc} + \bar{\nu}_{all}^{cc})} \sim 5\% \ (!)$$

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1994/1 Proposal
1994/end Approved
1996-97 Fixed Target RUN
1998/6 Report of the first candidate observation at $\nu$98
⋮

First Observation of Ds → μν (199?



Progress Theoretical Physics, Vol. 89, No. 1, January 1993

# Observation of the Muonic Decay, $D_s^{\pm} \to \mu^{\pm}\nu_{\mu}$

WA75 Collaboration

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[f)] *Department of Physics and Astronomy, University College London London WC1E 6BT*
[g)] *CERN, CH-1211 Geneva 23*
[h)] *Department of Physics, Toho University, Funabashi 274*
[i)] *Aichi University of Education, Kariya 448*
[j)] *Faculty of Education, Yokohama National University, Yokohama 240*
[k)] *Physics Department, Gifu University, Gifu 502*
[l)] *Dipartimento di Fisica Teorica e SMSA, Università di Salerno and INFN, I-84100 Salerno*
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(Received August 3, 1992)

The muonic decay of charmed strange mesons has been observed directly, in the analysis of a sample of 144 decays of charged charmed particles into a muon and no other charged particle. The branching ratio is estimated to be $BR(D_s^{\pm} \to \mu^{\pm}\nu_{\mu}) = (4.0^{+1.4}_{-1.2} \pm 1.7) \times 10^{-3}$, assuming a ratio $r = 0.27$ between production cross sections of $D_s^{\pm}$ and neutral charmed particles. The decay constant $f_{D_s}$ is estimated to be $(232 \pm 45 \pm 20 \pm 48)\,\mathrm{MeV}/c^2$ and does not depend on theoretical assumptions.

## § 1. Introduction

A measurement of the leptonic decay branching ratios of heavy pseudoscalar mesons provides a direct estimate of their pseudoscalar decay constants $f_P$, analogue

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a muon with $p_T \geq 0.85\,\mathrm{GeV}/c$ was carried out. A few events were removed because of errors either in the previous measurements or in data recording: To be more precise, two events were removed from the sample of charged-particle and three from that of neutral-particle decays; in all the other cases, no discrepancy was observed within the errors. Table I shows the main features of the charged decays with muon $p_T \geq 0.85\,\mathrm{GeV}/c$. It can be seen that the accuracy achieved in the $p_T$ measurement is on the average 3%. On the other hand, the accuracy achieved in the muon $p_T$ measurement from neutral decays decreases to 6% on the average, owing to the larger uncertainty in the determination of the line-of-flight of neutral particles. Finally, any systematic errors in muon momenta were less than 0.7% from an analysis of events where a $J/\psi$ was produced.[8)]

## § 3. Analysis and results

The fraction of leptonic decays could be extracted from a sample of semi-leptonic decays if the spectrum of lepton momenta in the c.m. system of the charmed particle were available. In fact, for a two-body decay $p_l^*$ has values of $0.98\,\mathrm{GeV}/c$ for $D_s^{\pm} \to \mu^{\pm}\nu_{\mu}$, and $0.93\,\mathrm{GeV}/c$ for $D^{\pm} \to \mu^{\pm}\nu_{\mu}$, whereas for multi-body decays $p_l^*$ spreads over phase space up to the kinematical limit. In the laboratory system the same technique can be applied using transverse momenta, taking into account that the $p_T$ distribution from a two-body decay appears as a spectrum peaked at the kinematical limit but also extends towards smaller values.

Figure 1 shows the muon $p_T$ distributions in decays with different topologies, namely C1 (charged particles into a single charged particle), and N2 (neutral particles into two charged particles); 144 decays are observed as C1 (Fig. 1(a)) and 157 as N2

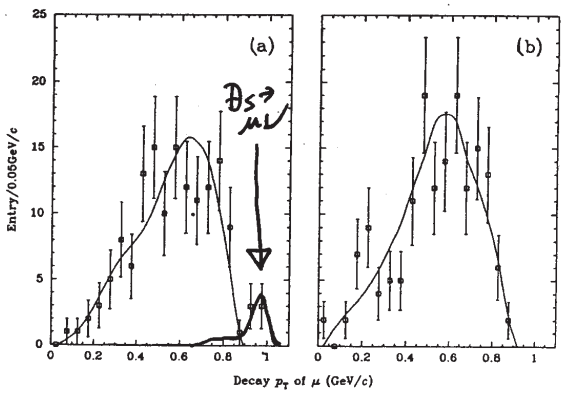



Fig. 1. Decay $p_T$ distributions of muons from 144 C1 decays (a) and from 157 N2 decays (b). The solid lines represent Monte Carlo results; the contribution from $D_s^{\pm} \to \mu^{\pm}\nu_{\mu}$ in (a) is evaluated to be $9.1^{+3.8}_{-3.0}$ events in the absence of background.

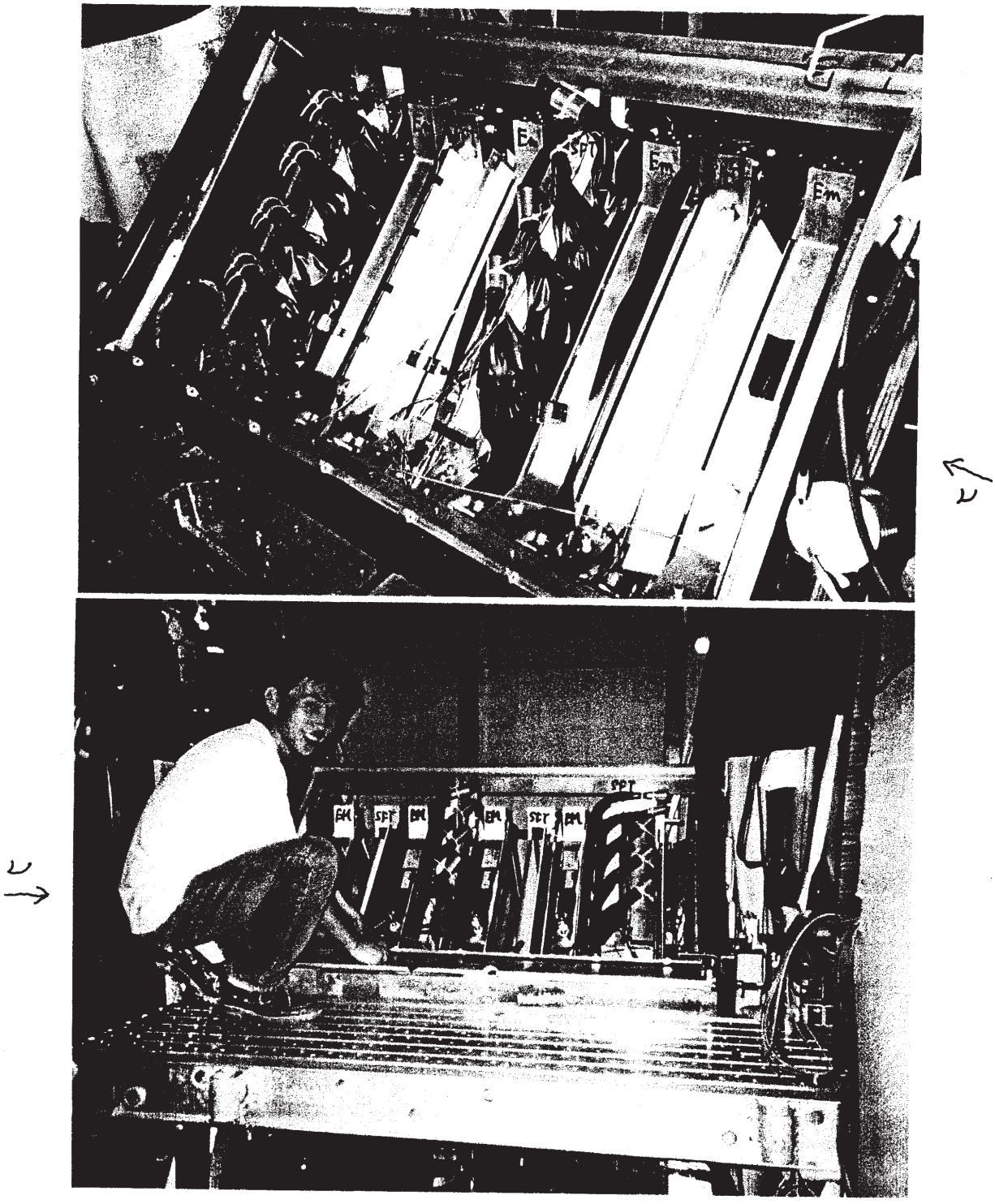


Nakamura Seminar 3 April 2000

# Collaboration List

DONUT · FNAL · E872

| | |
|---|---|
| Japan | Nagoya Univ. |
| | Kobe Univ. |
| | Aichi Univ of Education |
| | ⋮ |
| USA | Fermilab |
| | Minnesota Univ. |
| | Tuft Univ. |
| | Pittuburgh Univ. |
| | ⋮ |
| KOREA | Gyeonsang National Univ. |
| | ⋮ |
| Greek. | University of Athens |


