For every subtle complicated problem, there is an easy, simple and straightforward solution answer.....

which is always wrong.

HER:
no 1 priority

SR source I: Weak bend region kills SVD layer 1

SR source II: Outgoing HER beam makes CDC occupancy

} SR

Particle Backgrounds: 0 - 150m + arcs } Particle.

LER:

$$EI = \text{constant} \Rightarrow I_{LER} = \frac{8.0}{3.5} I_{HER}$$

Background/I is much lower but current is x2 higher and outgassing is faster.

Program for Background

- Questions
- Answers
- Action Items

Questions:

I) What is the composition of the SVD background?

90% particle, 10% SR ?
10% particle, 90% SR ?
other ?

After removing the soft (< 5keV) x-ray component, what is the composition ?

II) What is the CDC background composition?

90% particle, 10% SR ?
10% particle, 90% SR ?
other ?

Note: leakage current and occupancy may have different fractions.

On-line KEKB monitoring ?

III) Once the composition is established,

e.g. 90% particle background
How much comes from QC2-QC3 ?
How much from IP ?

e.g. 90% SR
How much from weak bend, how much from coil

Traditional diagnostic method

$$B = B_{SR} + B_{particle}$$

$$= \alpha I + \left(P_0 + \frac{dP}{dI} I \right) I$$

if $\frac{dP}{dI}$ is small, both terms become linear

Most background studies with HER have no dynamic range in I_{HER}

- → lifetime is long
- → CDC trips if $I_{HER} >> 50$ mA
- → afraid to kick the beam with RF cavities
- → and anyways the dynamic pressure is small.

If we had a region in the HER with large outgassing that also produces background. Make a pressure bump there and fit to the current dependence.

Answers:

Method I: Monte Carlo simulation + pressure profile

Method II:

In CDC SVD $$B = \sum_i \left(\frac{dB}{dP}\right)_i P_i + SR$$

requires pressure profile

Method III:

Assume background is produced by the same source in TOF and CDC.

$$B_{CDC}^{HER} = R_{CDC}\left\{B_{particle}^{HER} + SR_{particle}^{HER}\right\}$$

$$B_{TOF}^{HER} = R_{TOF}\left\{B_{particle}^{HER}\right\}$$

From LER data, $B \propto I^2$

$$\left.\begin{aligned} B_{CDC}^{LER} &= R_{CDC}\, B_{particle}^{LER} \\ B_{TOF}^{LER} &= R_{TOF}\, B_{particle}^{LER} \end{aligned}\right\} \Rightarrow \text{obtain } \frac{R_{CDC}}{R_{TOF}}$$

→ Check results with pressure bumps

$$P \rightarrow P' = nP \qquad n \sim O(10)$$

$$B_{CDC}^{HER} = R_{CDC}\left\{B_{particle}^{\,n} + SR\right\}$$

$$B_{TOF}^{HER} = R_{TOF}\left\{B_{particle}^{\,n}\right\}$$

$$\frac{B_{CDC}^{HER}}{B_{TOF}^{HER}} = \frac{R_{CDC}}{R_{TOF}}\left\{1 + \frac{SR}{B_{particle}^{\,n}}\right\}$$

Also can use EFC or crystals.

Action items

Short term

→ SR coatings on beampipe + SR shield on electronics + corrugated beampipe

→ effect of steering and IP mask on SVD x-ray background. {on line monitoring of occupancy}

→ Particle background shielding for outgoing HER + LER beams → more Pb needed

→ Can we take data during machine physics? ⇒ more $\int L dt$

Long term

→ Improvement of vacuum pressure and monitoring

→ Understand effect of all steering parameters (find the best steering)

→ Understand origin of all particle backgrounds (Add collimators + pumping)

Back ground source

- Particle background
- Photon background

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Particle background

- phi distribution
  - peak at zero degree
- z distribution
  - no z dependence

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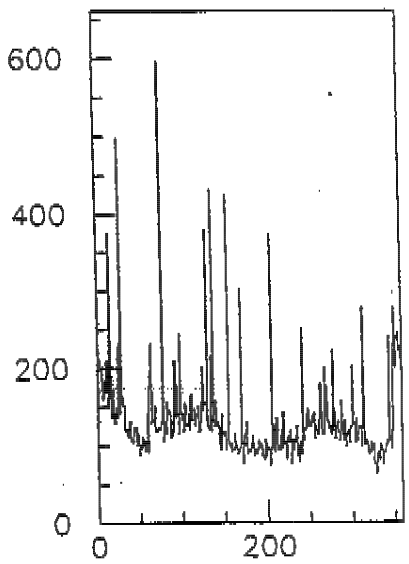
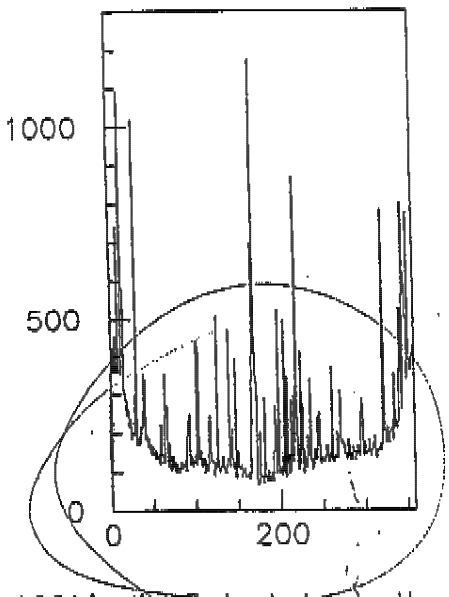
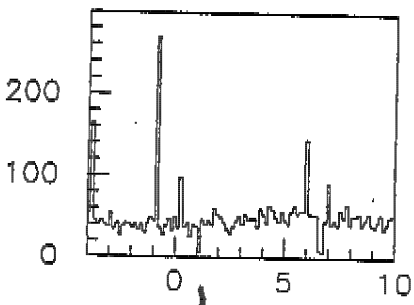
DATE No.



z0@hi−dist 2nd adc larger than 100



d0@hi−dist 3rd adc larger than 100



adc 100− z3rd layer 0

Z from IP −2

F-photon background

- phi distribution
  - peak ~180 degree
  - broad peak
- z distribution
  - 1st layer forward peak
  - 2nd layer peak at 5-2 cm

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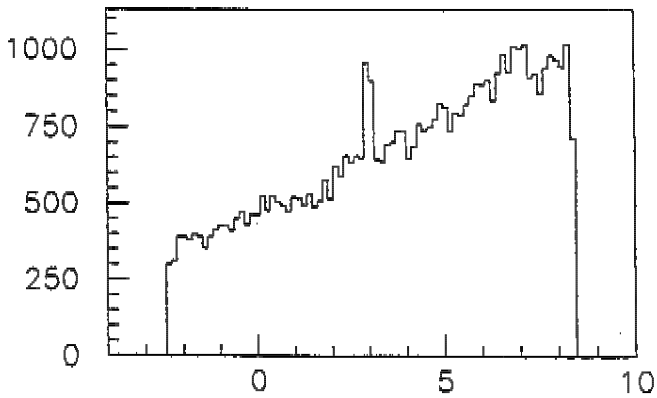
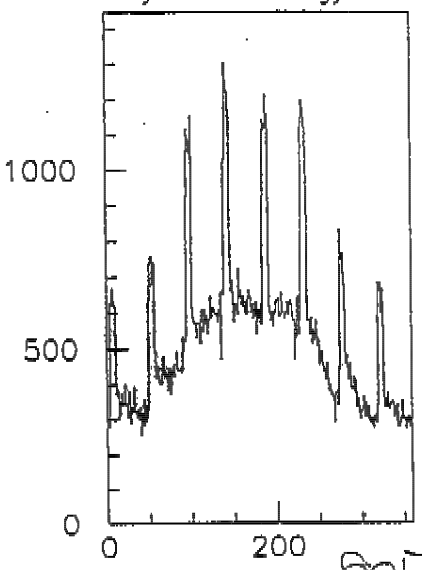
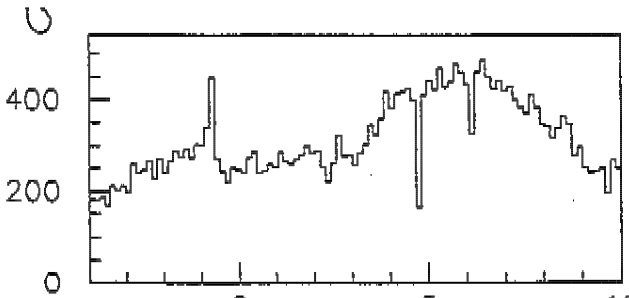


