T. Sugimoto / KEK

'Neutron Background from QC1 at JLC

Background Source

e^+e^- pair background

↓

EM shower in QC1

↓

$\gamma + A \rightarrow n + X$

Generation of e^+e^- pair

Calcuration using ABEL

Beam E = 250 GeV

Energy spectrum → see Fig. 1

1.8×10^4 e^+e^- / bunch

Average energy ≒ 6.5 GeV

Simulation

$\gamma + A \rightarrow n + X$ process coded by T. Maruyama is implemented into GEANT3-based JLC detector simulator JIM.

Cross section is artificially increased by × 100.

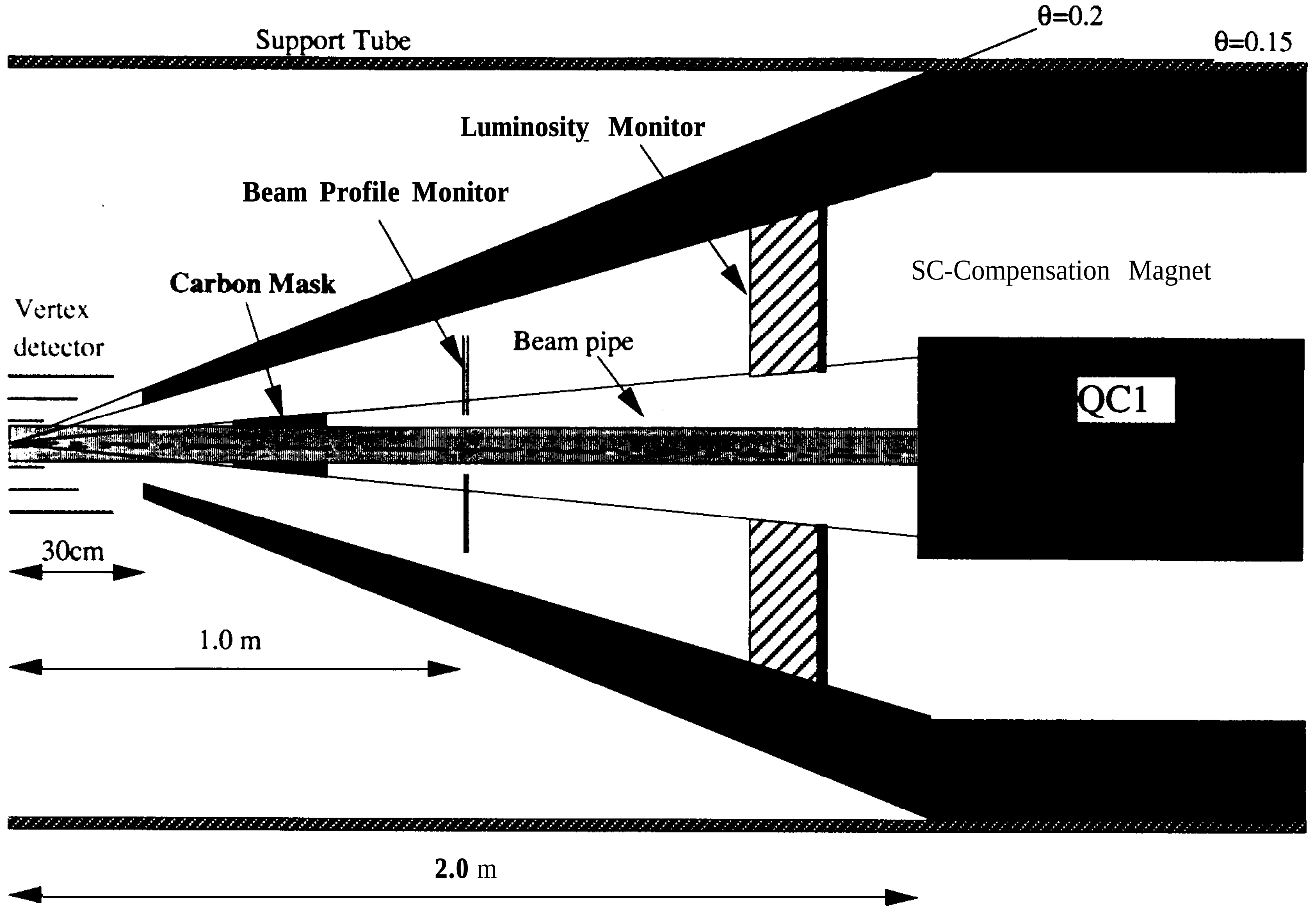
θ=0.2
Support Tube
θ=0.15
Luminosity Monitor
Beam Profile Monitor
SC-Compensation Magnet
Carbon Mask
Vertex detector
Beam pipe
QC1
30cm
1.0 m
2.0 m