Em
Spt
Em
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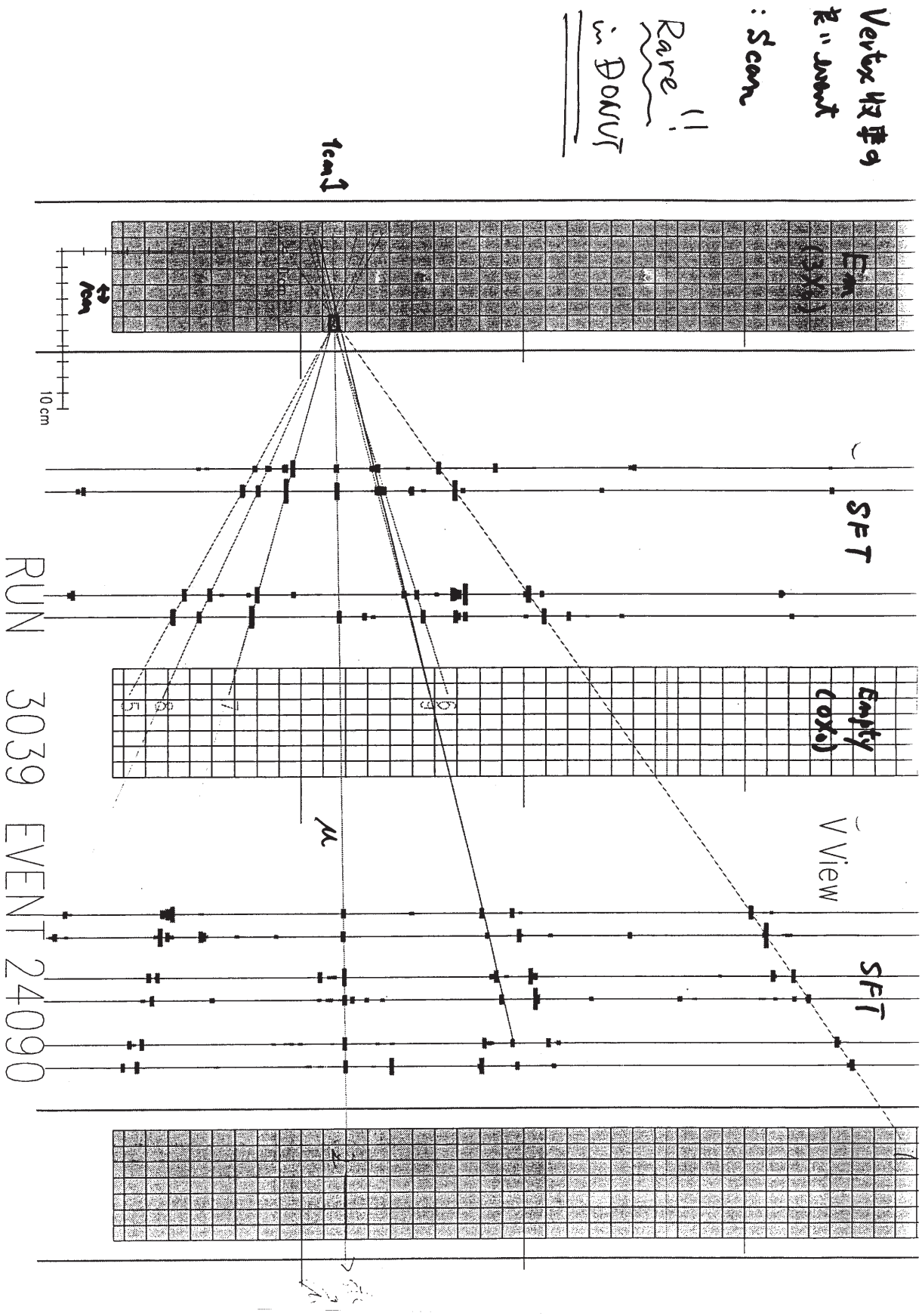
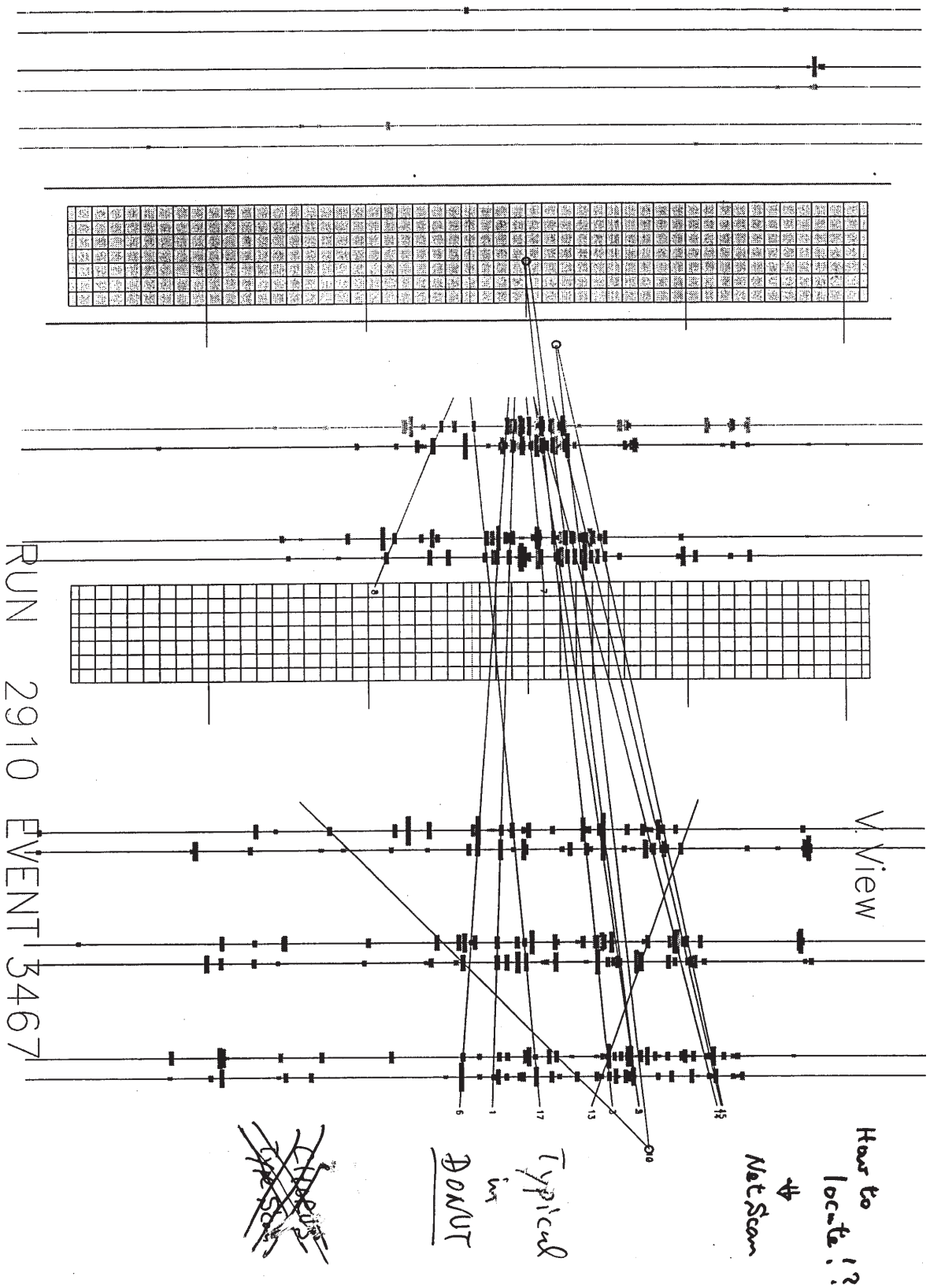
Em


Vertex 収束
k" event
: 5cm
Rare !!
in DONUT
1cm
Em
(3X0)
SFT
Empty
(0X0)
V View
SFT
10 cm
RUN 3039 EVENT 24090


RUN 2910 EVENT 3467
V. View
How to locate!?
Net Scan
Typical in DONUT

# Statistics in DONUT

Recorded & Counter Reconstructed Vint Candidate

$\sim 750$ ev. ( @ $3.54 \times 10^{17}$ Proton on Target )

In the region with reasonable BG.

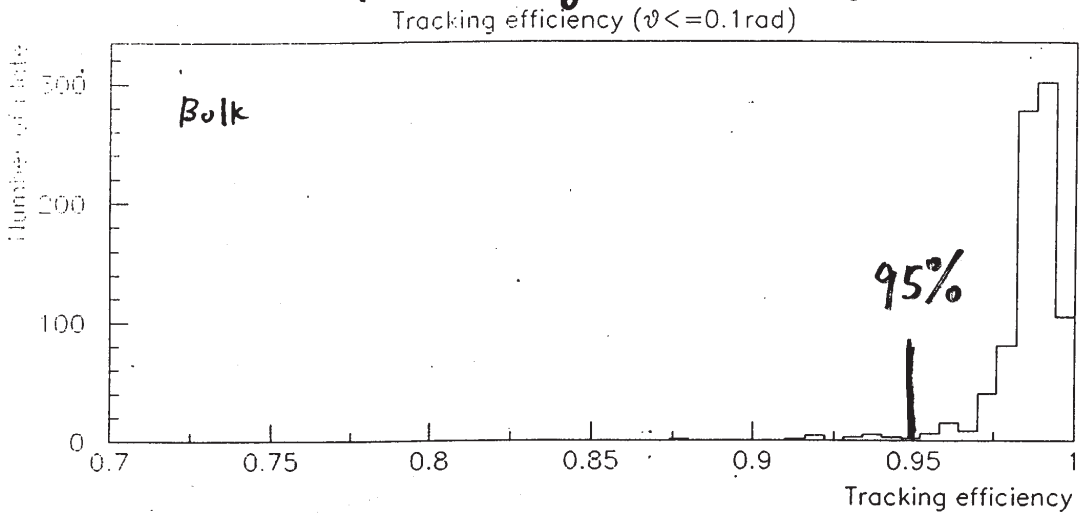
$\sim 530$ ev.

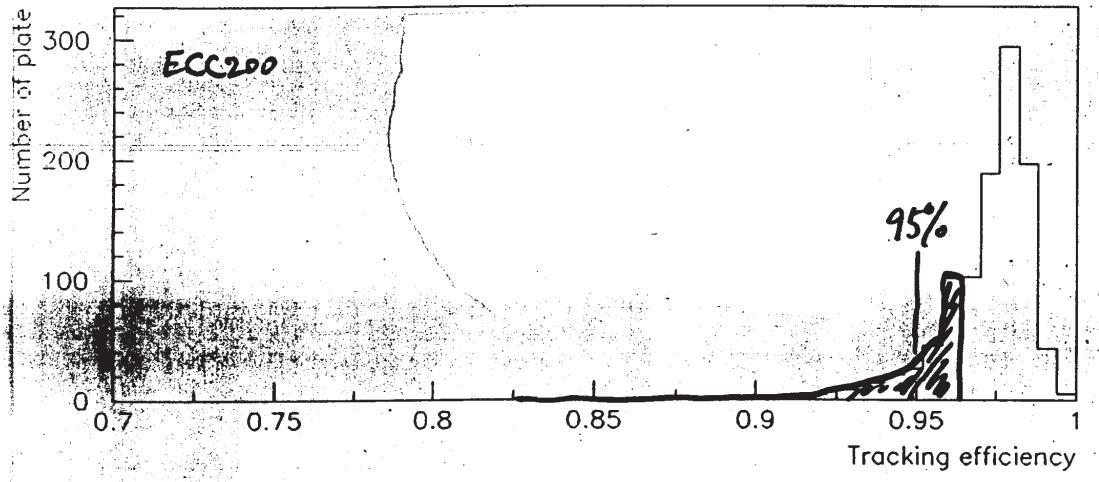
Located util. 2000 Feb. 261 ev.

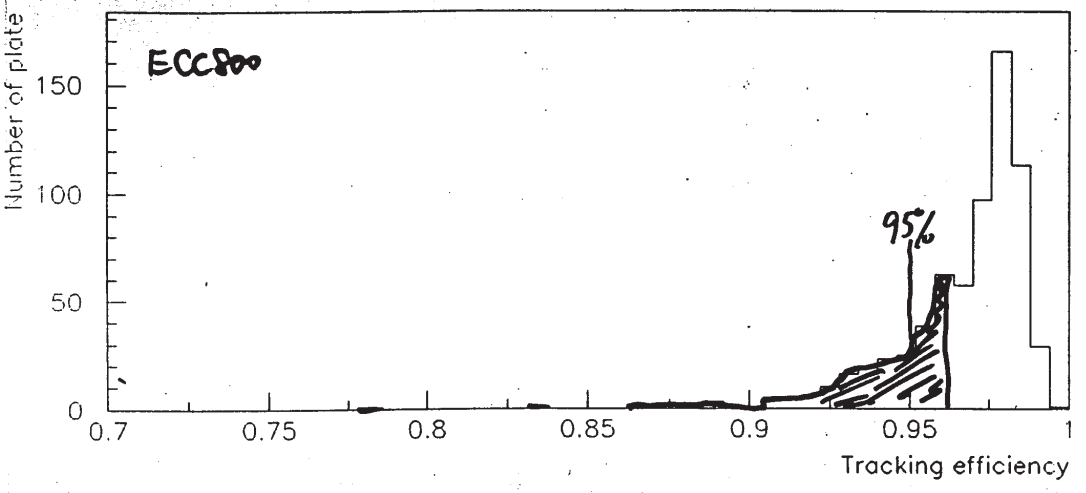
location efficiency ~50%

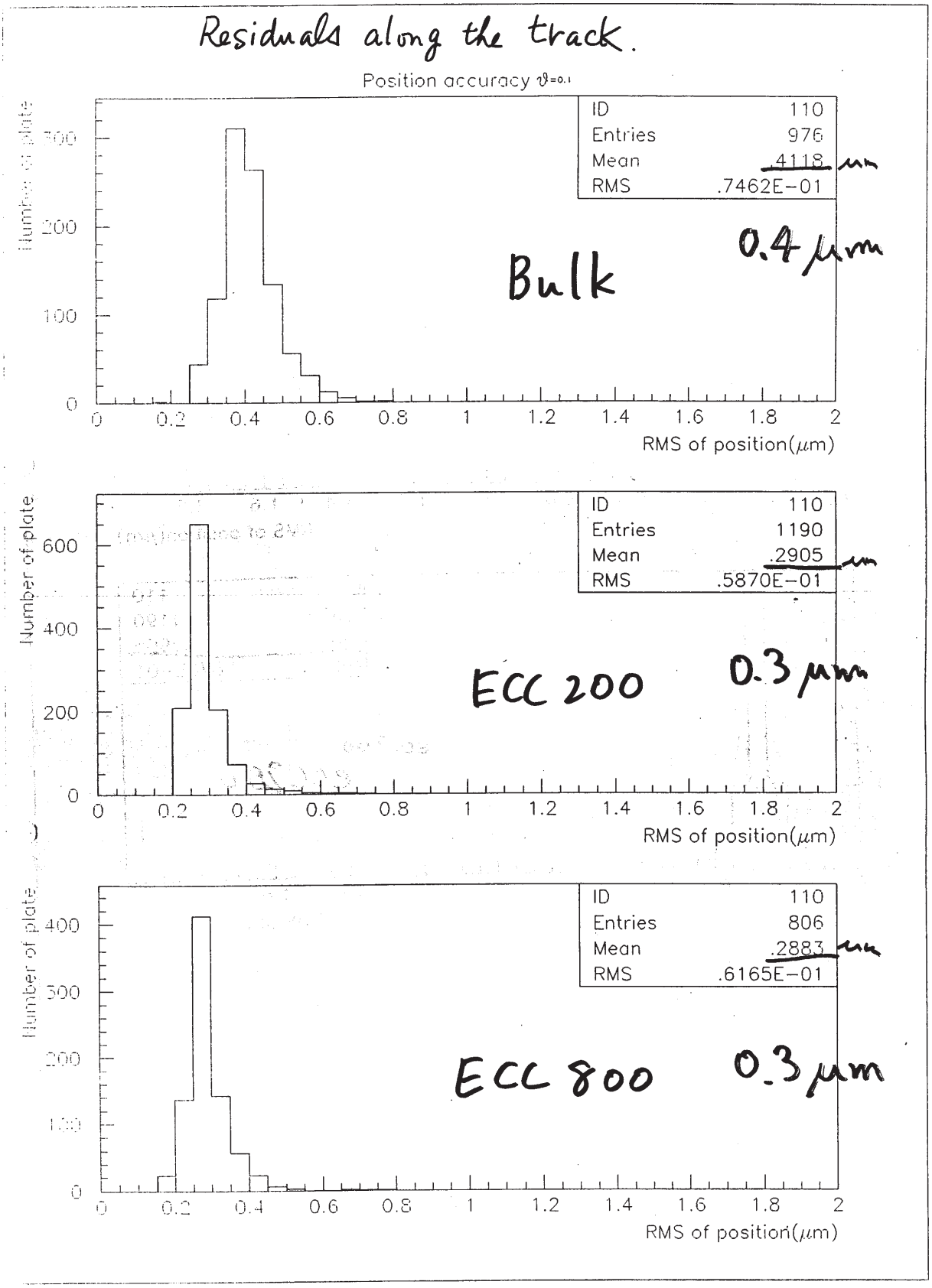
Systematic Decay Search was applied 203 ev