c3 adc 5−50 z1 layer 5 3DSSD

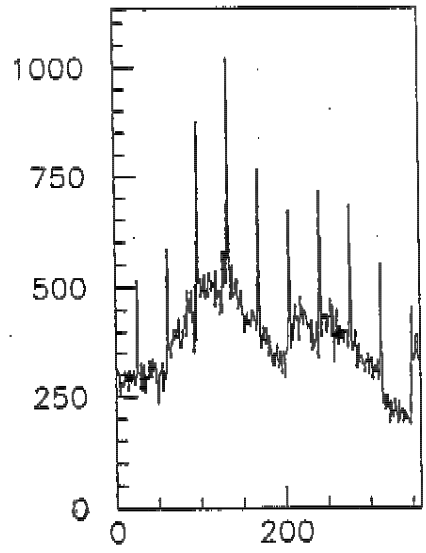
Layer 1st energy cut

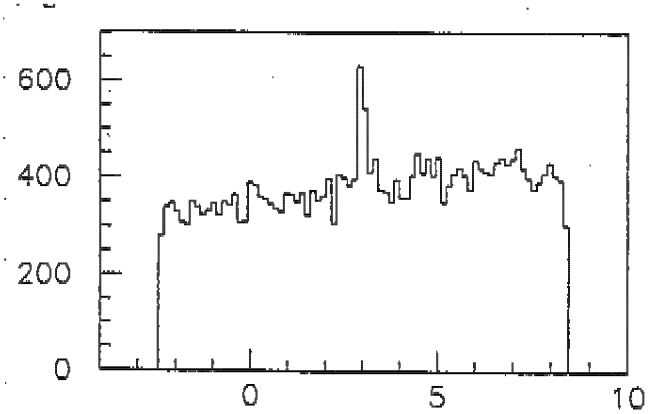




adc 5−50 z2 layer 4 4DSSD

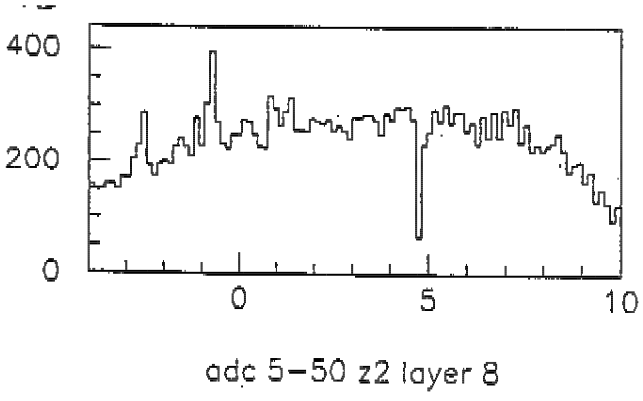
phi−dist 1st adc less than





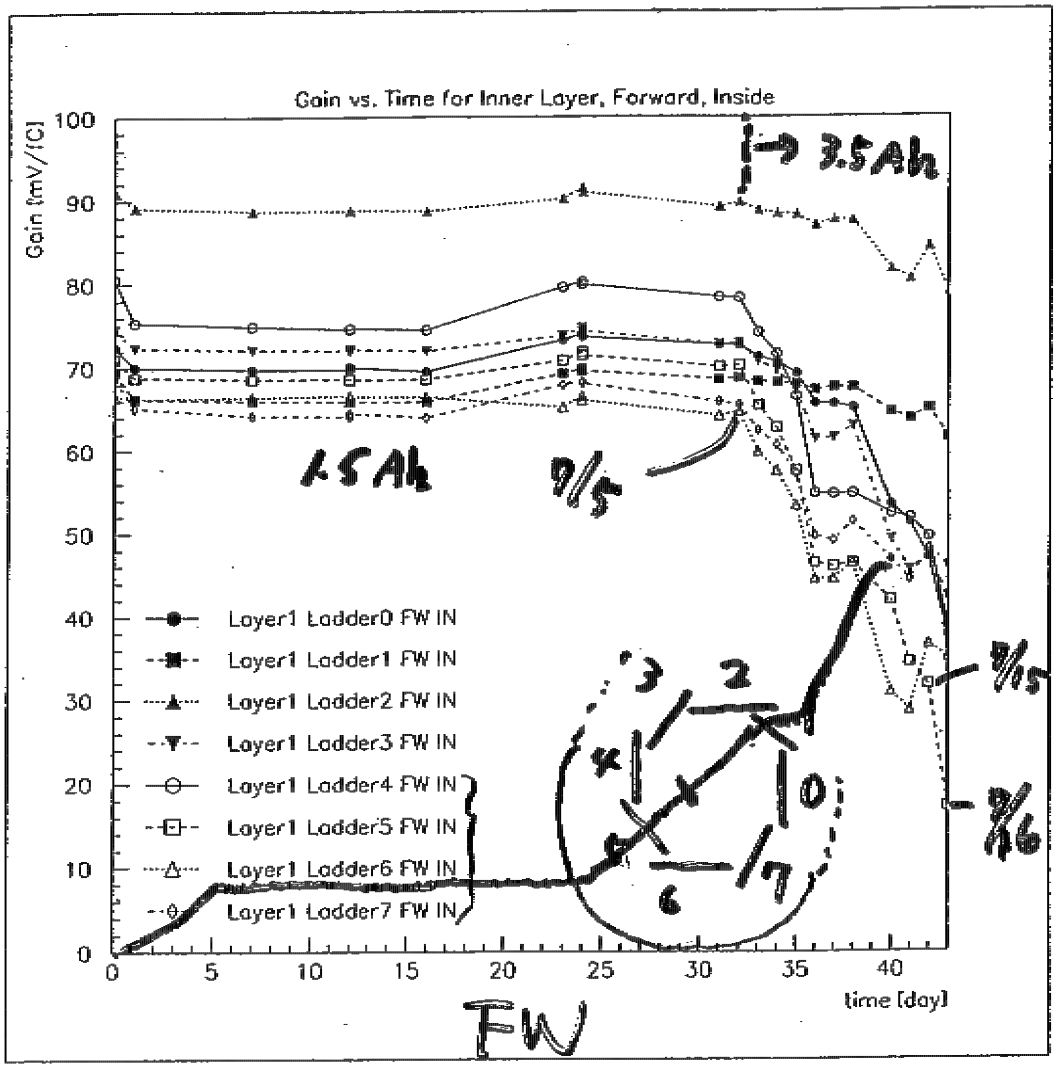
c3 adc 5−50 z1 layer 7

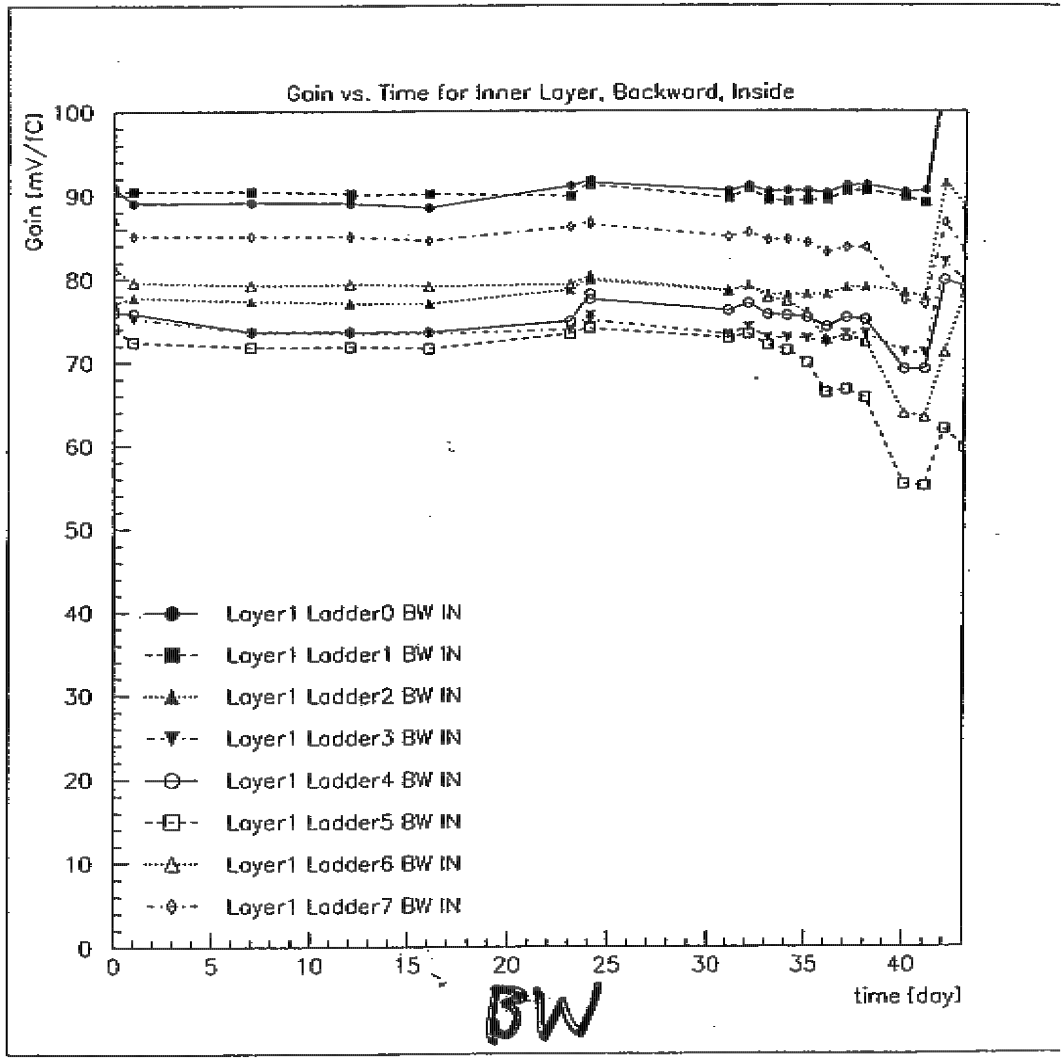