Fig.2(a)

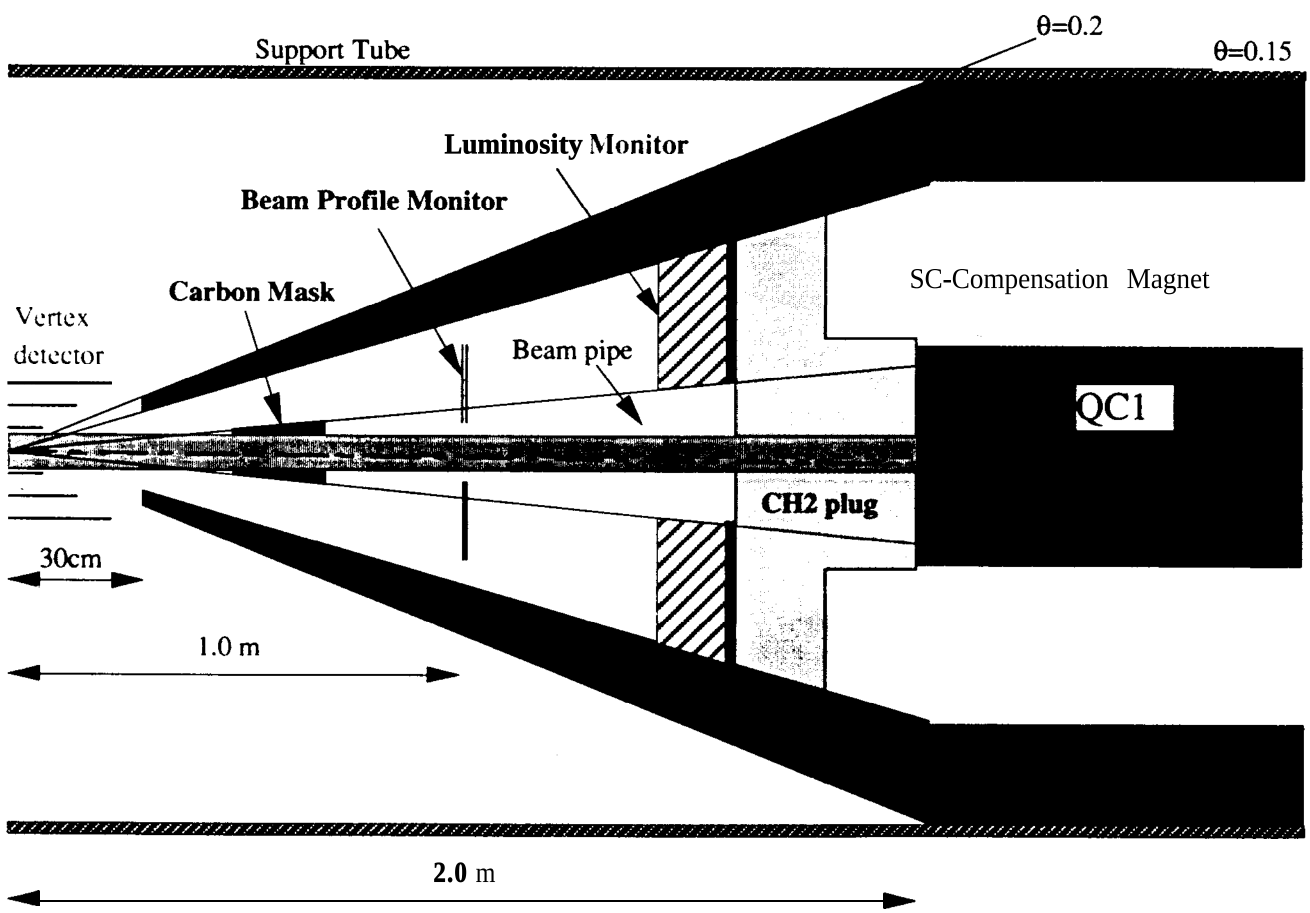
θ=0.2
Support Tube
θ=0.15
Luminosity Monitor
Beam Profile Monitor
SC-Compensation Magnet
Carbon Mask
Vertex detector
Beam pipe
QC1
CH2 plug
30cm
1.0 m
2.0 m