# Tracking efficiency

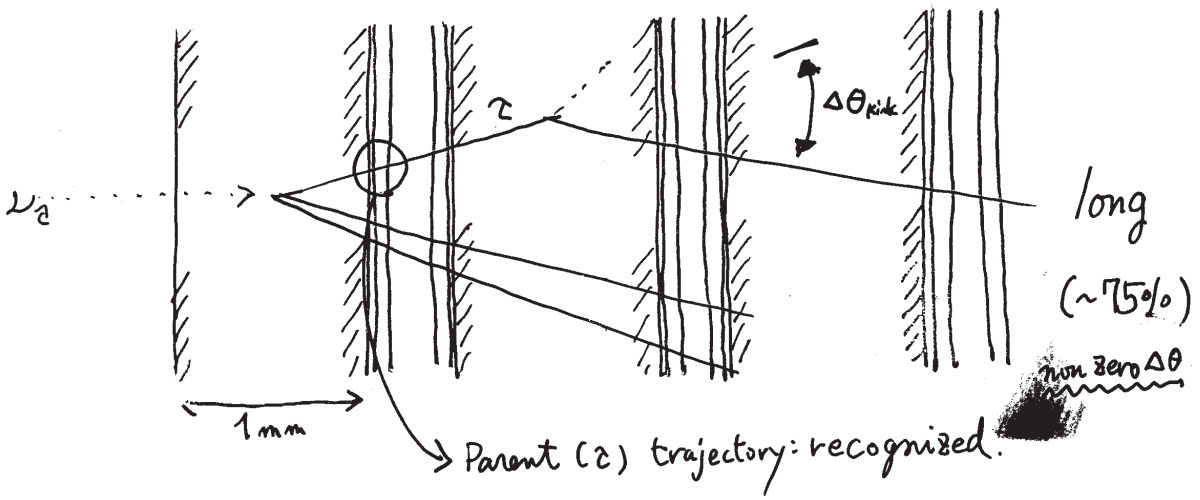


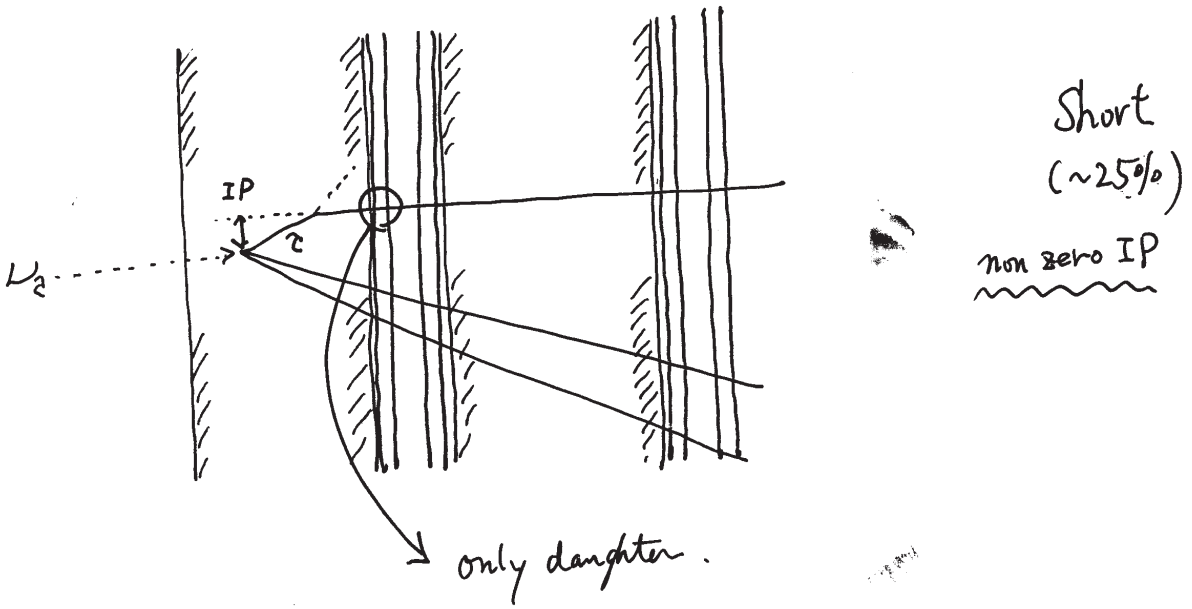



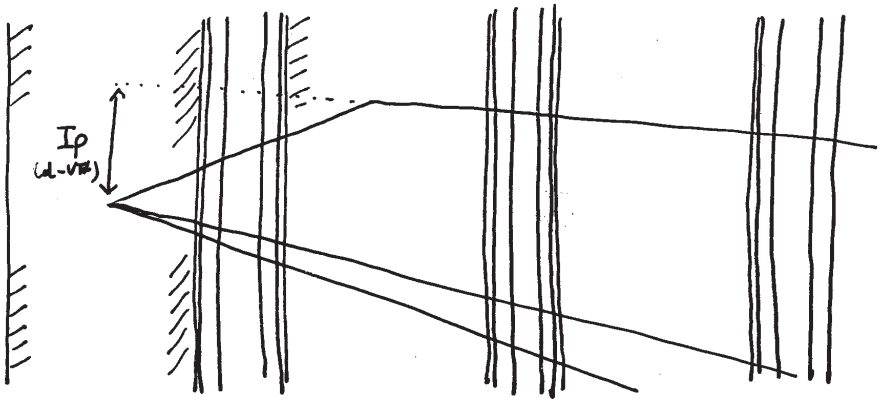

Residuals along the track.
Position accuracy ϑ=0.1
Number of plate
ID 110
Entries 976
Mean .4118 μm
RMS .7462E-01
Bulk
0.4 μm
RMS of position(μm)
ID 110
Entries 1190
Mean .2905 μm
RMS .5870E-01
ECC 200
0.3 μm
ID 110
Entries 806
Mean .2883 μm
RMS .6165E-01
ECC 800
0.3 μm

# τ Detection in DONUT



# Long Decay Search




o Primary Track Stop

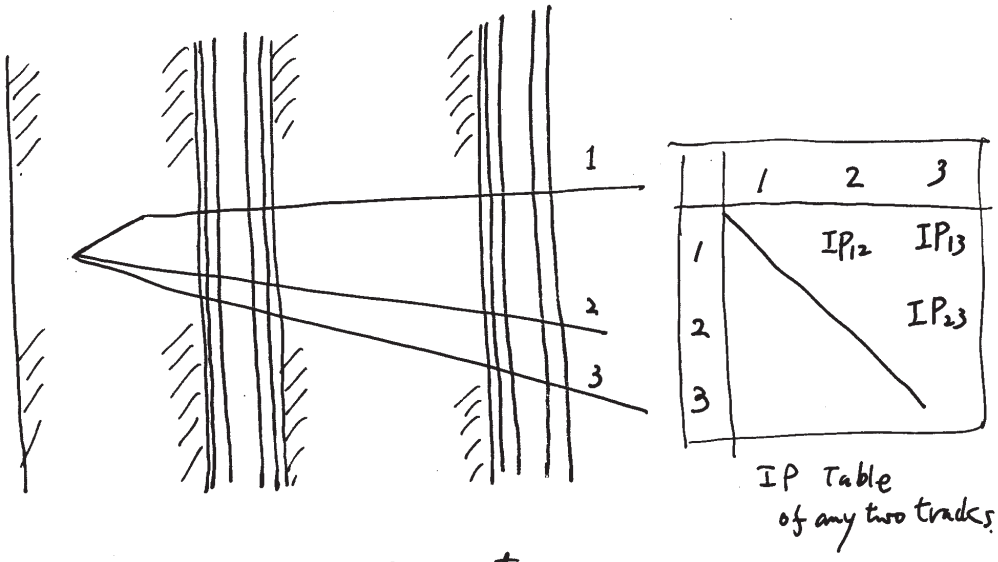
+ Connected daughter (IP(Parent − daughter) ≤ 10μm)
(IP(daughter − Vtx) ≤ 500μm)

events with KINK topology

| event # | Flight Length [mm] | $\Theta_{kink}$ [mrad] | $P_{daughter}$ [GeV/c] | $Pt_{daughter}$ [GeV/c] |
|---|---|---|---|---|
| 30175 | 4.5 | 93 | $> 3.3^{+3.7}_{-1.2}$ | > 0.31 |
| 01910 | 0.28 | 90 | $4.6 \pm^{1.6}_{0.9}$ | 0.41 |
| 17665 | 0.54 | 13 | $> 8.6^{+4.0}_{-2.2}$ | > 0.11 |
| 25102 | 1.8 | 130 | $2.0^{+2.2}_{-0.7}$ | 0.26 |
| 03238 | 1.5 | 250 | $1.2^{+0.5}_{-0.3}$ | 0.41 |
| 28864 | 0.36 | 97 | $0.8^{+0.4}_{-0.2}$ | 0.08 |

Measured by Multiple Coulomb Scattering

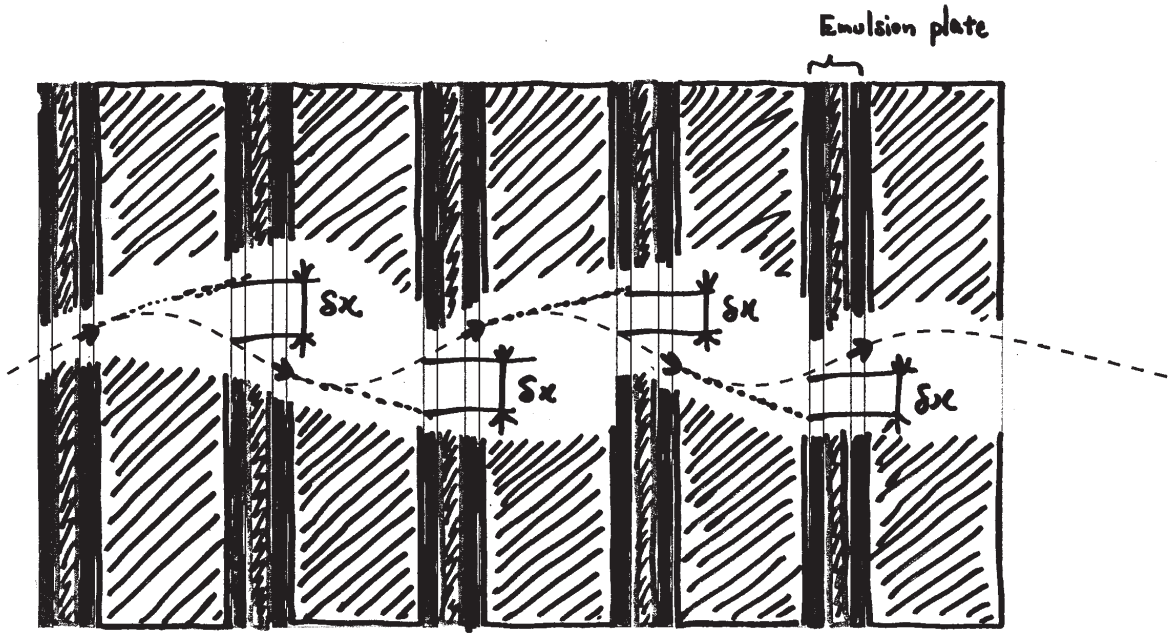
# Short Decay Detection




- Calculate Impact Parameter between any two tracks

- Origin of non-zero IP
  1. measurement error
  2. multiple Scattering in Materials.