phi−dist 2nd adc less than



adc 5−50 z2 layer 8

hybrids facing beampipe





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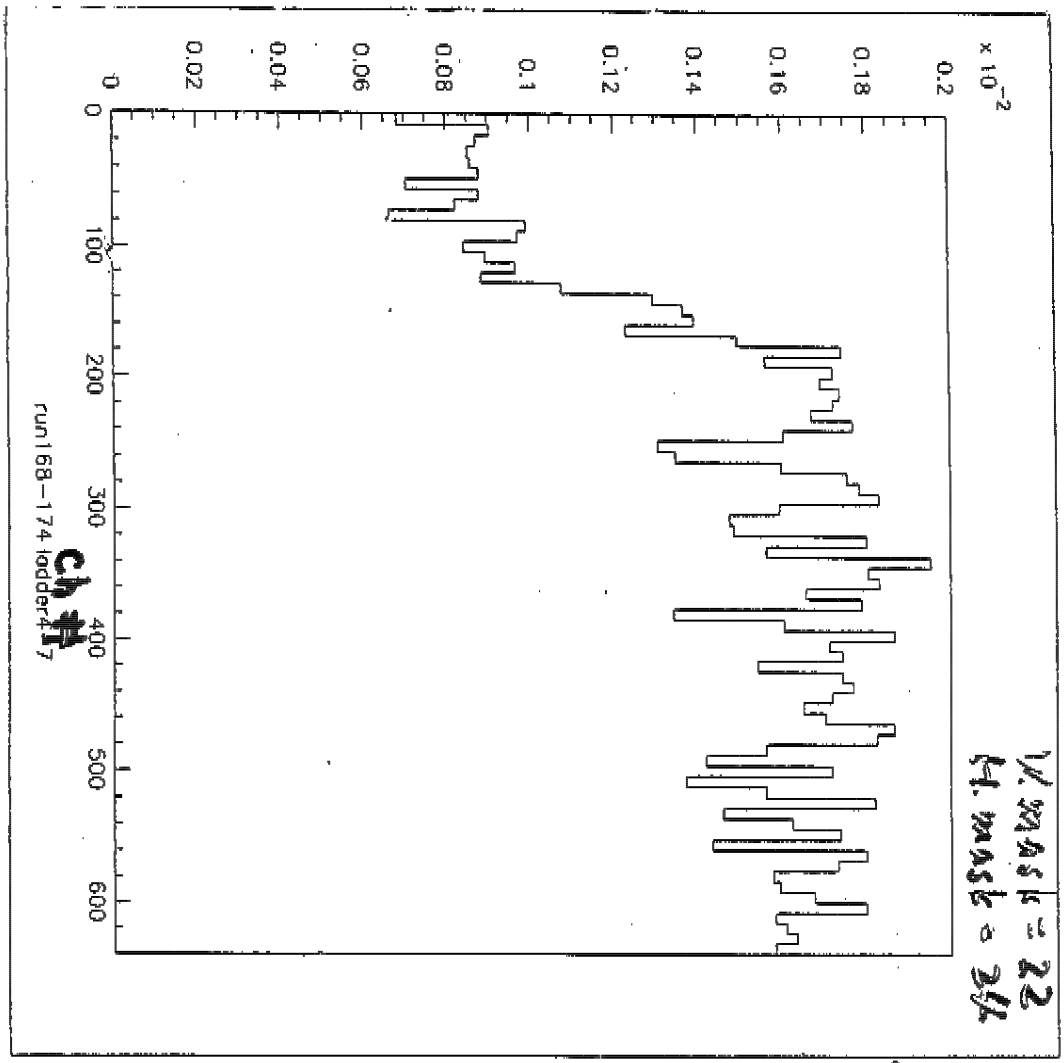
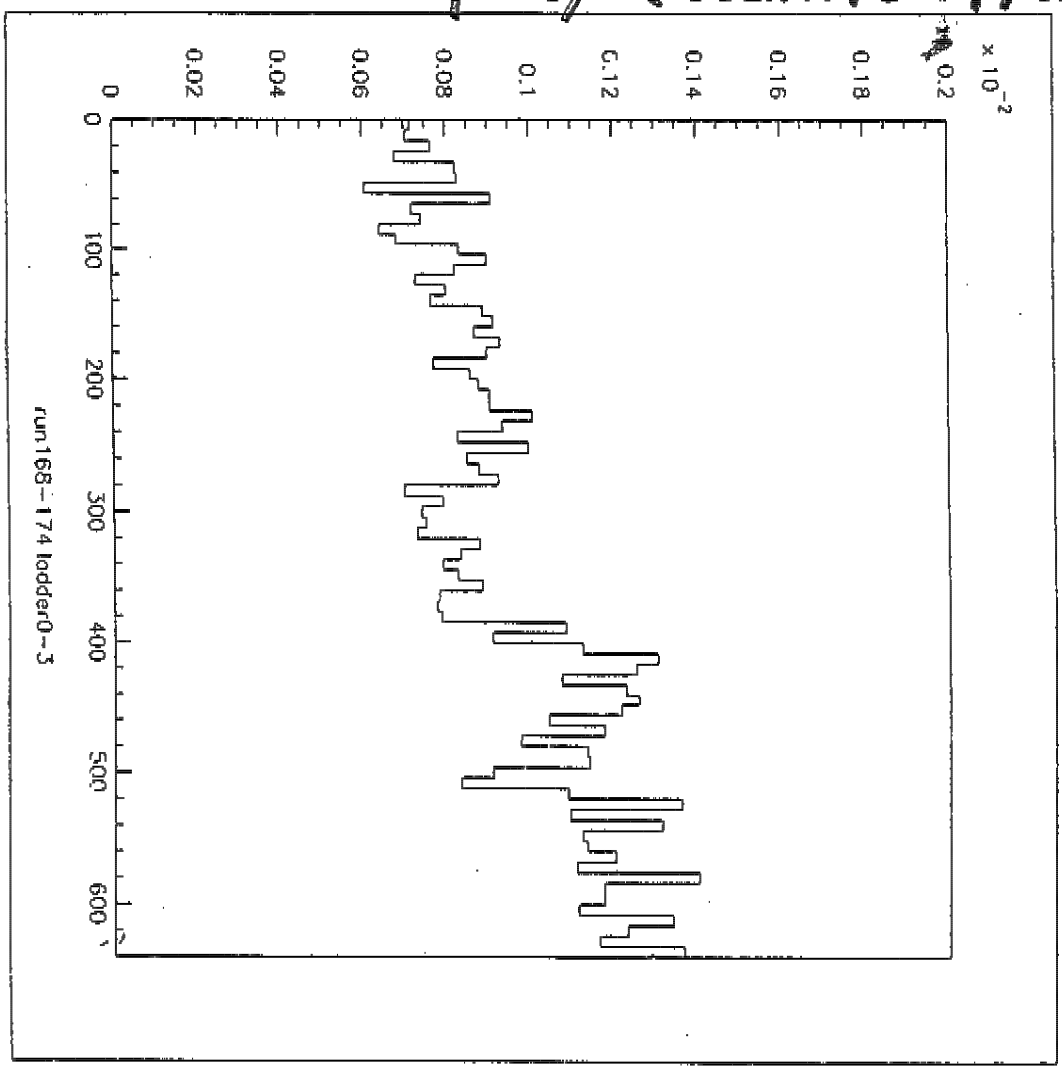
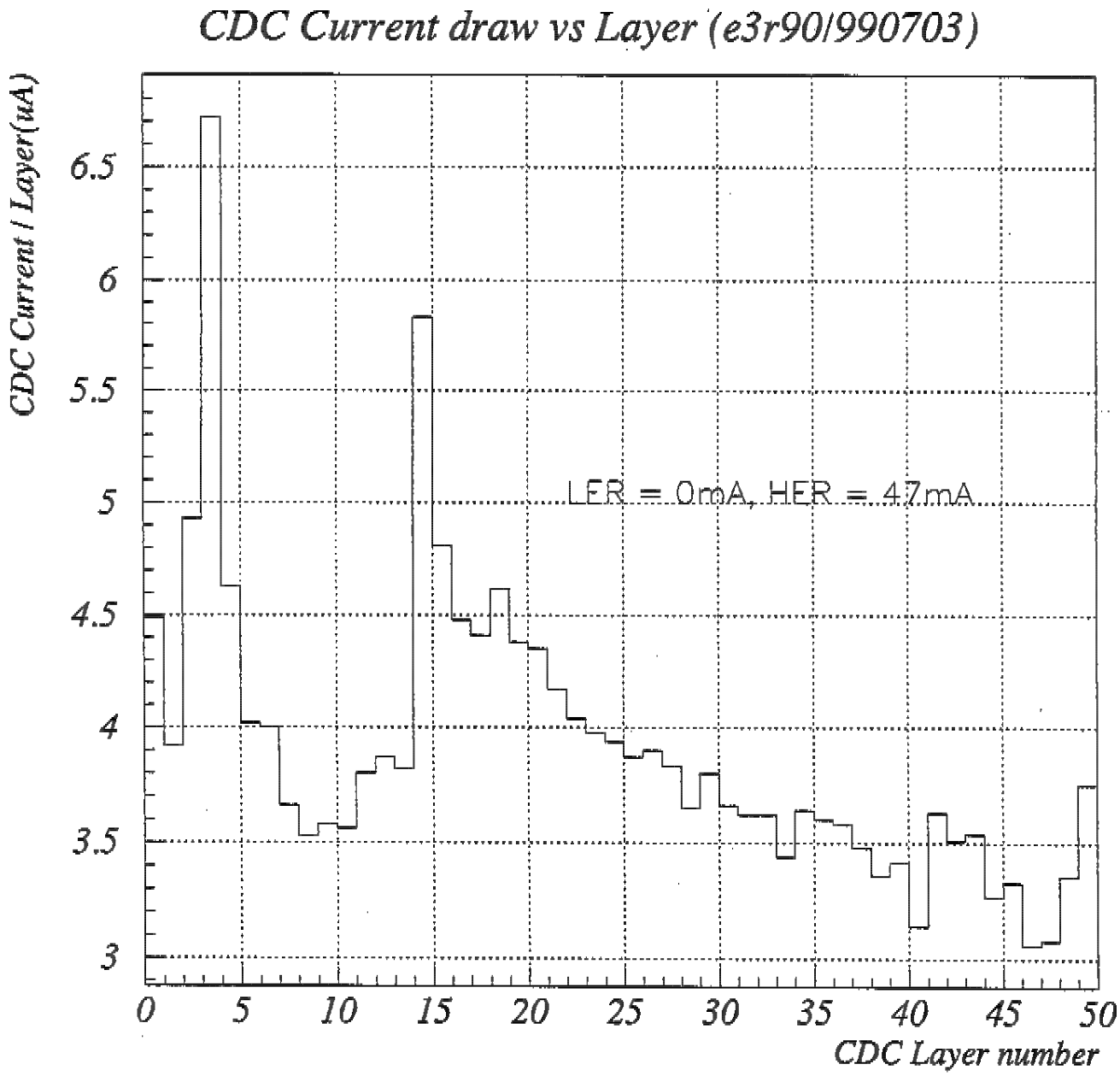
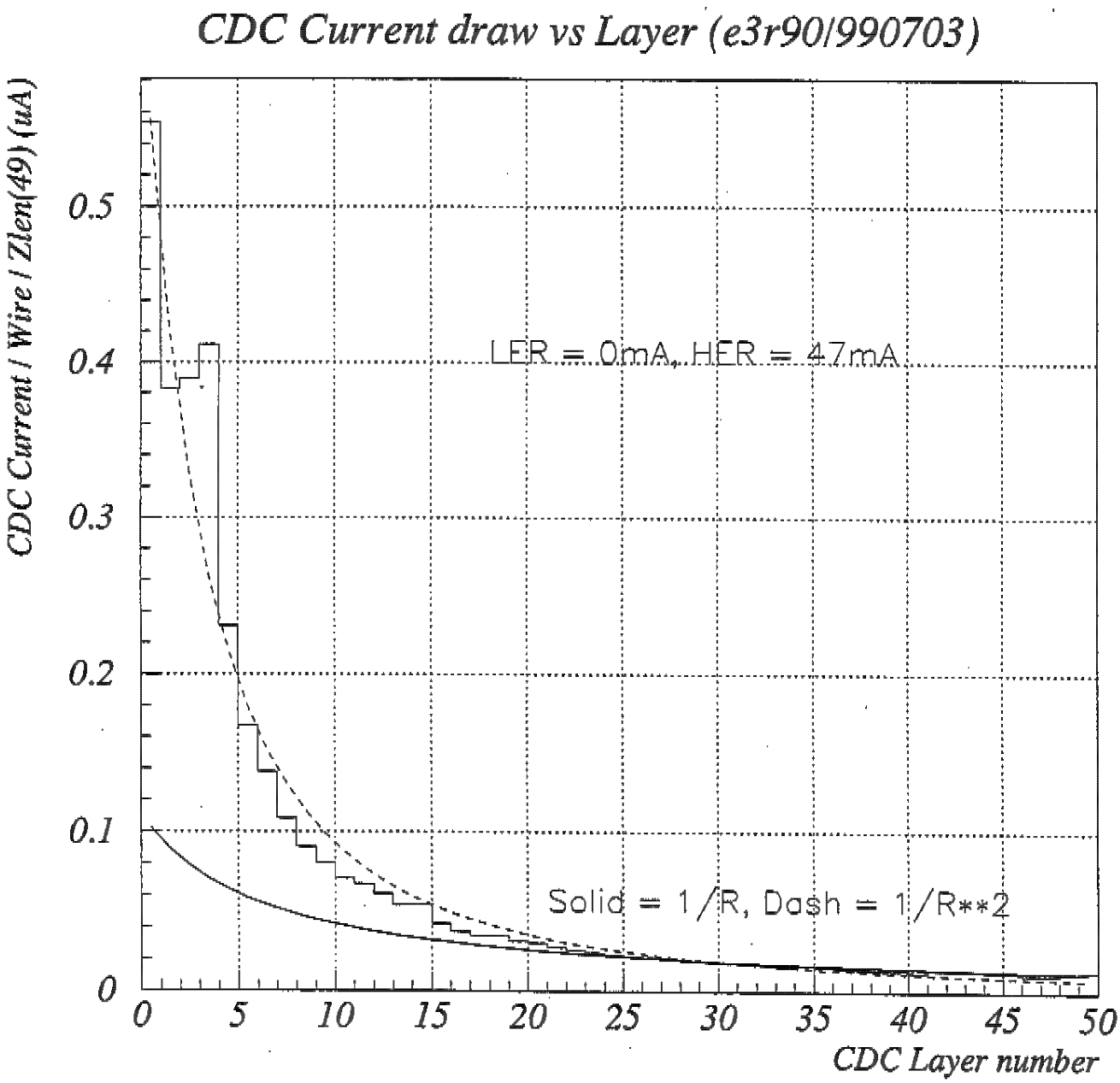
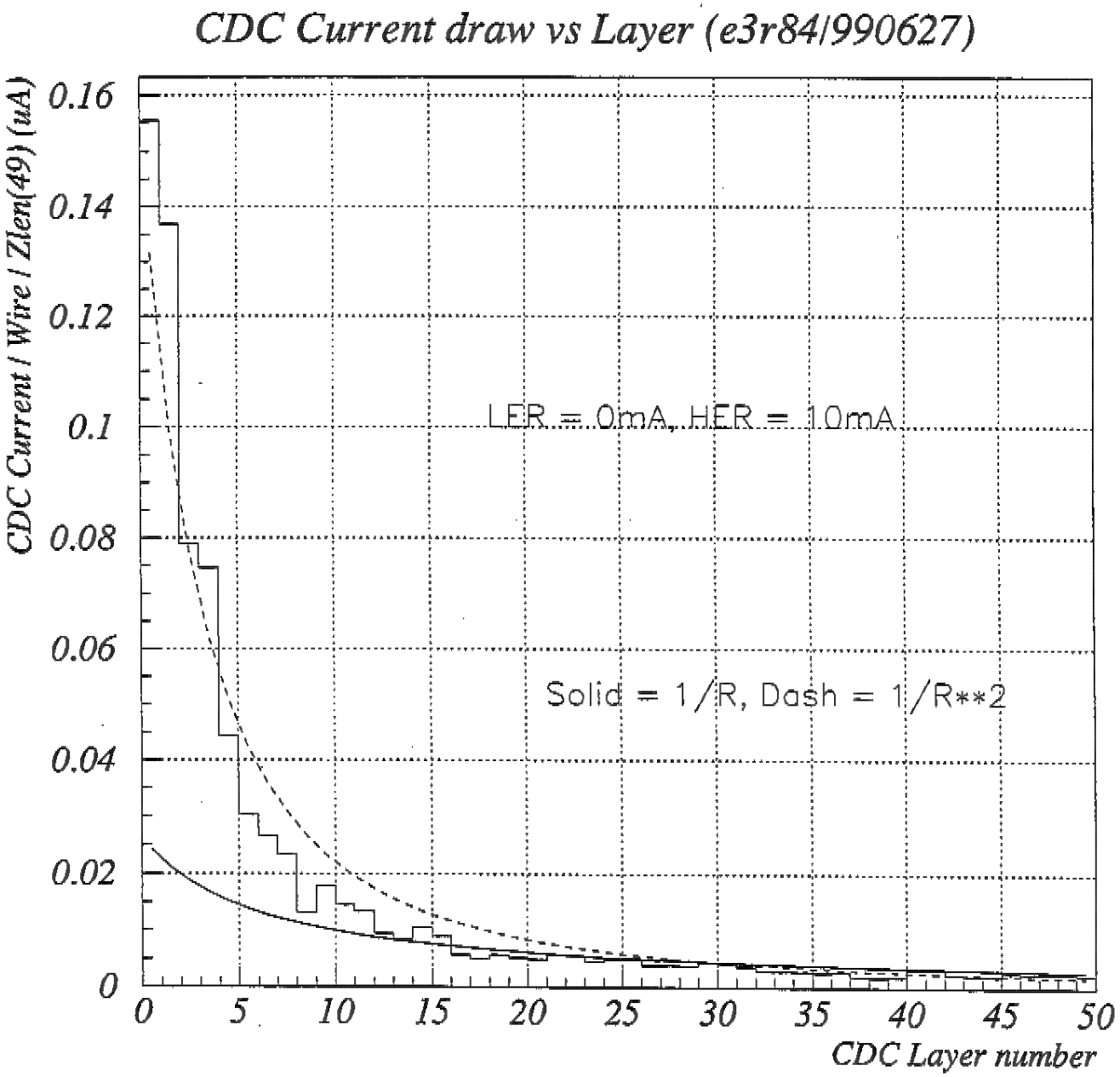