Fig.2(b)

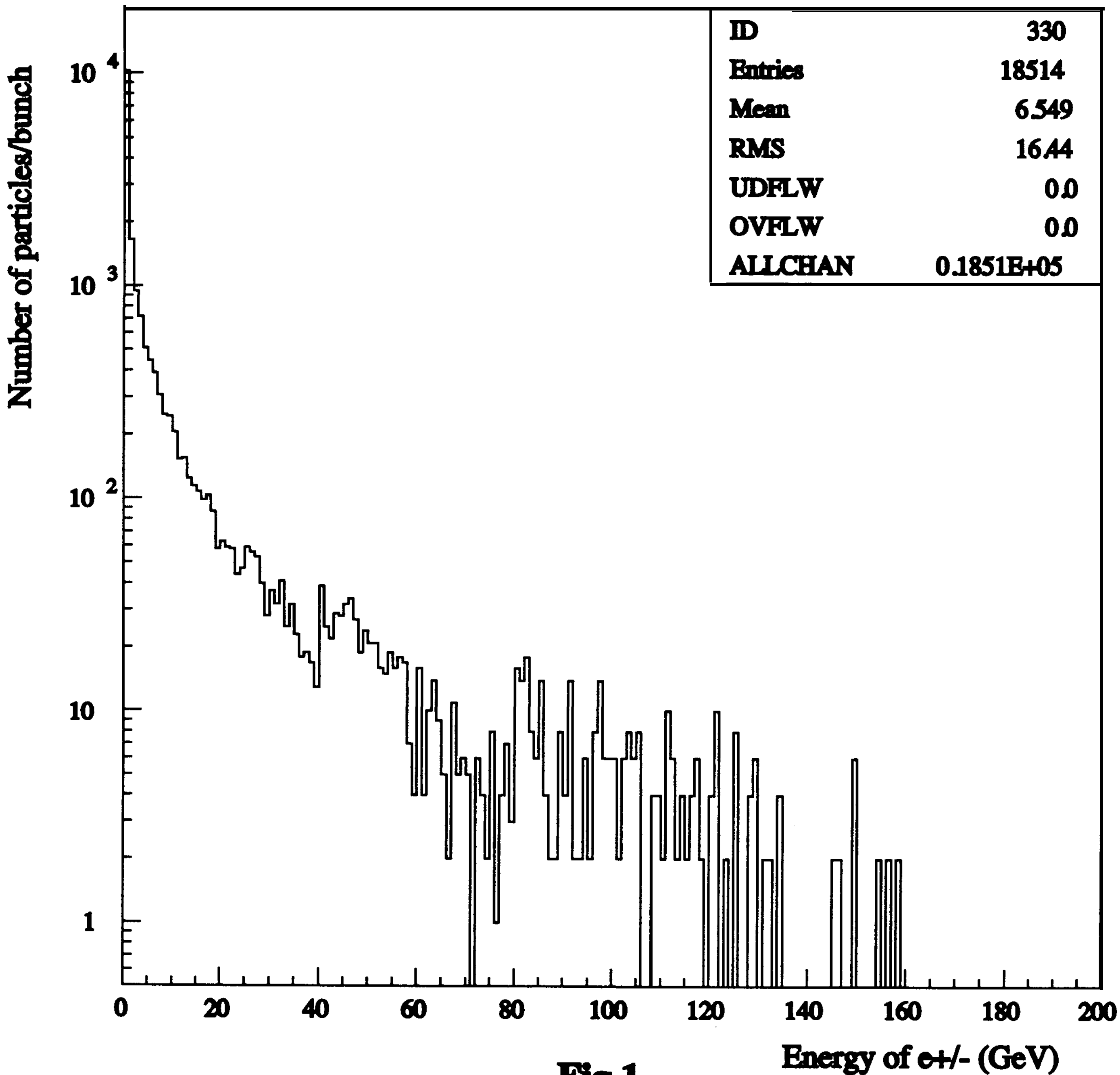
ID 330
Entries 18514
Mean 6.549
RMS 16.44
UDFLW 0.0
OVFLW 0.0
ALLCHAN 0.1851E+05
Number of particles/bunch
Energy of e+/- (GeV)

Fig.1.