# Momentum Measurement by Multiple Coulomb Scattering in ECC




Scattered angle $\sqrt{\langle\theta^2\rangle} = \frac{21\ \text{Mev}}{P\beta}\sqrt{T}$

(P: Momentum
T: Cascade length

error $\frac{\Delta(\sqrt{\langle\theta^2\rangle})}{\sqrt{\langle\theta^2\rangle}} \propto \frac{1}{\sqrt{n}}$

n: Number of layer

(if P=10 Gev/c Fe = 1 mm

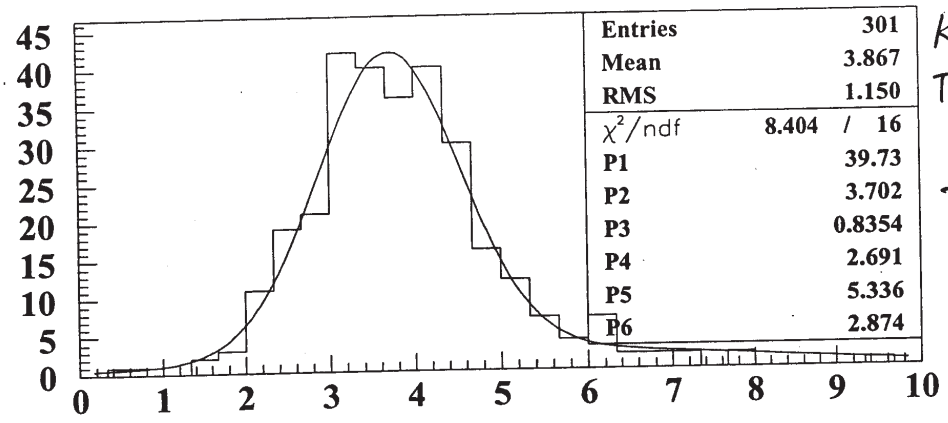
deviation of scattering = 0.3 μm

Merit of ECC

- $X_0$(Pb) / $X_0$(Fe) > $X_0$(Emulsion)
- ⇒ Multiple Coulomb Scattering is larger!

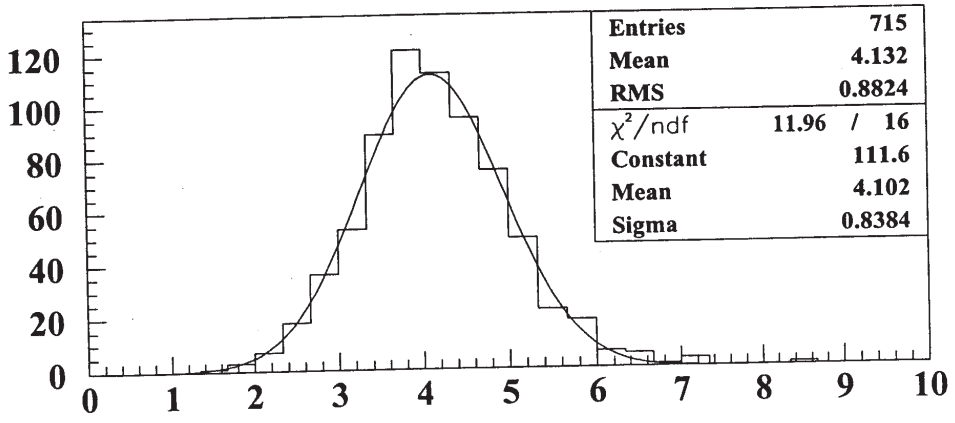
ECC (Pb) Calibration Test 4$X_0$

(23 lead plate)

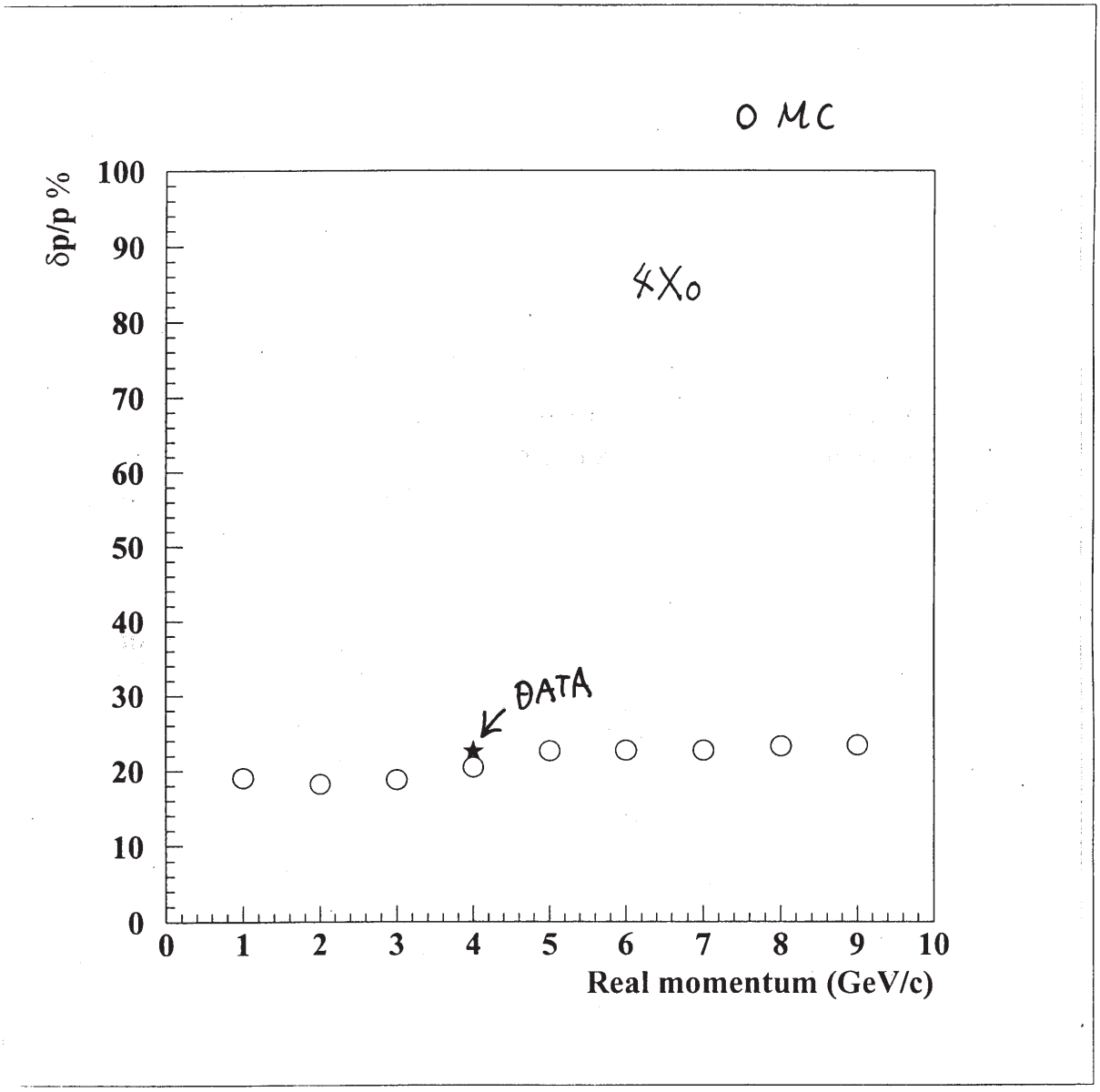



KEK Test Beam 4GeV/c

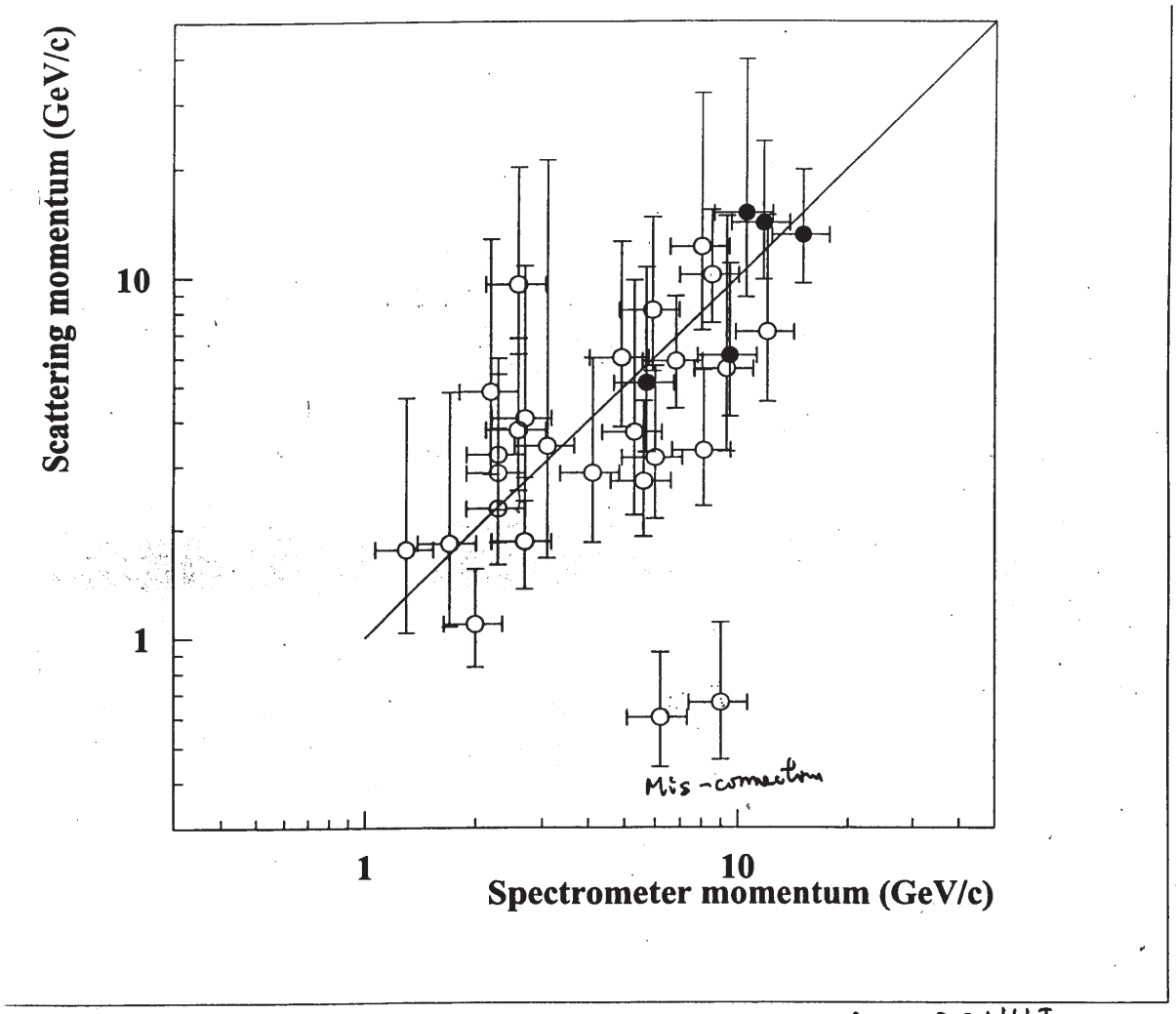
Data 4GeV/c




M.C. 4GeV/c


o MC
δp/p %
100
90
80
70
60
50
40
30
20
10
0
4X₀
DATA
0 1 2 3 4 5 6 7 8 9 10
Real momentum (GeV/c)