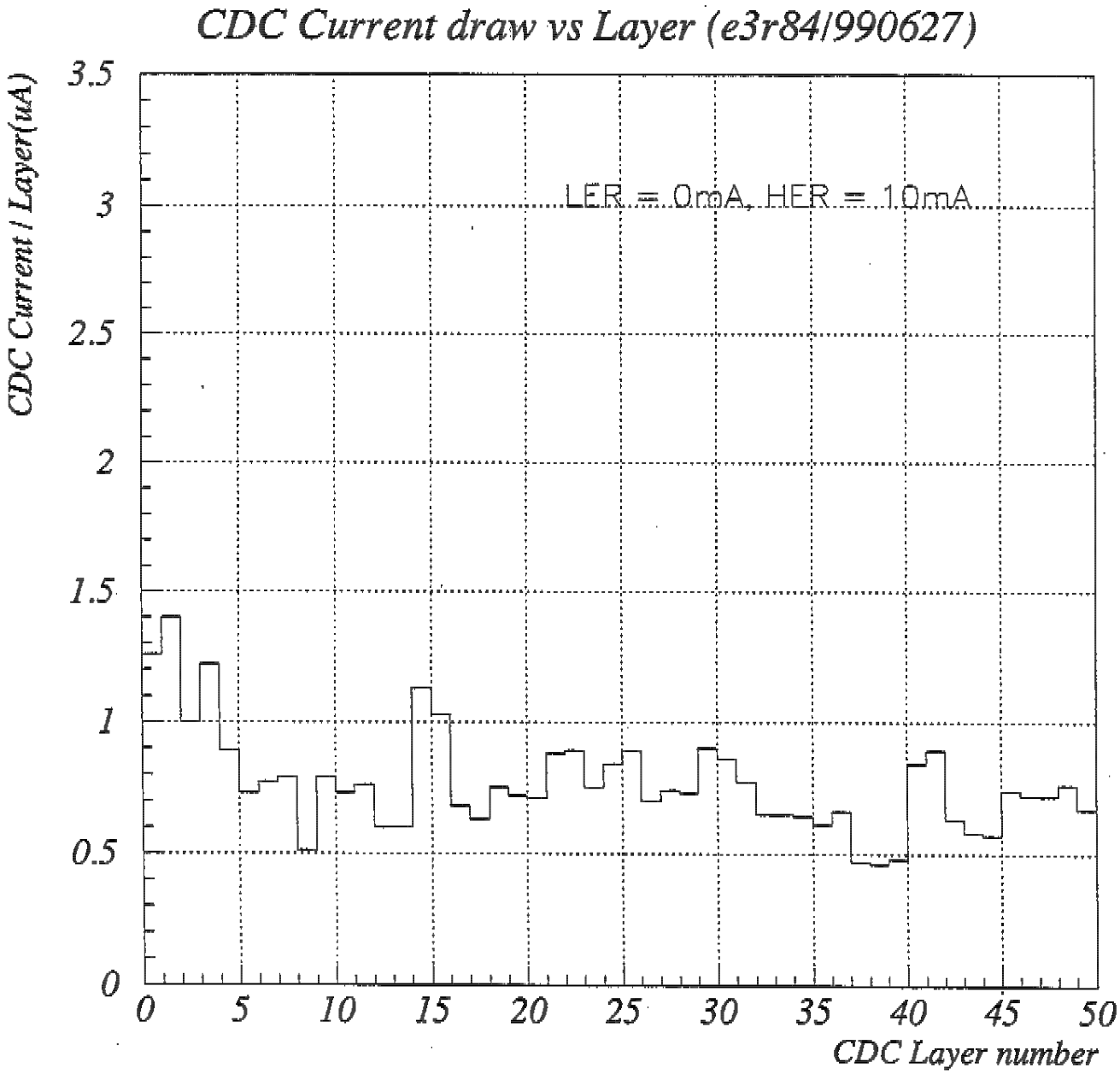
Occupancy (counts/strip/event)