Results of the Simulation

z-coordinate of the production point (Fig.3(a)) and kinetic energy (Fuig.3(b)) of the generated neutron

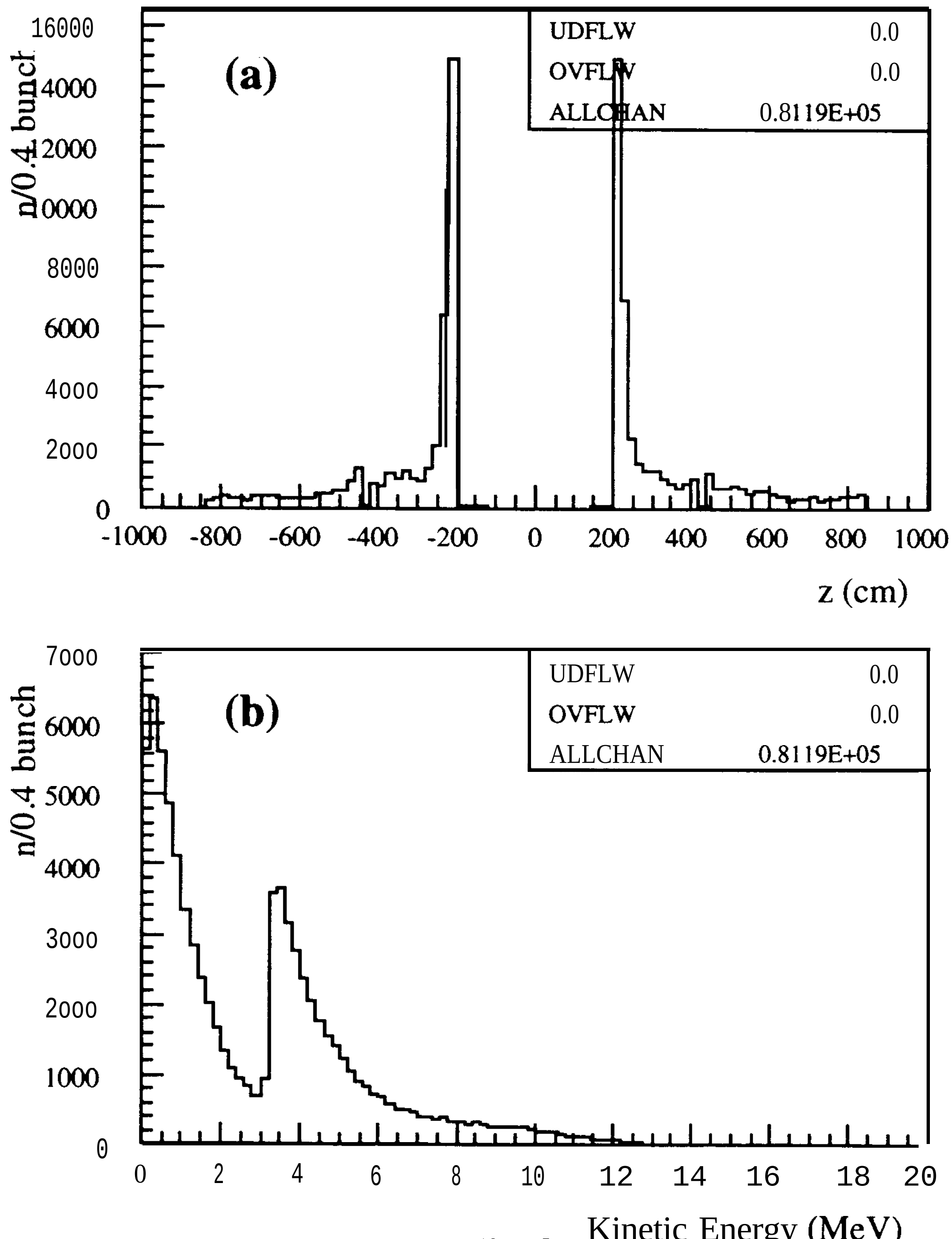

Fig.3

R distribution of neutrons passing z=0 plane

Fig.4(a) shows the R distribution of neutrons at z=0 for the geometry shown in Fig.2(a). A bump can be seen at small R corresponding to holes and thin regions of the mask.