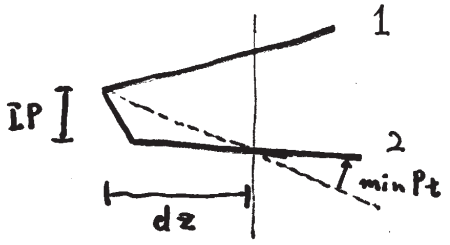
CHECK in DONUT




sample : DONUT

# 「Short」 decay selected events.

$$\min P_t \equiv \frac{IP}{dz} \times P_{max}$$



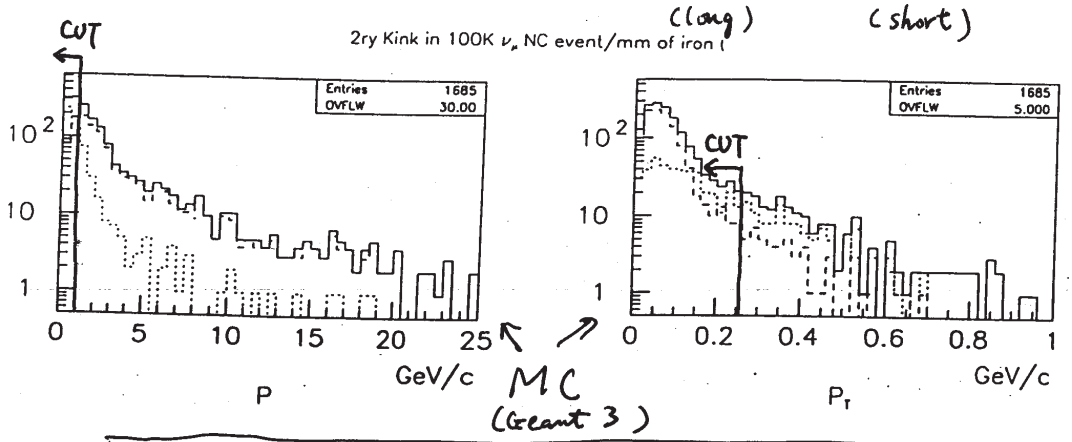

| event # | dz [μm] | IP [μm] | $P_1$ [GeV/c] | $P_2$ [GeV/c] | $\min P_{t_1}$ | $\min P_{t_2}$ |
|---|---|---|---|---|---|---|
| 17099 | 208 | 21 | $5.7^{+2.9}_{-1.5}$ | $2.5^{+1.3}_{-0.7}$ | 0.87 | 0.38 |
| 22786 | 821 | 11 | $24.2^{+39.7}_{-10.0}$ | $4.8^{+7.9}_{-2.0}$ | 0.87 | 0.17 |
| 01910 | 353 | 24 | $4.1^{+6.8}_{-1.7}$ | $7.7^{+3.9}_{-2.0}$ | 0.73 | 0.78 |
| 17665 | 234 | 2.5 | $8.6^{+4.0}_{-2.2}$ | — | 0.14 | — |
| 10406 | 819 | 3.3 | $7.0^{+5.6}_{-2.3}$ | $10.5^{+5.4}_{-2.8}$ | 0.05 | 0.06 |
| 18223 | 412 | 5.7 | $2.3^{+2.5}_{-0.8}$ | $2.5^{+2.0}_{-0.8}$ | 0.07 | 0.06 |
| 24151 | 947 | 5.1 | $5.0^{+8.2}_{-2.1}$ | $3.0^{+1.5}_{-0.8}$ | 0.07 | 0.02 |
| 15521 | 753 | 7.8 | $4.3^{+3.4}_{-1.4}$ | $2.4^{+1.4}_{-0.7}$ | 0.08 | 0.04 |
| 00880 | 974 | 5.0 | $7.9^{+4.0}_{-2.1}$ | $9.4^{+4.8}_{-2.5}$ | 0.06 | 0.07 |
| 31223 | 759 | 4.0 | $4.0^{+2.7}_{-1.2}$ | $5.1^{+5.6}_{-1.9}$ | 0.04 | 0.06 |
| 17099 | 892 | 5.4 | $1.5^{+1.2}_{-0.5}$ | $8.1^{+5.4}_{-2.4}$ | 0.02 | 0.08 |
| 18635 | 295 | 26. | $0.3^{+0.2}_{-0.1}$ | $1.2^{+0.9}_{-0.4}$ | 0.05 | 0.18 |
| 00470 | 694 | 6.3 | $3.4^{+1.7}_{-0.9}$ | $1.4^{+0.7}_{-0.4}$ | 0.05 | 0.02 |
| 09110 | 284 | 6.7 | $0.2^{+0.2}_{-0.1}$ | $0.8^{+0.6}_{-0.3}$ | 0.01 | 0.03 |
| 13369 | 672 | 12 | $0.3^{+0.2}_{-0.1}$ | $25.2^{+130}_{-13}$ | 0.01 | 2.7 |
| | dz [μm] | IP [μm] | track 1 運動量 | track 2 運動量 | 最小 $P_{t_1}$ | 最小 $P_{t_2}$ |

# Physics Filter 1.
## — Secondary Int. rejection —

1. If daughter is lepton ($\mu$, e) ⇒ Pass

2. If daughter is hadron ↓

$P_T$ Cuts (min $P_T$ cuts)
(long) (short)




MC (Geant 3)

for Long : $P_{daughter} > 1$ GeV/c, $Pt > 0.25$ GeV/c

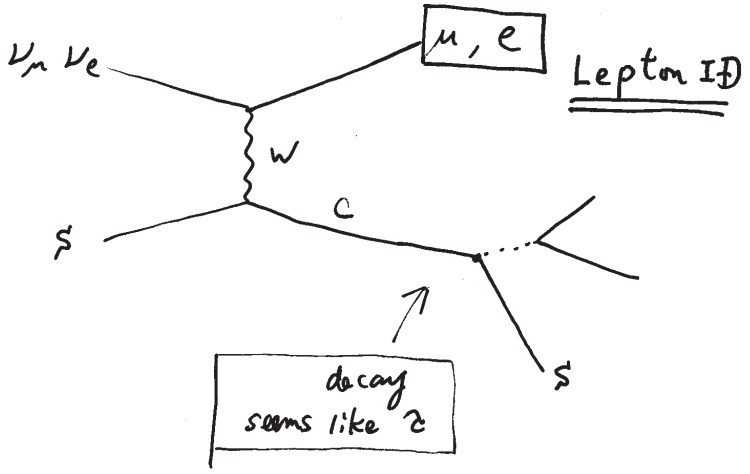
Short : $P_{daughter} > 1$ GeV, min $Pt > 0.1$ GeV/c

Estimated Contamination from 2ndary INT after this Filter

long : ~ 0.5 Track

Short : ~ 0.1% Track

# Physics Filter 2
## — Charm rejection —




1. $\nu_\mu^{CC}$ ⇒ μ ID Counter $\varepsilon \simeq 85\%$

2. $\nu_e^{CC}$ ⇒ Existence of Electromagnetic Shower in Emulsion

$\varepsilon \simeq 70\%$ ($E_e = 20$ GeV/c, 1X$_0$ follow-down)

# 「long」 decay

| event # | FL [mm] | $\theta_{kink}$ [mrad] | $P_{娘}$ [GeV/c] | $P_t$ [GeV/c] | 娘レプトン | 1ry レプトン | 分類 |
|---|---|---|---|---|---|---|---|
| 30175 | 4.5 | 93 | $3.3^{+3.7}_{-1.2}$ | 0.31 | e | | τ |
| 01910 | 0.28 | 90 | $4.6^{+1.6}_{-0.9}$ | 0.41 | | | τ |
| 17665 | 0.54 | 13 | $8.6^{+4.0}_{-2.2}$ | 0.11 | e | | τ |
| 25102 | 1.8 | 130 | $2.0^{+2.2}_{-0.7}$ | 0.26 | | | τ |
| 03238 | 1.5 | 250 | $1.2^{+0.5}_{-0.3}$ | 0.41 | | e | charm |
| 28864 | 0.36 | 97 | $0.8^{+0.4}_{-0.2}$ | 0.08 | | | 2ndary |

# 「short」 decay

| event# | dz [μm] | IP [μm] | $P_1$ [GeV/c] | $P_2$ [GeV/c] | min $P_t$ | min $P_{t_2}$ | daughter lepton (娘レプトン) | 1ry lepton (1ryレプトン) | Category |
|---|---|---|---|---|---|---|---|---|---|
| 17099 | 208 | 21 | $5.7^{+2.9}_{-1.5}$ | $2.5^{+1.3}_{-0.7}$ | 0.87 | 0.38 | | | (分 |
| 22786 | 821 | 11 | $24.2^{+39.7}_{-10.0}$ | $4.8^{+7.9}_{-2.0}$ | 0.87 | 0.17 | $\mu^-$ | $\mu^+$ | cha |
| 01910 | 353 | 24 | $4.1^{+6.8}_{-1.7}$ | $7.7^{+3.9}_{-2.0}$ | 0.73 | 0.78 | | | て( |
| 17665 | 234 | 2.5 | $8.6^{+4.0}_{-2.2}$ | — | 0.14 | — | e | | て( |
| 10406 | 819 | 3.3 | $7.0^{+5.6}_{-2.3}$ | $10.5^{+5.4}_{-2.8}$ | 0.05 | 0.06 | | | × |
| 18223 | 412 | 5.7 | $2.3^{+2.5}_{-0.8}$ | $2.5^{+2.0}_{-0.8}$ | 0.07 | 0.06 | | | × |
| 24151 | 947 | 5.1 | $5.0^{+8.2}_{-2.1}$ | $3.0^{+1.5}_{-0.8}$ | 0.07 | 0.02 | | | × |
| 15521 | 753 | 7.8 | $4.3^{+3.4}_{-1.4}$ | $2.4^{+1.4}_{-0.7}$ | 0.08 | 0.04 | | | × |
| 00880 | 974 | 5.0 | $7.9^{+4.0}_{-2.1}$ | $9.4^{+4.8}_{-2.5}$ | 0.06 | 0.07 | | | × |
| 31223 | 759 | 4.0 | $4.0^{+2.7}_{-1.2}$ | $5.1^{+5.6}_{-1.9}$ | 0.04 | 0.06 | | | × |
| 17099 | 892 | 5.4 | $1.5^{+1.2}_{-0.5}$ | $8.1^{+5.9}_{-2.4}$ | 0.02 | 0.08 | | | × |
| 18635 | 295 | 26. | $0.3^{+0.2}_{-0.1}$ | $1.2^{+0.9}_{-0.4}$ | 0.05 | 0.18 | | | × |
| 00470 | 694 | 6.3 | $3.4^{+1.7}_{-0.9}$ | $1.4^{+0.7}_{-0.4}$ | 0.05 | 0.02 | | | × |
| 09110 | 284 | 6.7 | $0.2^{+0.2}_{-0.1}$ | $0.8^{+0.6}_{-0.3}$ | 0.01 | 0.03 | | | × |
| 13369 | 672 | 12 | $0.3^{+0.2}_{-0.1}$ | $25.2^{+130}_{-13}$ | 0.01 | 2.7 | | | × |

# Summary Long & Short

## τ, charm decay cand.

| event # | FL [mm] | $\theta_{kink}$ [mrad] | $P_d$ [GeV/c] | daughter lepton | 1ry lepton | |
|---|---|---|---|---|---|---|
| 3024-30175 | 4.5 | 93 | $3.3^{+3.7}_{-1.2}$ | e | | τ |
| 3039-01910 | 0.28 | 90 | $4.6^{+1.6}_{-0.9}$ | | | τ |
| 3333-17665 | 0.54 | 13 | $8.6^{+4.0}_{-2.2}$ | e | | τ |
| 3263-25102 | 1.8 | 130 | $2.0^{+2.2}_{-0.7}$ | | | τ |
| 3356-17099 | <0.9 | >26 | $5.7^{+2.9}_{-1.5}$ | | | τ |
| 3245-22786 | 0.38 | C3 | | $\mu^-$ | $\mu^+$ | charm |
| 3065-03238 | 1.5 | 250 | $1.2^{+0.4}_{-0.2}$ | | e | charm |

## neutral decay cand.

| event # | FL [mm] | $\theta_{opening}$ [mrad] | daughter lepton | 1ry lepton | |
|---|---|---|---|---|---|
| 3137-23878 | 2.0 | 78 | | | charm |
| 3249-03536 | 0.9 | 30 | | $\mu^-$ | charm |

τ candidate : 5 (short 1, long 4)

charm : 4 (charged 2, neutral 2)

# Comparison between Observed & Expected (I) — Charm —

ε (detection) estimated by MC.

for Charged Charm : 35 %

Neutral Charm : 35 %

Expected

$203 \times \frac{3}{4} \times 0.07 \times 0.5 \times 0.35 = 1.9$ (charged)

$\times 0.5 \times 0.35 = 1.9$ (Neutral)

events — $\frac{CC}{NC+CC}$ — Charm Production — Charged & Neutral

⇕

Observed

2 (charged)

2 (neutral)

consistent

# Comparison between Observed & Expected (I)
## — 2ndary INT. —

Expected

In Iron. Total Track length / 208mm = 8.1
1690mm

In Emulsion 1144mm / 500mm = 2.3

Observed

| | |
|---|---|
| In Iron | 8 |
| Emulsion | 2 |
| Base. | 1 |

Consistent

# Background

- Charm

$$203 \times \frac{3}{4} \times 0.07 \times 0.5 \times 0.35 \times (1 - \varepsilon_{eid})$$

events · $\frac{CC}{NC+CC}$ · charm production · charged · $\varepsilon$ detection charm · ↓ 1ry lepton ID miss.