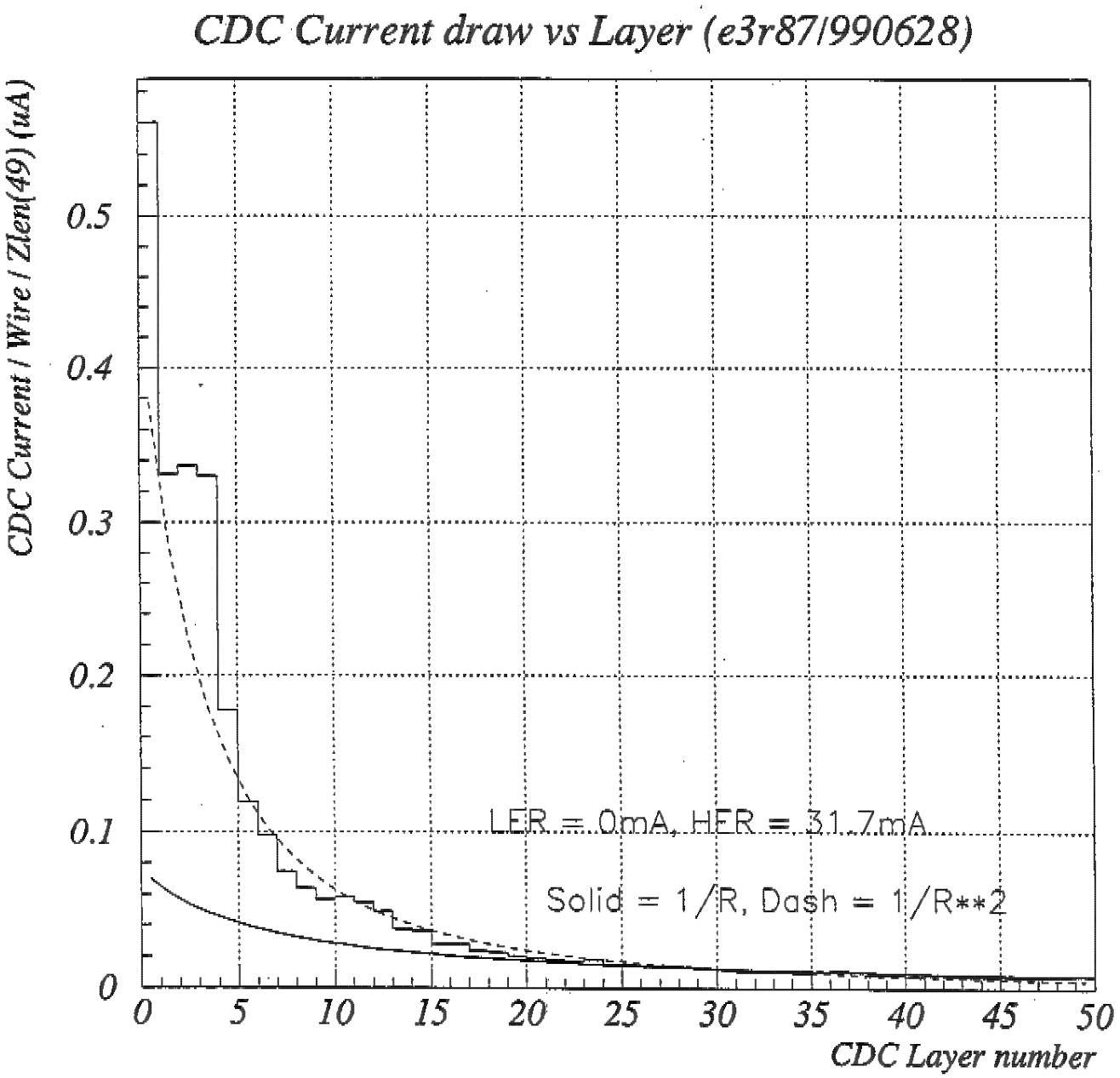


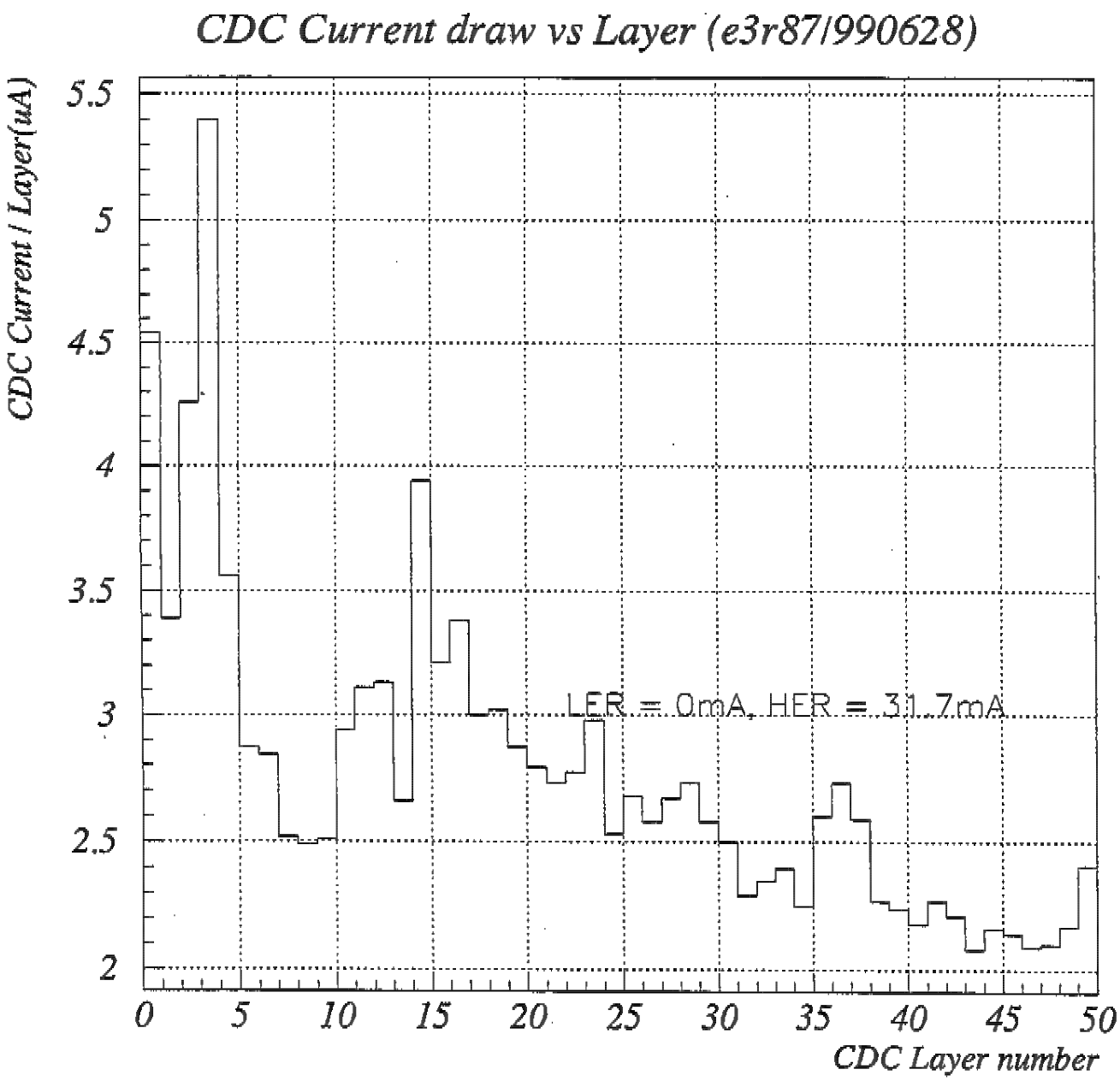

CDC Current draw vs Layer (e3r90/990703)
CDC Current / Layer(uA)
6.5
6
5.5
5
4.5
4
3.5
3
LER = 0mA, HER = 47mA
0
5
10
15
20
25
30
35
40
45
50
CDC Layer number