Fig.4(b) is the close-up of Fig.4(a) for R<30cm. There are 187 entries in 0.4 bunch crossing. Taking 100 times larger cross section into account, the neutron intensity near R=O is

$$(187/0.4\text{bunch}) \times 85\text{bunch} \times 150\text{Hz}/(\pi \times (30\text{cm})^2)/100 = 21/\text{cm}^2/\text{s}$$

$$= \quad 2.1 \times 10^8/\text{cm}^2/\text{year}(=10^7\text{sec})$$

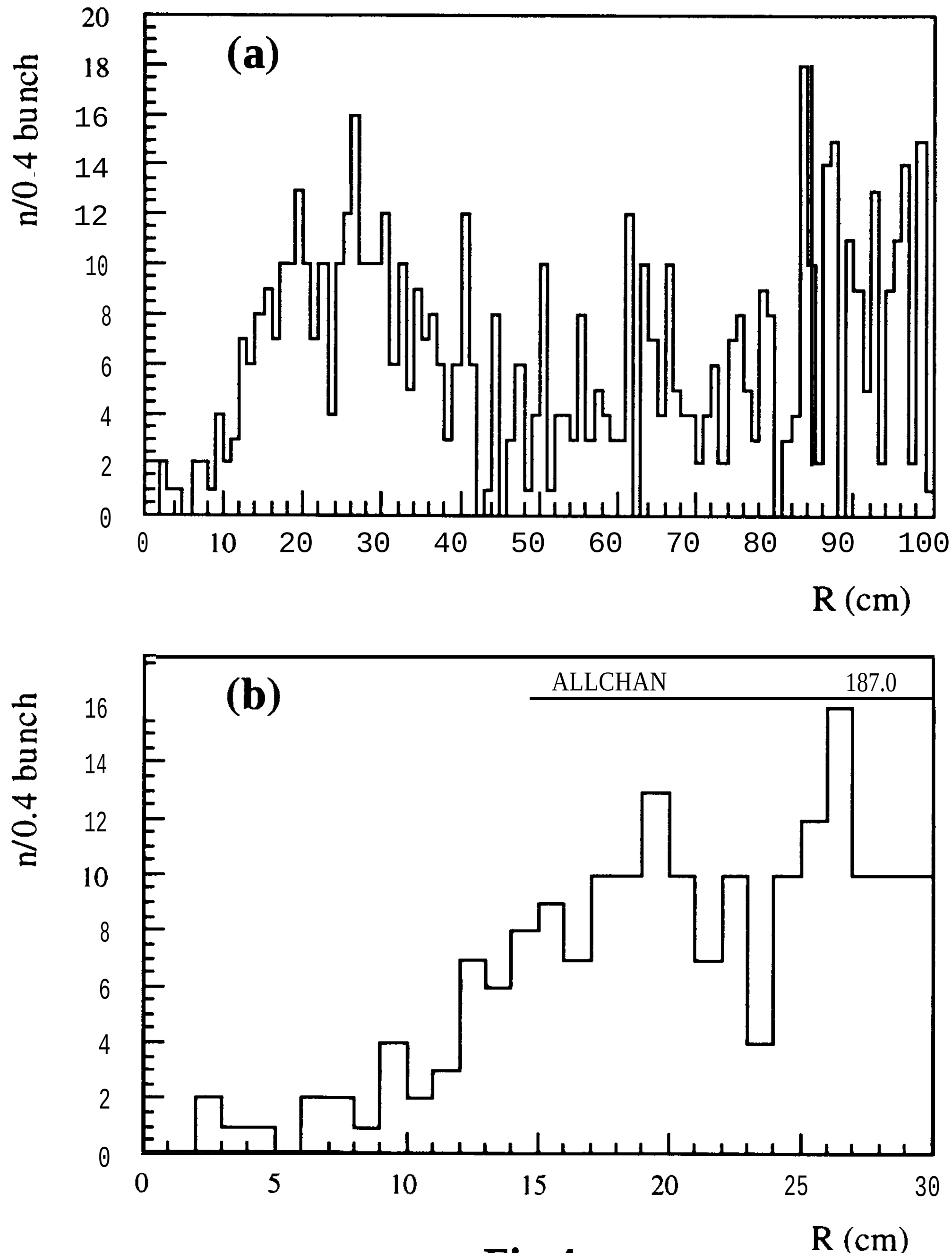

Fig.4

Fig.5(a) and (b) are the same plot as Fig.4(a) and (b), respectively but for the geometry shown in Fig.2(b).