$$\simeq 1.9 \times (1 - \varepsilon_{eid})$$

$$\simeq 0.14\ (\mu \text{ ID miss}) + \sim 0.3 \sim 0.6\ (e \text{ ID miss})$$

$$< 0.8 \text{ event}.$$

- 2ndary Int

long : ~ 0.5 track
short : ~ 0.14 track

} 0.16 (NC) + 0.1 ~ 0.17 ($\nu_e^{CC}$ 2ndary e ID miss) $< 0.4$ event

→ Homework $\varepsilon$ (e tagg) ↑

## Comparison between Expected & Observed. (III)
## — 2 —

Estimated $\tau$-detection efficiency (MC)

| | Short | Long | Total |
|---|---|---|---|
| $\tau^-$ | 39% (25%) | 60% (75%) | 55% |
| $\tau^+$ | 45% (17%) | 59% (83%) | 57% |

$\nu_\tau : \bar{\nu}_\tau \sim 2 : 1$ とする

Short : 41% (short ~22%)

Long : 60% (long ~78%)

Expected

$$203 \times \frac{3}{4}\ (\frac{CC}{NC+CC}) \times 0.05\ (\nu_\tau \text{ expected}) \times \begin{cases} 0.22 \times 0.41 \simeq 0.7 \text{ (short)} \\ 0.78 \times 0.60 \simeq 3.6 \text{ (long)} \end{cases}$$

⇕

Data

1 (short)

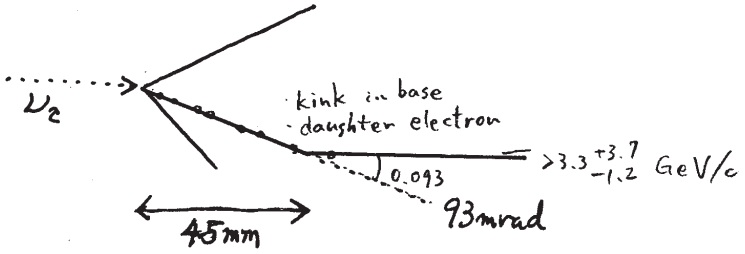
4 (long)

consistent !

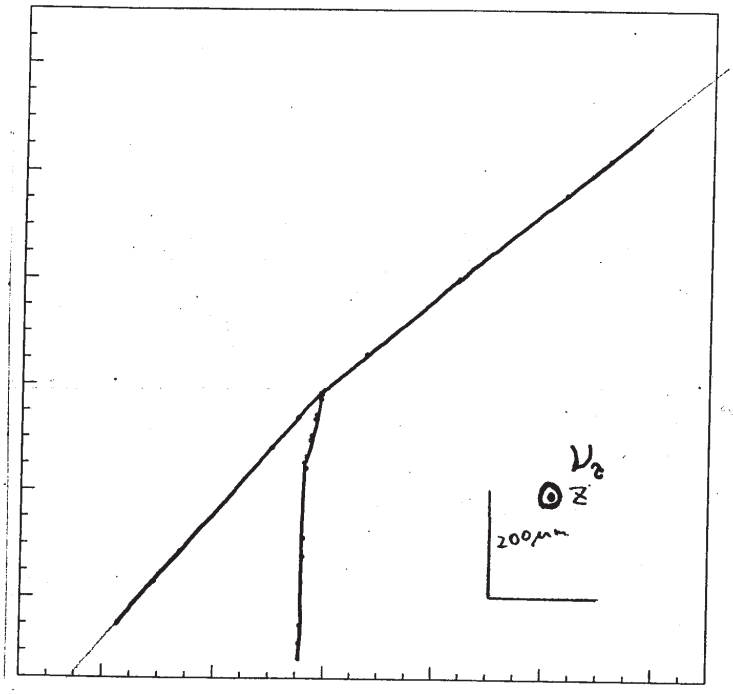
regretably no-surprise !!

# 3024 - 30175 ( $\tau \to e \bar{\nu}_e \nu_\tau$ )

Tochiwan




| | | | |
|---|---|---|---|
| 121-4485 | -6 | -29 | parent |
| 121-4657 | 265 | 220 | |
| 121-4373 | -156 | -187 | |
| 92-4391 | -4 | -121 | daughter |
| 21-6415 | 0 | -152 | e-pair |

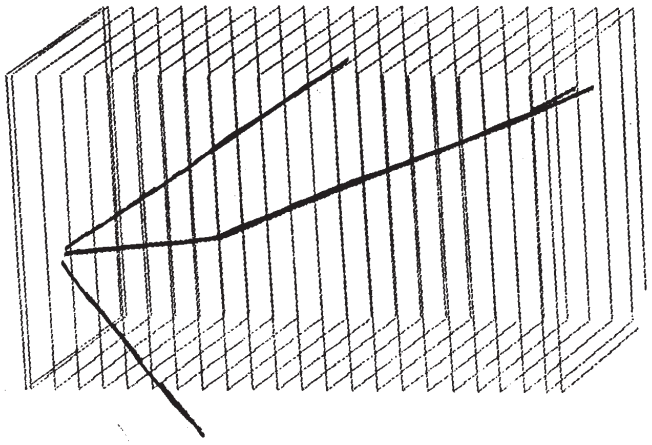



KINK in Base

$\theta_{kink} \sim 93$mrad

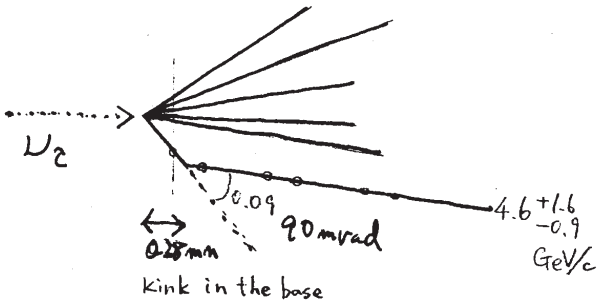
FL ~ 4.5mm

Daughter e
(identified)

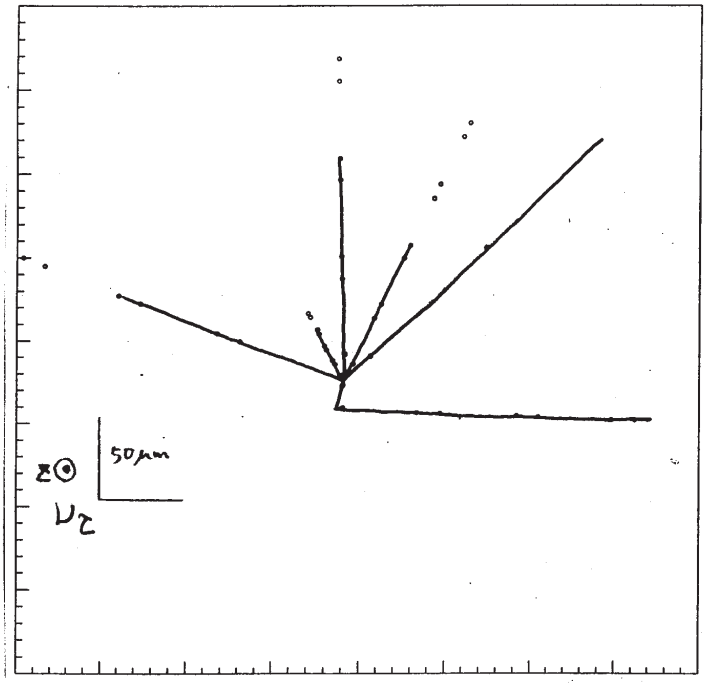


# 3039-01910 ($\tau \to h \nu_\tau$)

Tsuchimoto




| | | | |
|---|---|---|---|
| 181-3979 | −25 | −60 | parent |
| 181-3994 | −4 | 6 | |
| 171-4275 | −40 | 16 | |
| 181-4031 | 214 | 206 | |
| 182-3534 | 11 | 25 | |
| 182-3551 | −1 | 41 | |
| 182-3461 | 39 | −2 | daughter |




KINK in Base

$\theta_{kink} \sim 90$ mrad

FL $\sim .28$ mm

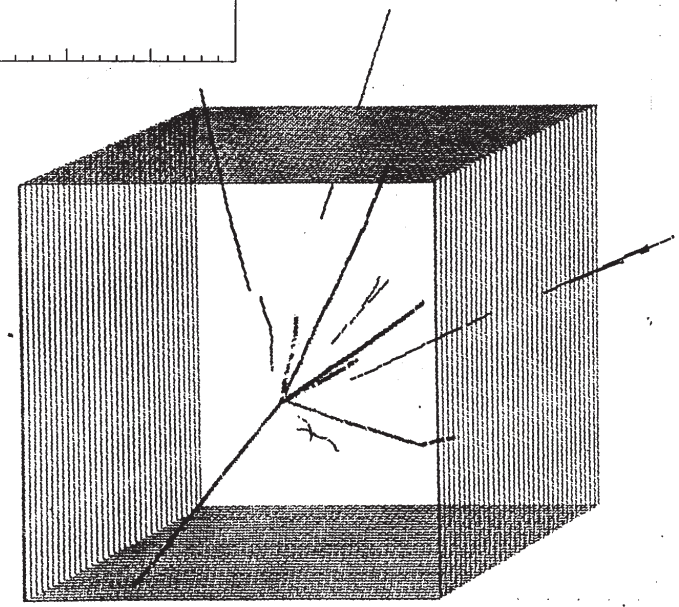
Daughter h

$p \simeq 4.6^{+1.6}_{-0.9}$ GeV/c

($P_T = 0.41$ GeV/c)

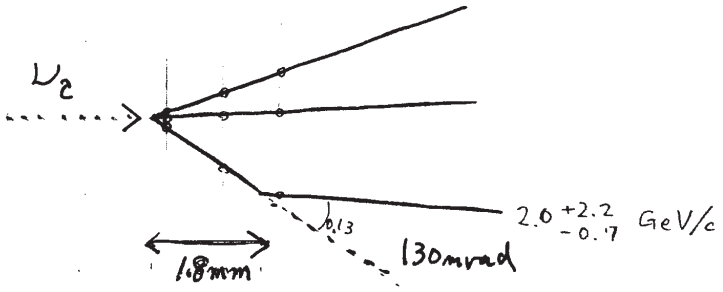
$\pi^0 \to \gamma\gamma$

$\hookrightarrow ee$

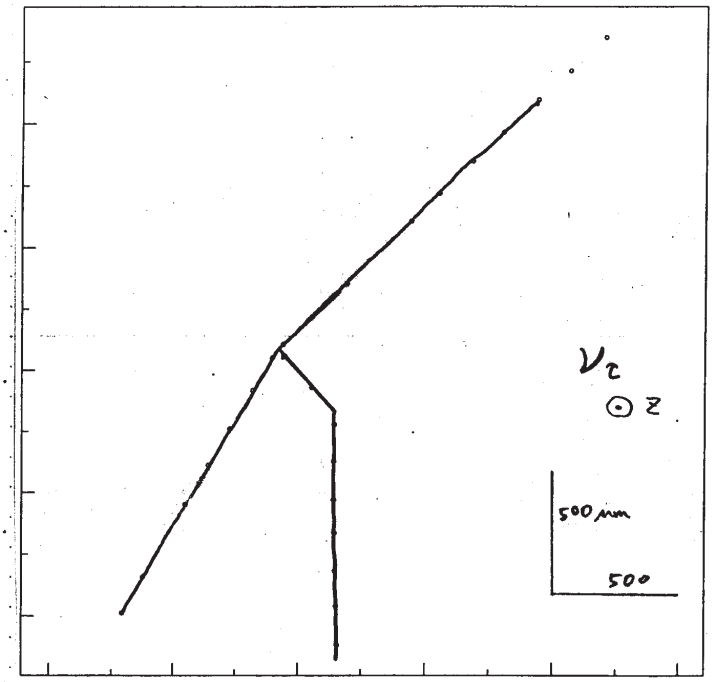


# 3263-25102 ($\tau \to h \nu_\tau$)

Toshiaki



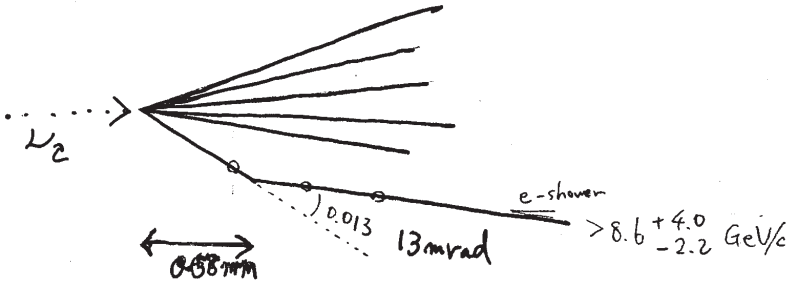

| | $\theta_u$ | $\theta_v$ | |
|---|---|---|---|
| 401-3833 | 128 | −140 | parent |
| 401-3831 | −87 | −151 | |
| 401-3956 | 129 | 128 | |
| 391-3610 | 0 | −153 | daughter |