CDC Current draw vs Layer (e3r90/990703)
CDC Current / Wire / Zlen(49) (uA)
0.5
0.4
0.3
0.2
0.1
0
LER = 0mA, HER = 47mA
Solid = 1/R, Dash = 1/R**2
0
5
10
15
20
25
30
35
40
45
50
CDC Layer number


CDC Current draw vs Layer (e3r84/990627)
CDC Current / Wire / Zlen(49) (uA)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
LER = 0mA, HER = 1.0mA
Solid = 1/R, Dash = 1/R**2
0
5
10
15
20
25
30
35
40
45
50
CDC Layer number


CDC Current draw vs Layer (e3r84/990627)
LER = 0mA, HER = 10mA
CDC Current / Layer(uA)
CDC Layer number
0
0.5
1
1.5
2
2.5
3
3.5
0
5
10
15
20
25
30
35
40
45
50

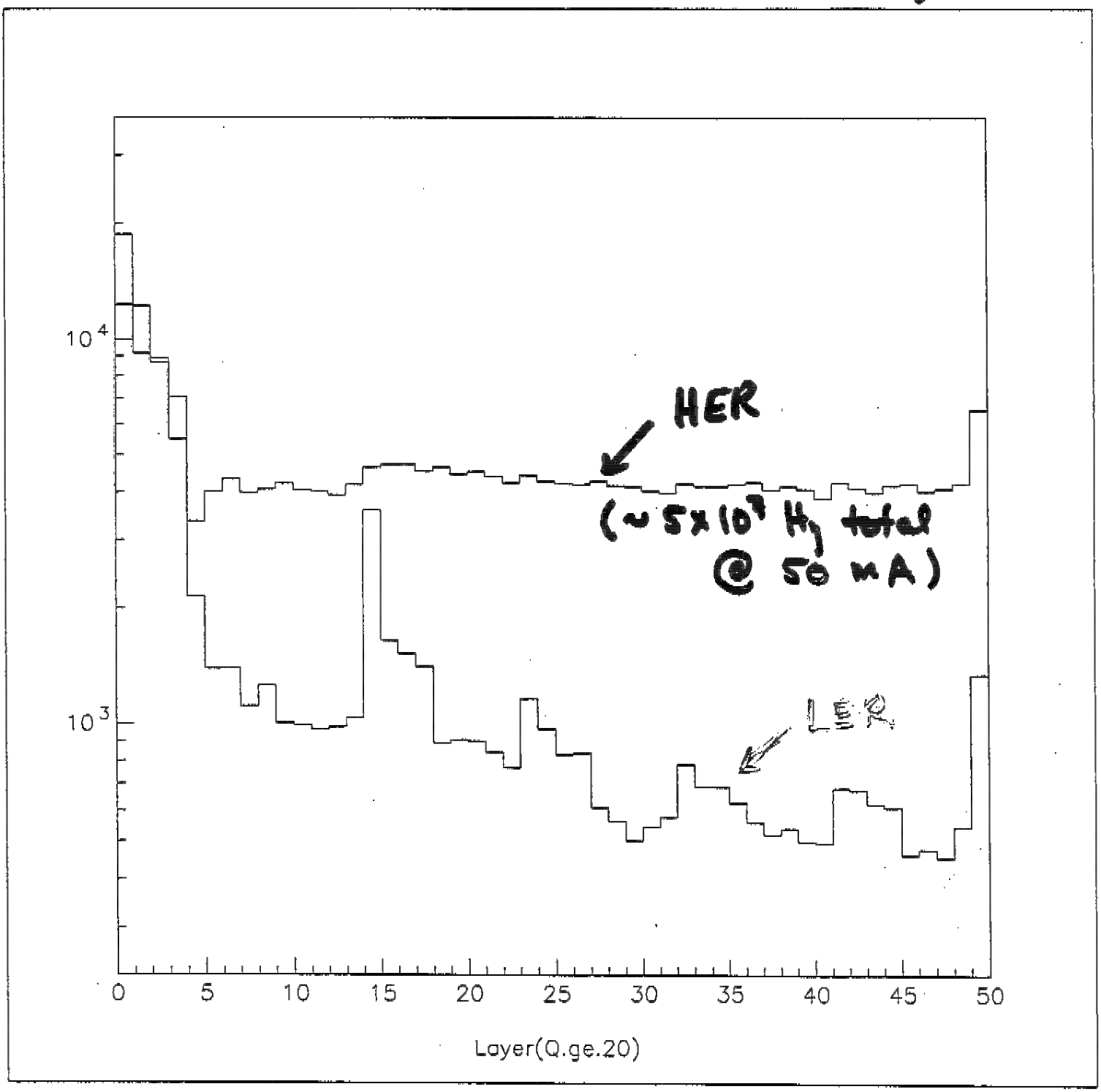

CDC Current draw vs Layer (e3r87/990628)
CDC Current / Wire / Zlen(49) (uA)
0.5
0.4
0.3
0.2
0.1
0
0
5
10
15
20
25
30
35
40
45
50
CDC Layer number
LER = 0mA, HER = 31.7mA
Solid = 1/R, Dash = 1/R**2

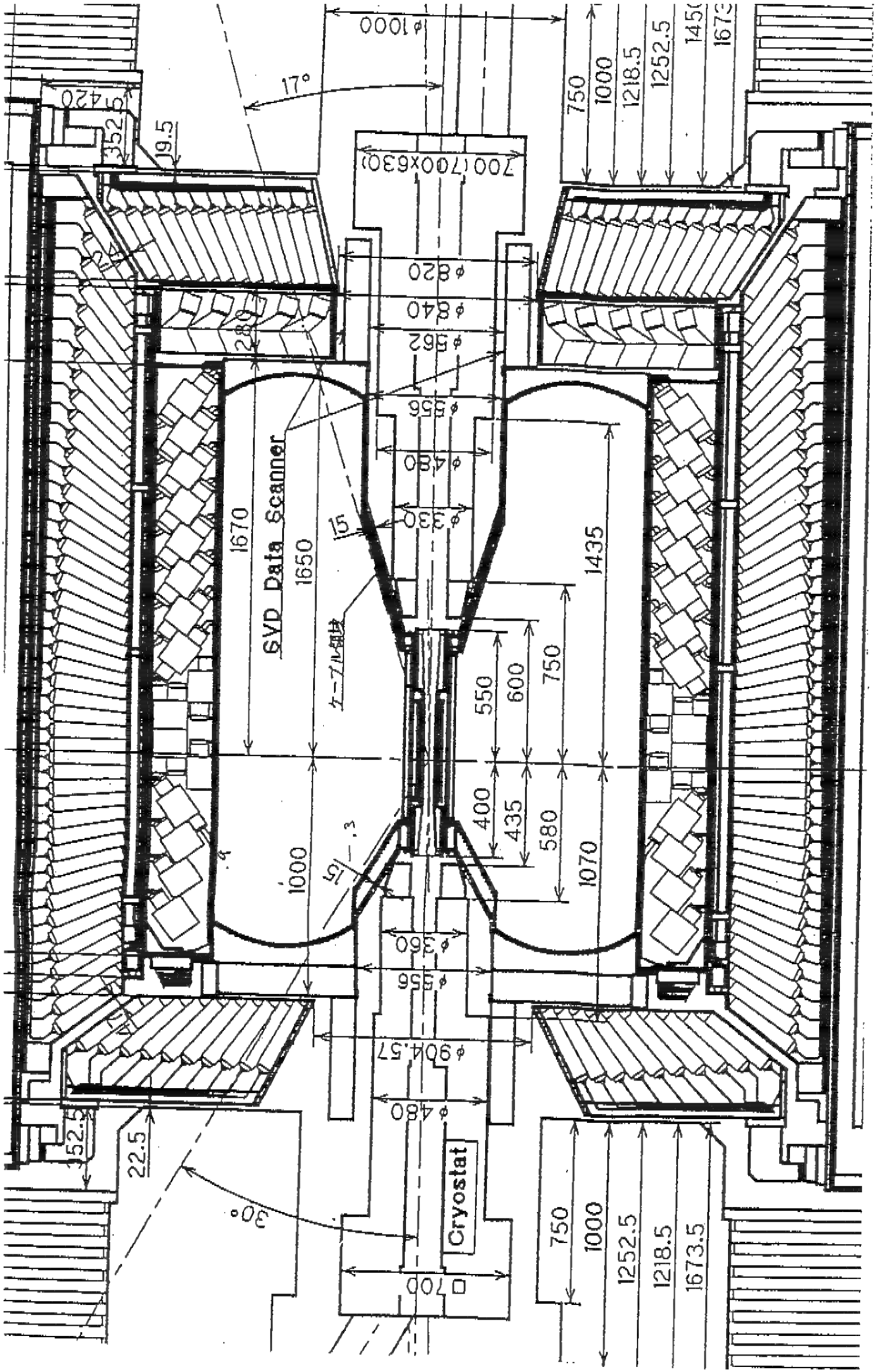

CDC Current draw vs Layer (e3r87/990628)
CDC Current / Layer(uA)
5.5
5
4.5
4
3.5
3
2.5
2
LER = 0mA, HER = 31.7mA
0
5
10
15
20
25
30
35
40
45
50
CDC Layer number