Since hydrogen atoms in CH_2 effectively stop neutrons, the bump seen in Fig.4 becomes quite small.

The neutron intensity in this case is $6 \times 10^7/cm^2/year$.

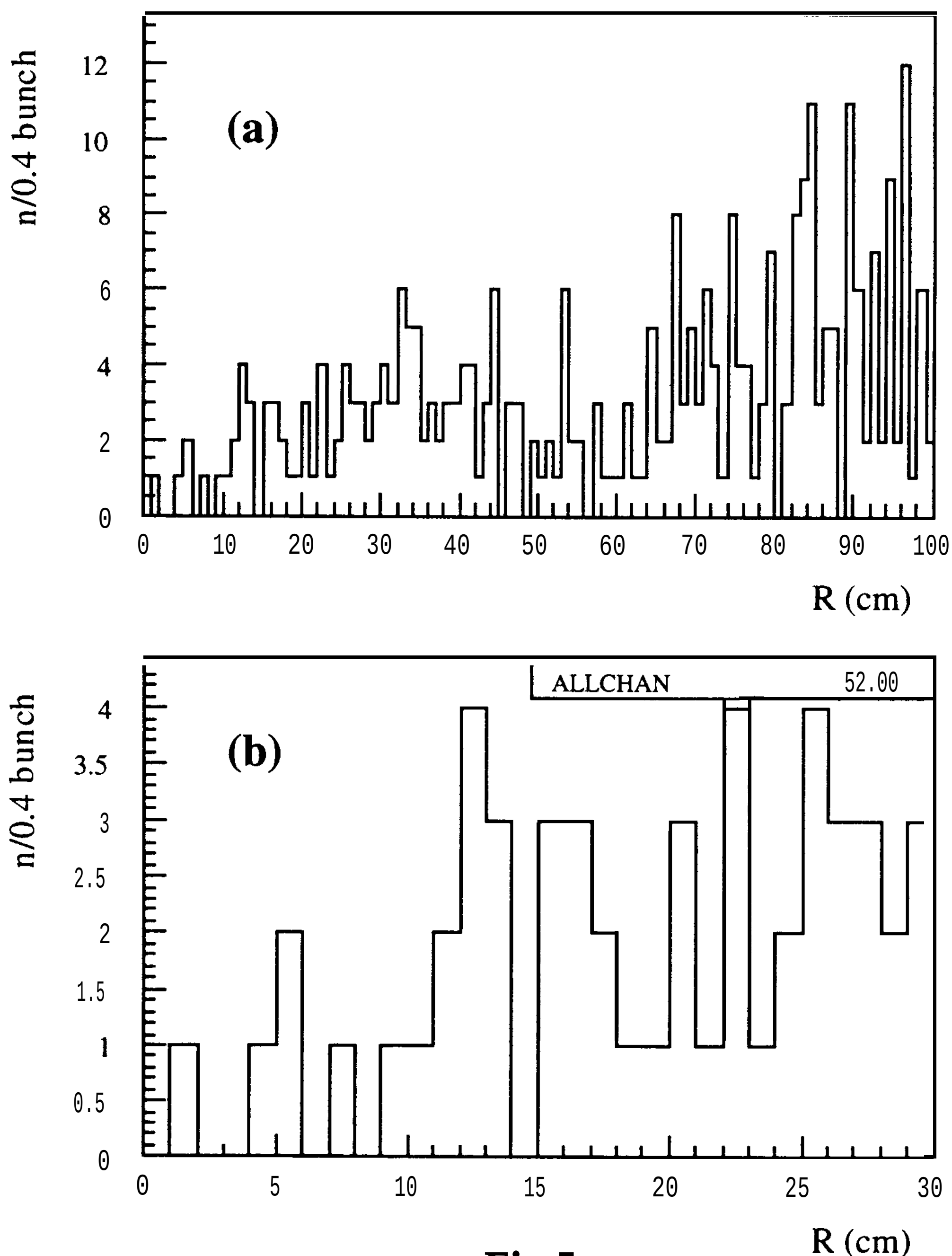

Fig.5

CDC background hits by neutrons

Neutrons make background hits in CDC ($45cm<R<230cm$, $-230cm<Z<230cm$, gas mixture is $CO_2/isoC_4H_{10}=90/10$)