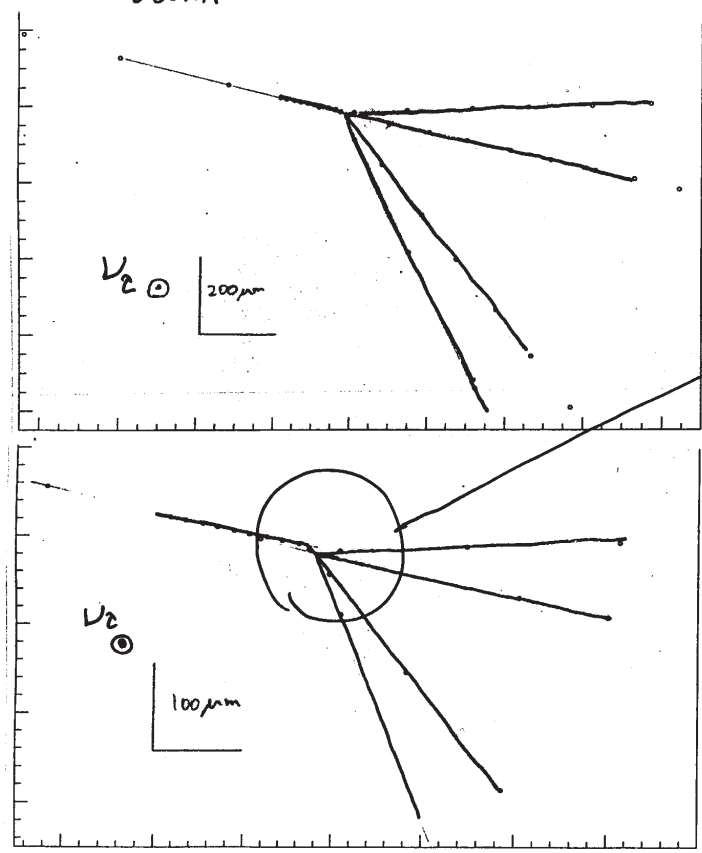

Decay IN Fe

3263-25102

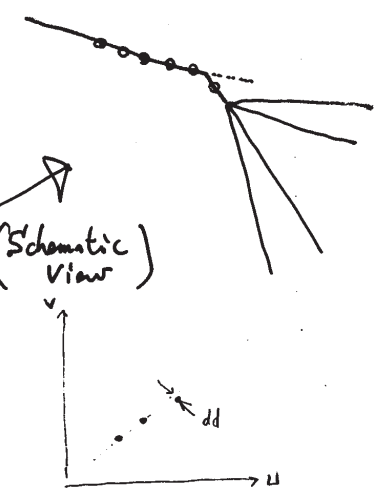
# 3333 − 17665 ($\tau \to e \bar{\nu}_e \nu_\tau$)




| | $\theta_u$ | $\theta_v$ | |
|---|---|---|---|
| 561-4110 | −6 | 9 | parent |
| | −17 | 4 | daughter |
| 561-4134 | −256 | 65 | |
| 561-4107 | 151 | 4 | |
| 561-4094 | 102 | −23 | |
| 561-4033 | 93 | −120 | |
| 561-3910 | 155 | −323 | |




Decay In Base

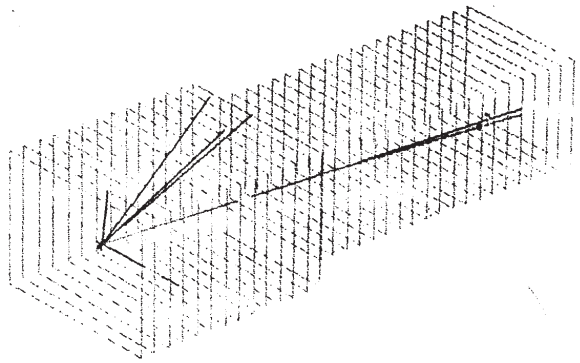



561-4110

| | | | dd |
|---|---|---|---|
| 532 | −0.0173 | 0.0037 | 0.151 |
| 531 | −0.0178 | 0.0036 | 0.381 |
| 542 | −0.0177 | 0.0040 | 0.196 |
| 541 | −0.0172 | 0.0041 | 0.255 |
| 552 | −0.0181 | 0.0040 | 0.272 |
| 551 | −0.0178 | 0.0037 | 0.135 |
| 562 | −0.0182 | 0.0039 | 0.214 |
| 561 | −0.0167 | 0.0038 | 3.773 |

平均 0.2

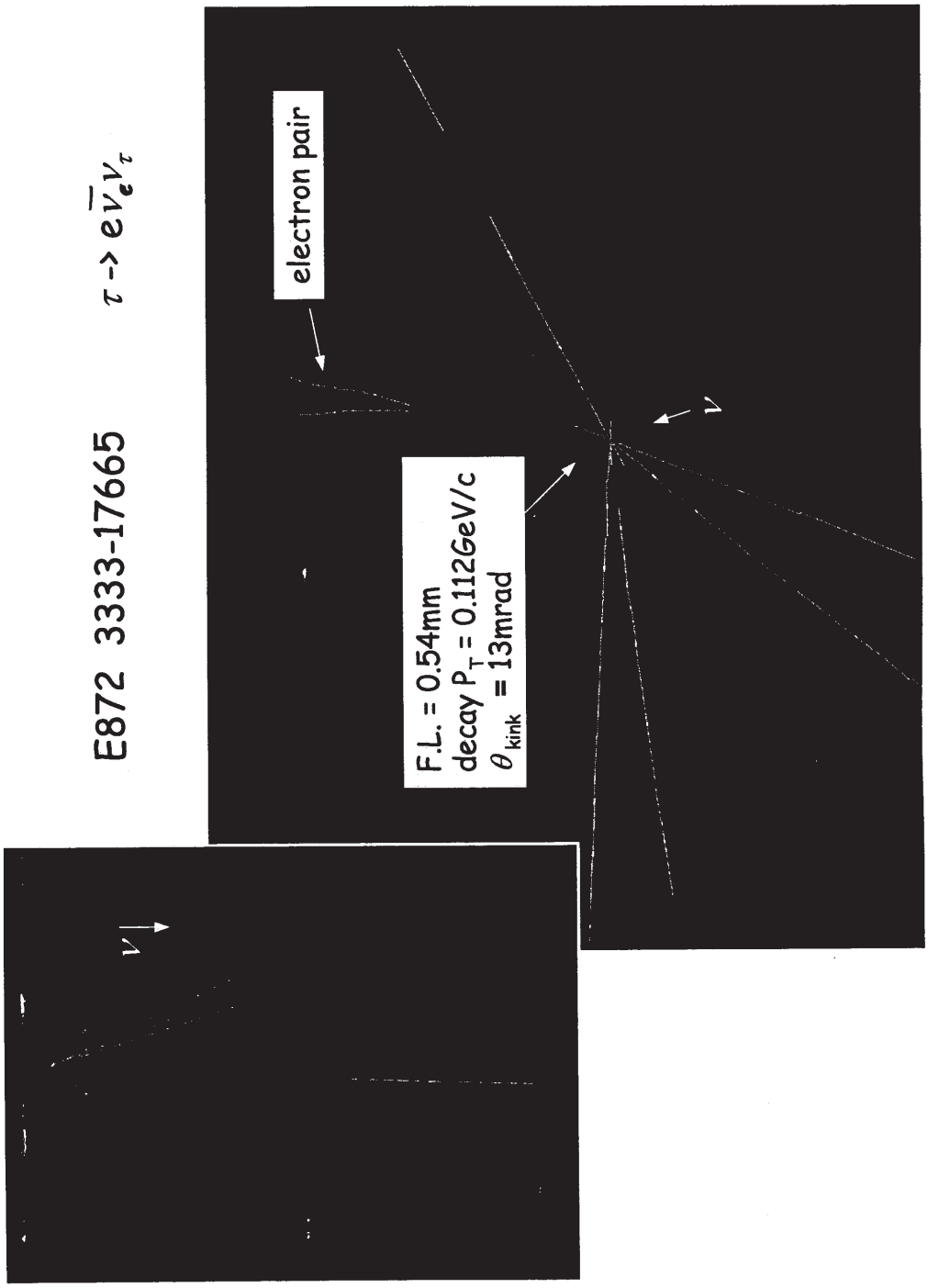
16σ



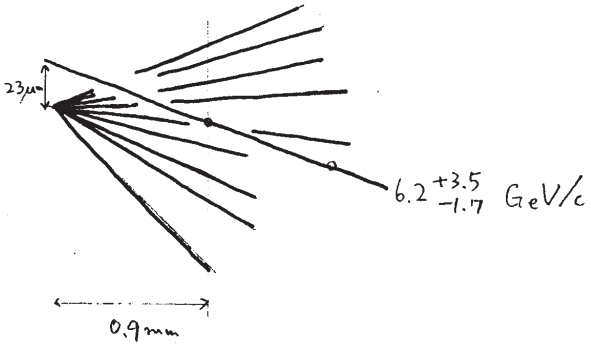
ゆk 561-4107では

| | | | |
|---|---|---|---|
| 531 | 0.1547 | 0.0031 | 0.613 |
| 542 | 0.1547 | 0.0024 | 1.160 |
| 541 | 0.1527 | 0.0034 | 0.669 |
| 552 | 0.1526 | 0.0041 | 0.038 |
| 551 | 0.1525 | 0.0041 | 0.341 |
| 562 | 0.1528 | 0.0045 | 0.446 |
| 561 | 0.1512 | 0.0048 | 0.554 |

平均 0.54

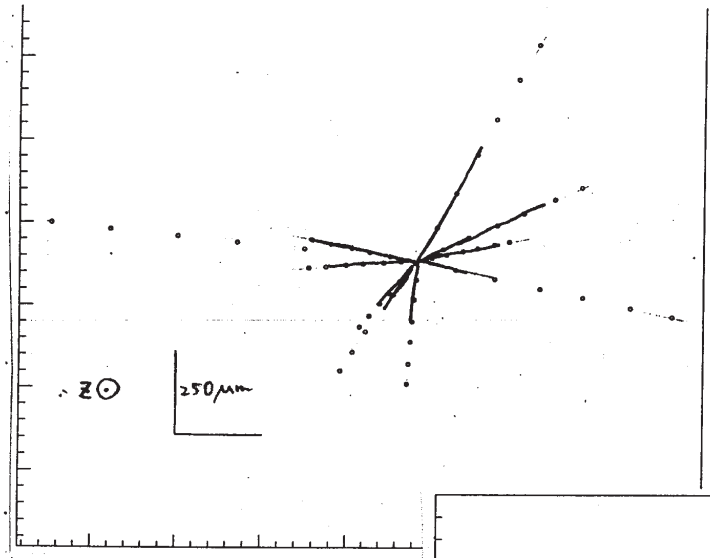

E872 3333-17665
$\tau \rightarrow e\bar{\nu}_e\nu_\tau$
electron pair
F.L. = 0.54mm
decay $P_T$ = 0.112GeV/c
$\theta_{kink}$ = 13mrad
$\nu$
$\nu$