HER Backgrounds in the CDC

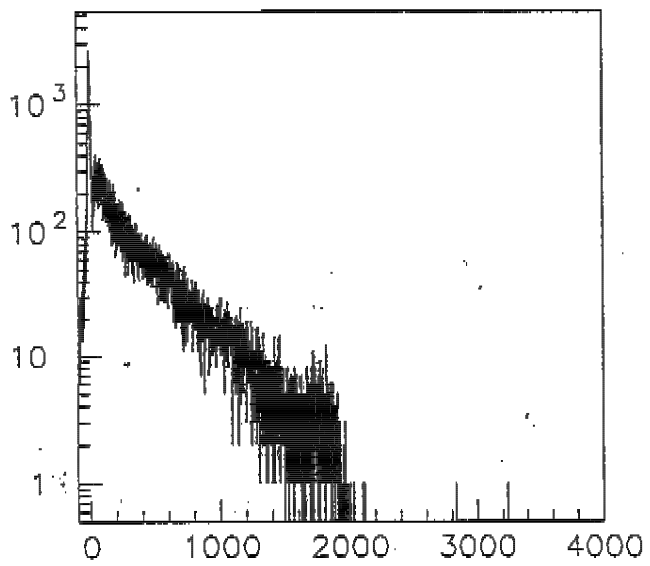
What does the data tell us?

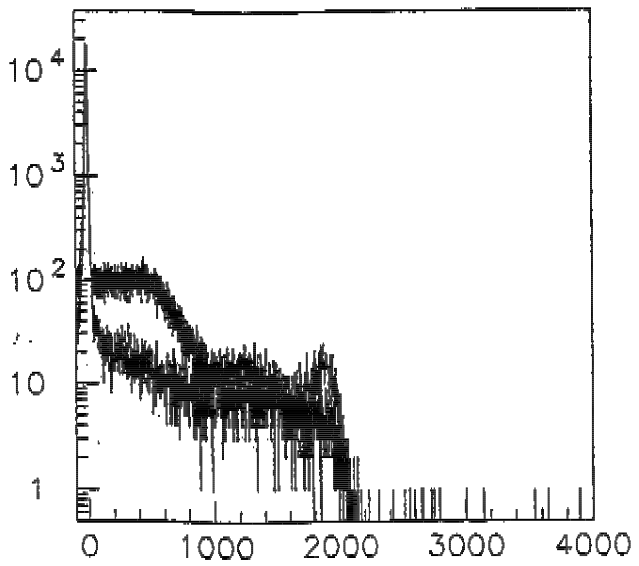
Single Beam: Rates/CDC layer

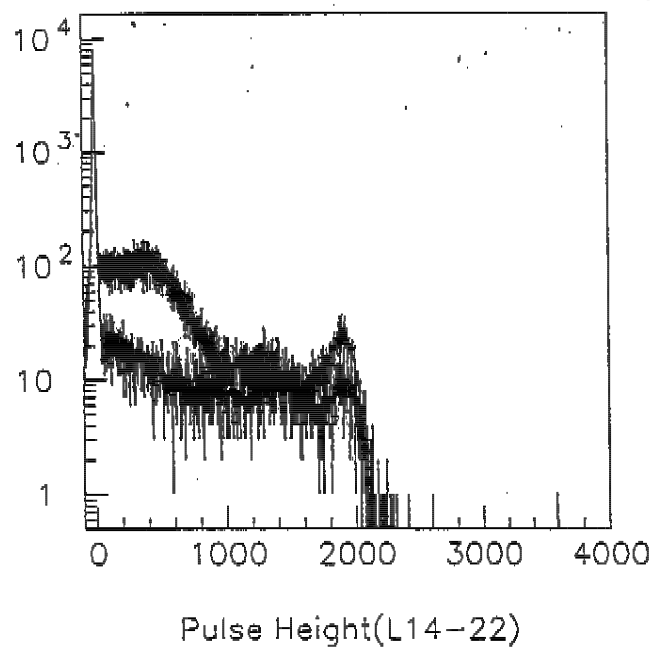


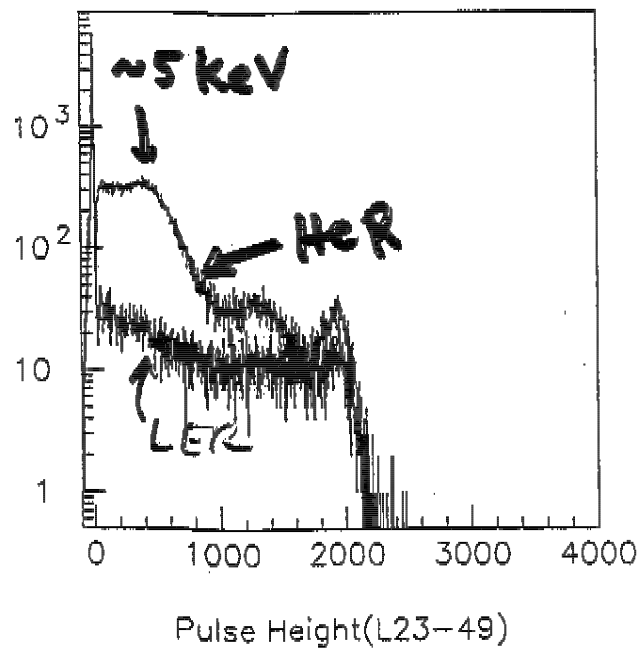

φ1000
17°
750
1000
1218.5
1252.5
420
352
19.5
700(700x630)
φ820
φ840
φ862
φ556
φ480
φ330
280
15
1670
1650
SVD Data Scanner
ケーブル組立
1435
550
600
750
400
435
580
1070
1000
15
3
φ360
φ556
φ904.57
φ480
52.5
22.5
30°
Cryostat
□700
750
1000
1252.5
1218.5
1673.5

Pulse height spectrum on CDC wires







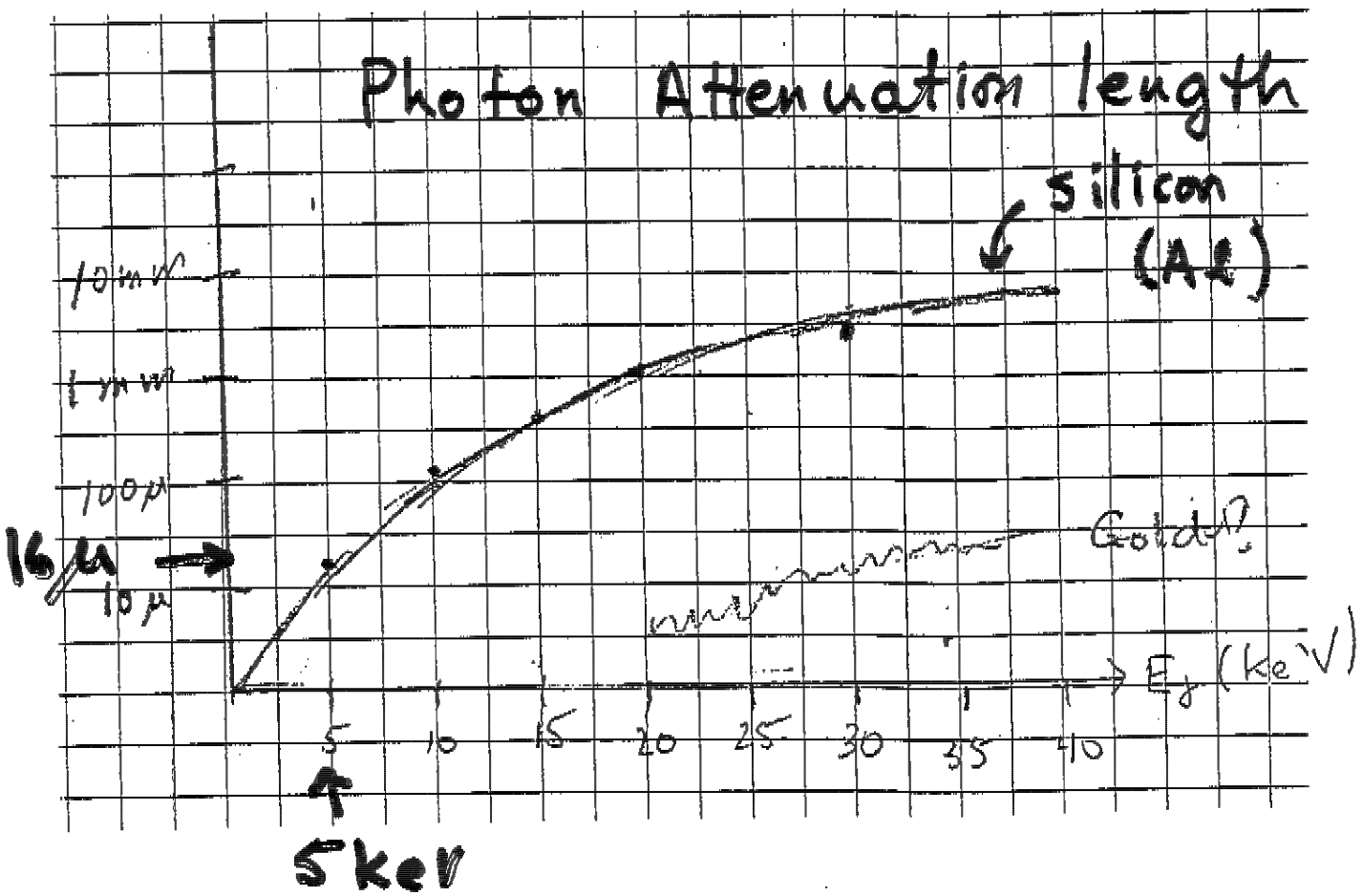


Extra rate in CDC associated with "5-keV line". Rate $\propto I_{e^-}$. Not in LER.