From Fig.6, the hit rate in the gas volume of the CDC is found to be

$$(364/100/0.4\text{bunch}) \times 85\text{bunches/train}$$
$$\fallingdotseq 800 \text{ hits/train}$$

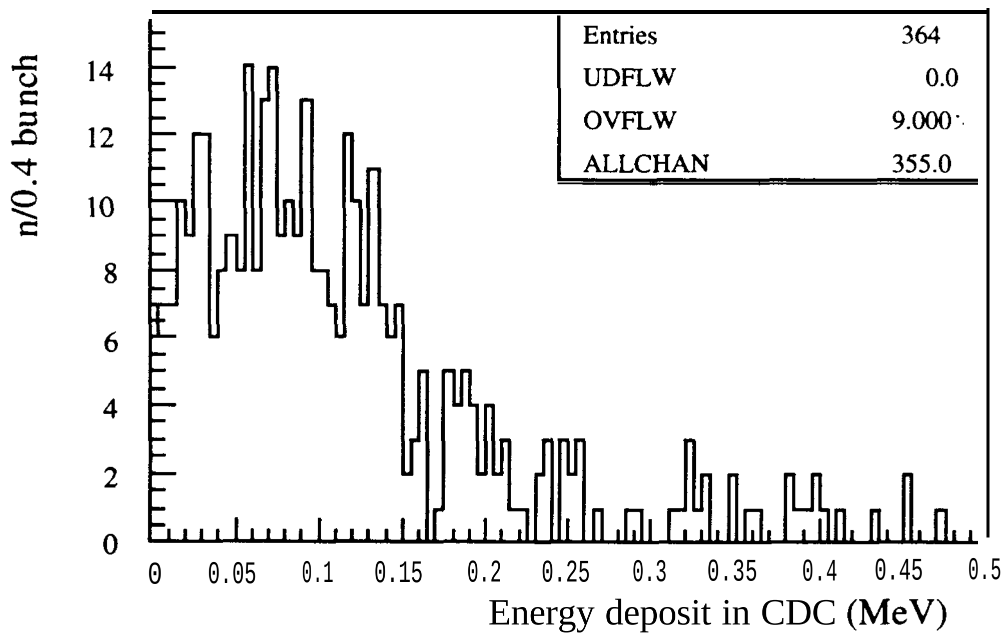

Fig.6

CDC background hits by γ

To see the contribution from γ background to the CDC hits shown in Fig.6, simulation without neutron production is also made and the result is shown in Fig.7(a). Comparing this figure with Fig.6, the γ contribution to Fig.6 is found to be less than 10% (Note that the cross section of neutron production is multiplied by 100 in Fig.6).

From Fig.7, on the other hand, the CDC hits by γ is estimated as

35/bunch × 85bunch/train = 3000/train !

Original energy of γ which made the CDC hits are plotted in Fig.7(b). It can be seen that most of the y come from annihilation γ and tungsten K X-ray (≒ 60 keV).