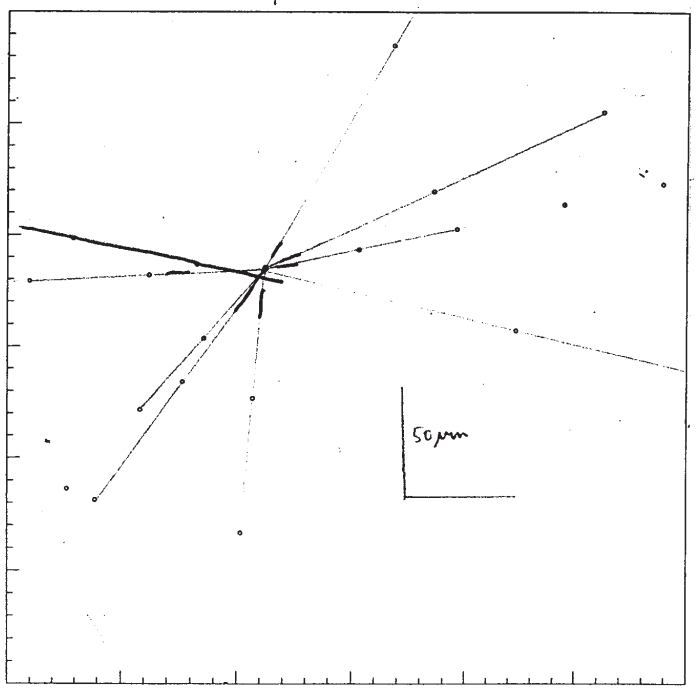
# 3356 − 17099 ($\tau \to h \nu_\tau$)$_{short}$




| | $\theta_x$ | $\theta_y$ | IP | |
|---|---|---|---|---|
| 411-4844 | −58 | 12 | 23.5 | ☆ |
| 411-4933 | 83 | 37 | 2.1 | |
| 411-4862 | 47 | 10 | 1.6 | |
| 411-4819 | −57 | −3 | 0.6 | |
| 411-4654 | −41 | −57 | 0.6 | |
| 411-4712 | −30 | −34 | 0.5 | |
| 411-5120 | 61 | 112 | 1.1 | |
| 412-9057 | −186 | 20 | 0.3 | |
| 411-4732 | 128 | −29 | 4.4 | |
| 411-4628 | −6 | −64 | 1.0 | |

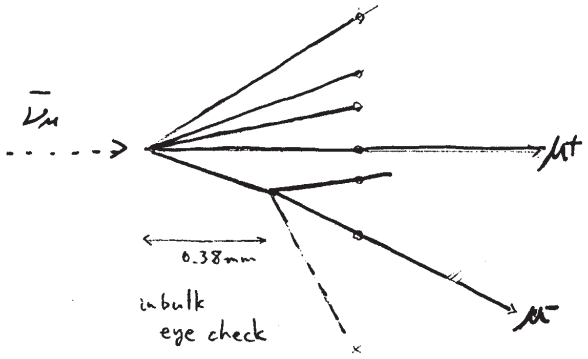
Decay in Fe.



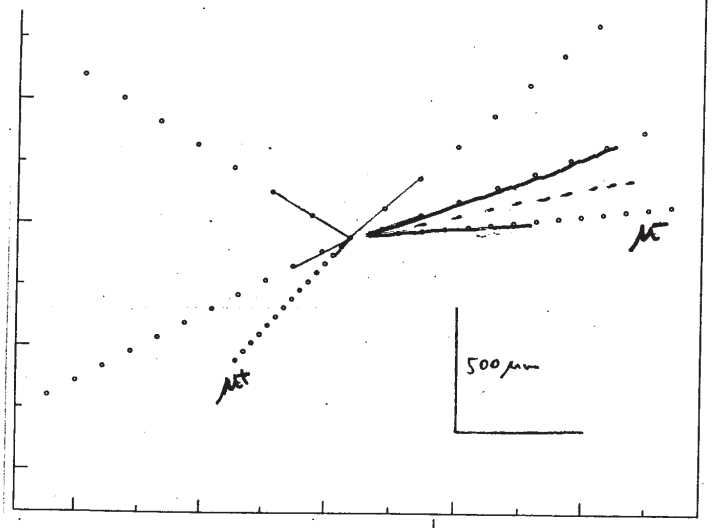
# 3245 - 22786 (Charm → C3)

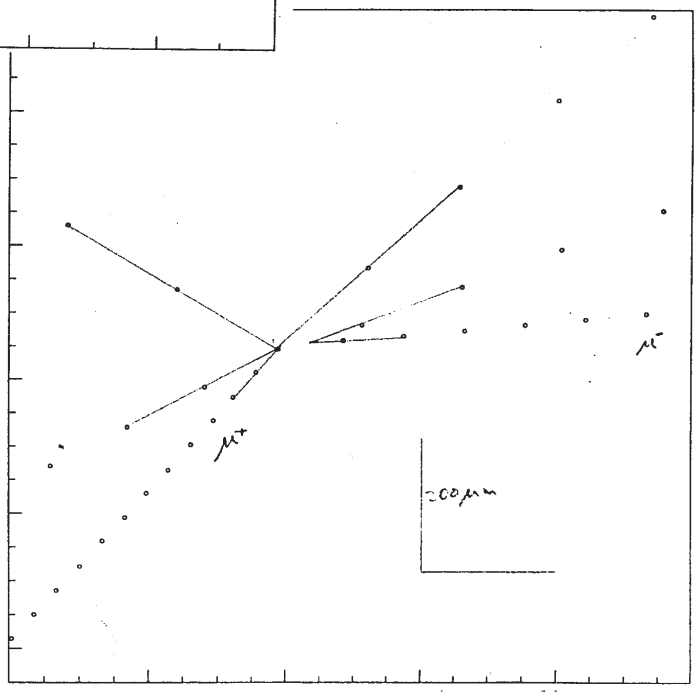
Tochimura




| | 157.30 | | |
|---|---|---|---|
| 301-4864 | -39 | -43 | parent $\mu^+$ |
| 301-4868 | -133 | -71 | |
| 291-4615 | -187 | 116 | |
| 291-4671 | 168 | 150 | |
| 291-4449 | 108 | 9 | C3 daughter $\mu^-$ |
| 291-4501 | 179 | 68 | C3 daughter |

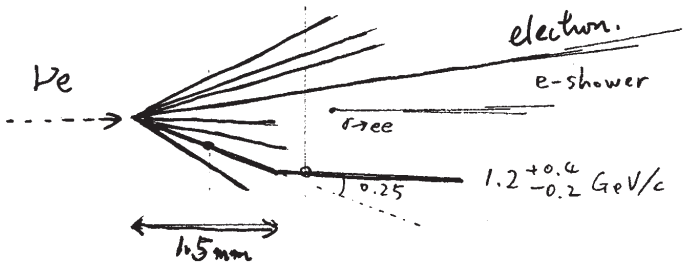
Decay in Base/Bulk.



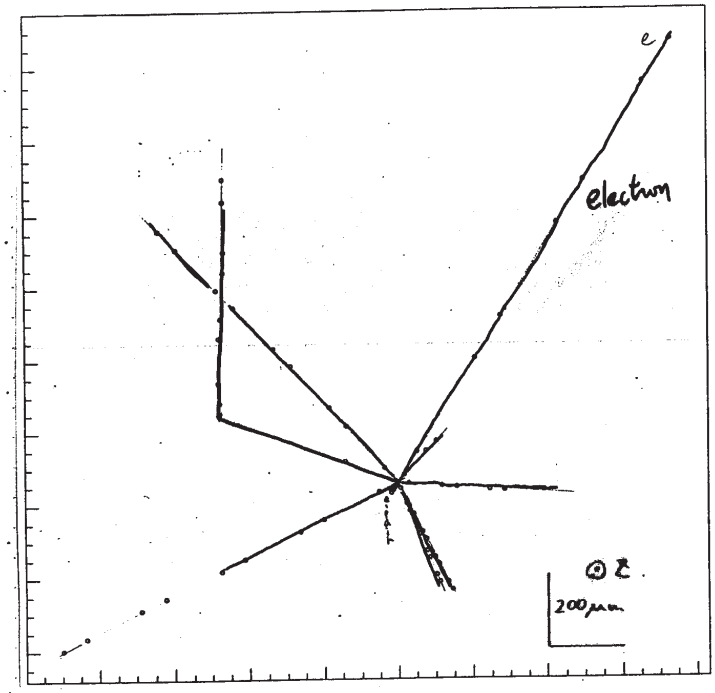



# 3065 - 03238 (Charm → C1)

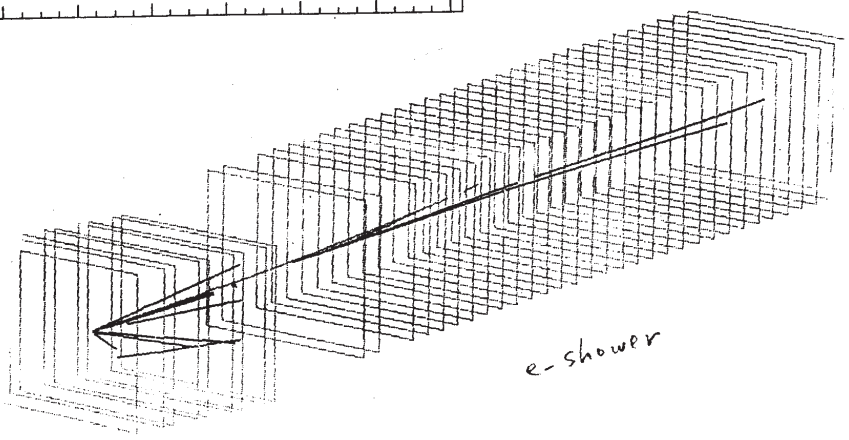
Tochman



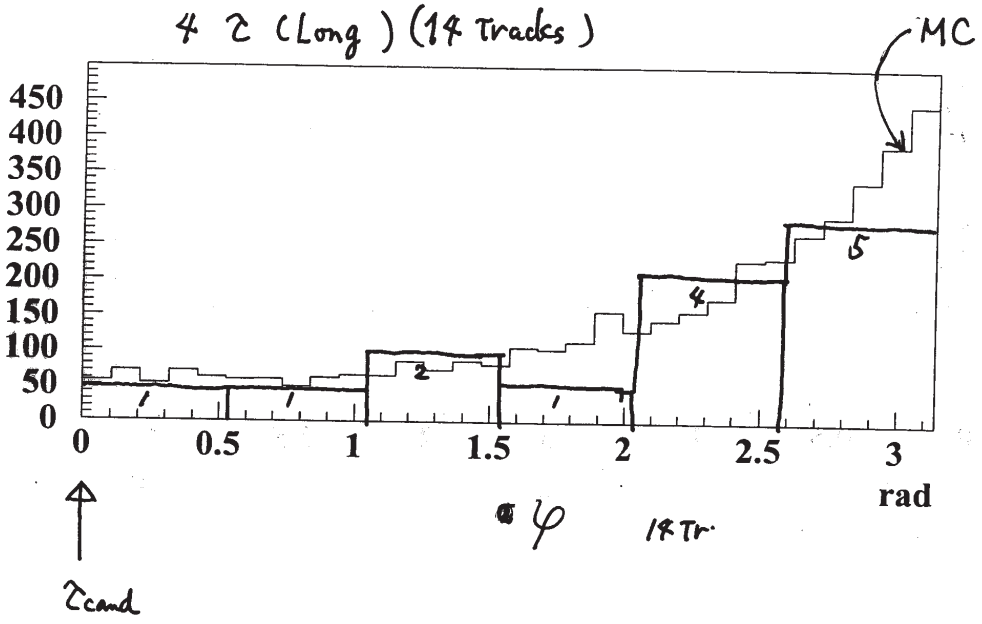

| | | | |
|---|---|---|---|
| 531-5363 | -240. | 100 | parent |
| 531-5312 | -58 | 65 | |
| 531-5149 | 13 | -27 | |
| 521-5092 | 11 | -25 | |
| 531-5432 | 89 | 144 | e |
| 531-5196 | 50 | -4 | |
| 531-5259 | 33 | 36 | |
| 531-5111 | -83 | -42 | |
| 511-5047 | -2 | -3 | γ→ee |
| 521-5904 | 0 | 170 | daughter |

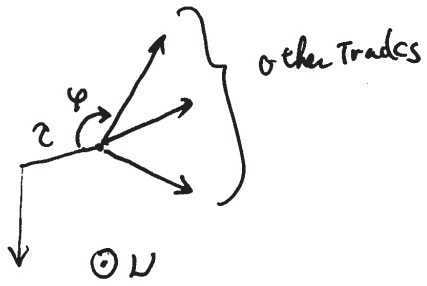



Decay in Fe



$\varphi$ (cand – other track) Distribution.



# Summary

- We have detected 5 $\tau$ candidates in 203 located neutrino interactions.

  [ The BG from Charm $< 0.8$
  The BG from 2ndary int $< 0.4$

- The observed # is consistent with the expected $\nu_\tau^{CC}$ ratio of 5% of $\nu_{all}^{CC}$.

---

- The newly developed Scanning Method NET Scan shows its power, but need much larger scanning power for future experiments. (OPERA)
- Particle ID, P measurement in ECC are well-studied and well applied.

} Ready for CHORUS PI & (OPERA) Need more Scanning Power