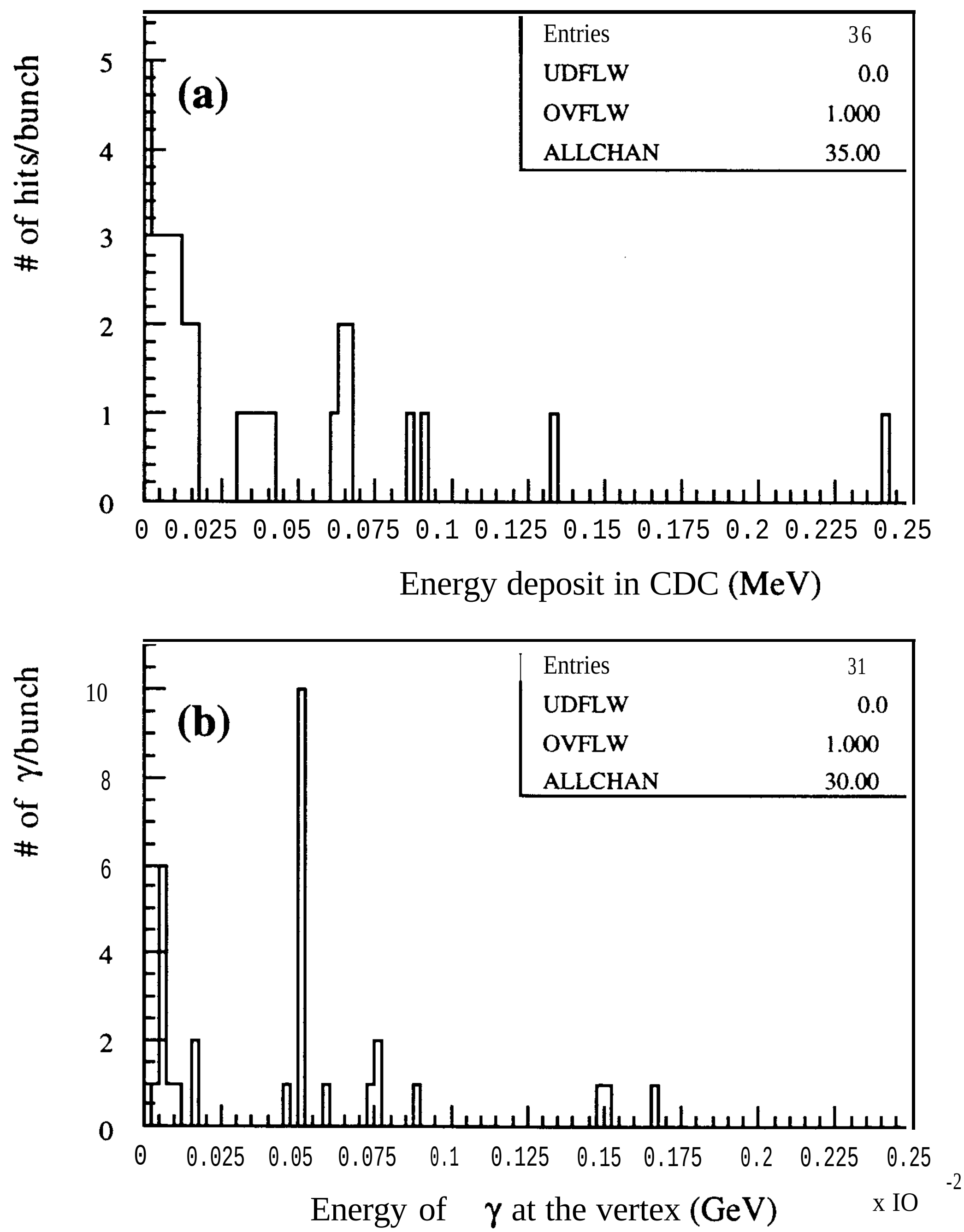
(a)
# of hits/bunch
Entries 36
UDFLW 0.0
OVFLW 1.000
ALLCHAN 35.00
0 1 2 3 4 5
0 0.025 0.05 0.075 0.1 0.125 0.15 0.175 0.2 0.225 0.25
Energy deposit in CDC (MeV)
(b)
# of γ/bunch
Entries 31
UDFLW 0.0
OVFLW 1.000
ALLCHAN 30.00
0 2 4 6 8 10
0 0.025 0.05 0.075 0.1 0.125 0.15 0.175 0.2 0.225 0.25
x IO -2
Energy of γ at the vertex (GeV)

Fig.7

Summarv

$e^{\pm}$ pair background:

$1.9\sim 10^4$/ bunch

<E> = 6.5 GeV → Etot=1.2×10^8 MeV

Neutron yield:

Etot → 1.2×10^4 n/bunch is expected

Simulation → 2.0×10^3 n/bunch

Not all the energy is absorbed

Neutron flux near IP:

Yield/($4\pi r^2$) → 50 n/cm^2/sec is expected

Simulation → 20(6) n/cm^2/sec

Shielded by the target itself and mask

$2X10^8$ n/10^7 sec → No problem for CCD

CDC background hits:

800 /train by n

3000/train by γ → More shield is needed

Background from downstream (beam dump etc.) is not estimated yet