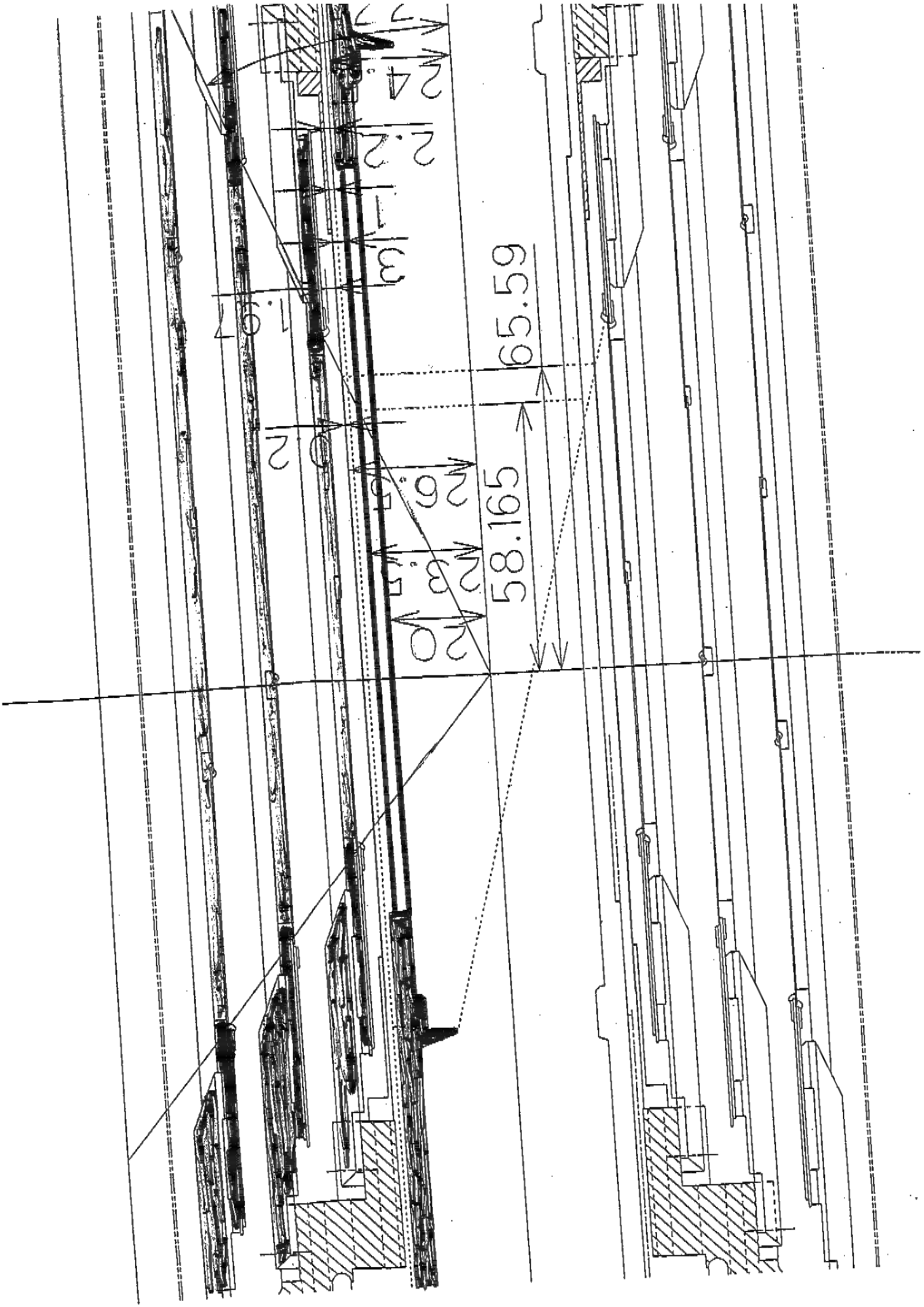
Synchrotron Xrays?

Two possibilities:

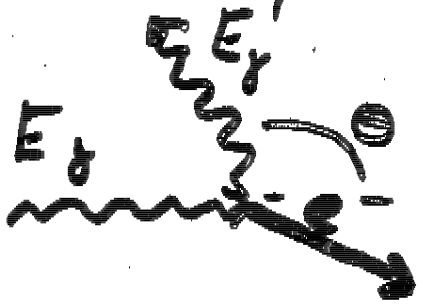
1) Photoelectrons from $E_\gamma \sim 5$ keV X-rays



Impossible for $E_\gamma = 5$ keV X-rays to pass thru the ~ 1000 μ of silicon in SVD.

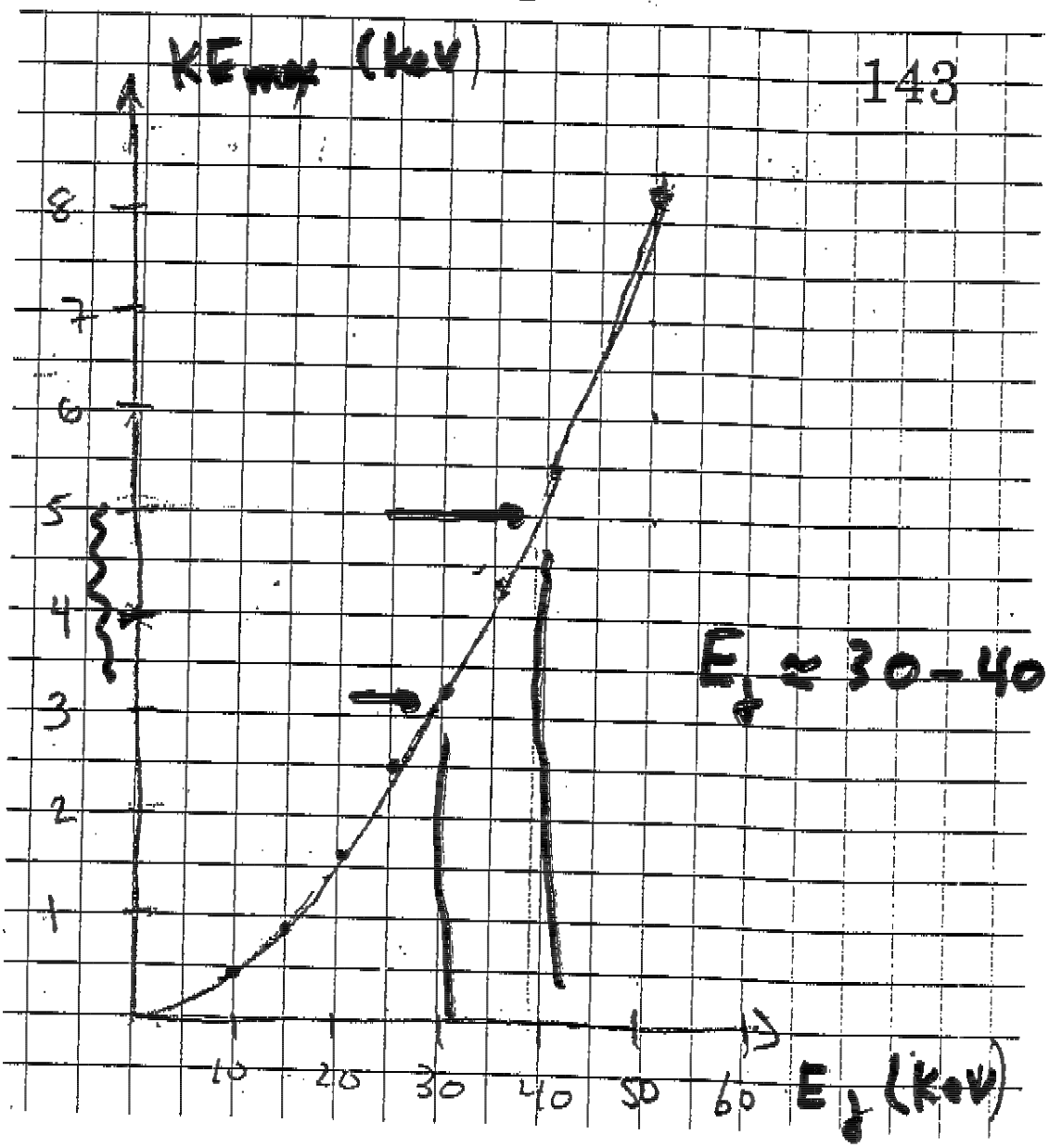

65.59
58.165

2) Compton electrons from higher Energy X-rays:



$KE_e = E_\gamma - E_\gamma' = f(\cos$

KE_e^{max} @ $\cos\theta =$ -

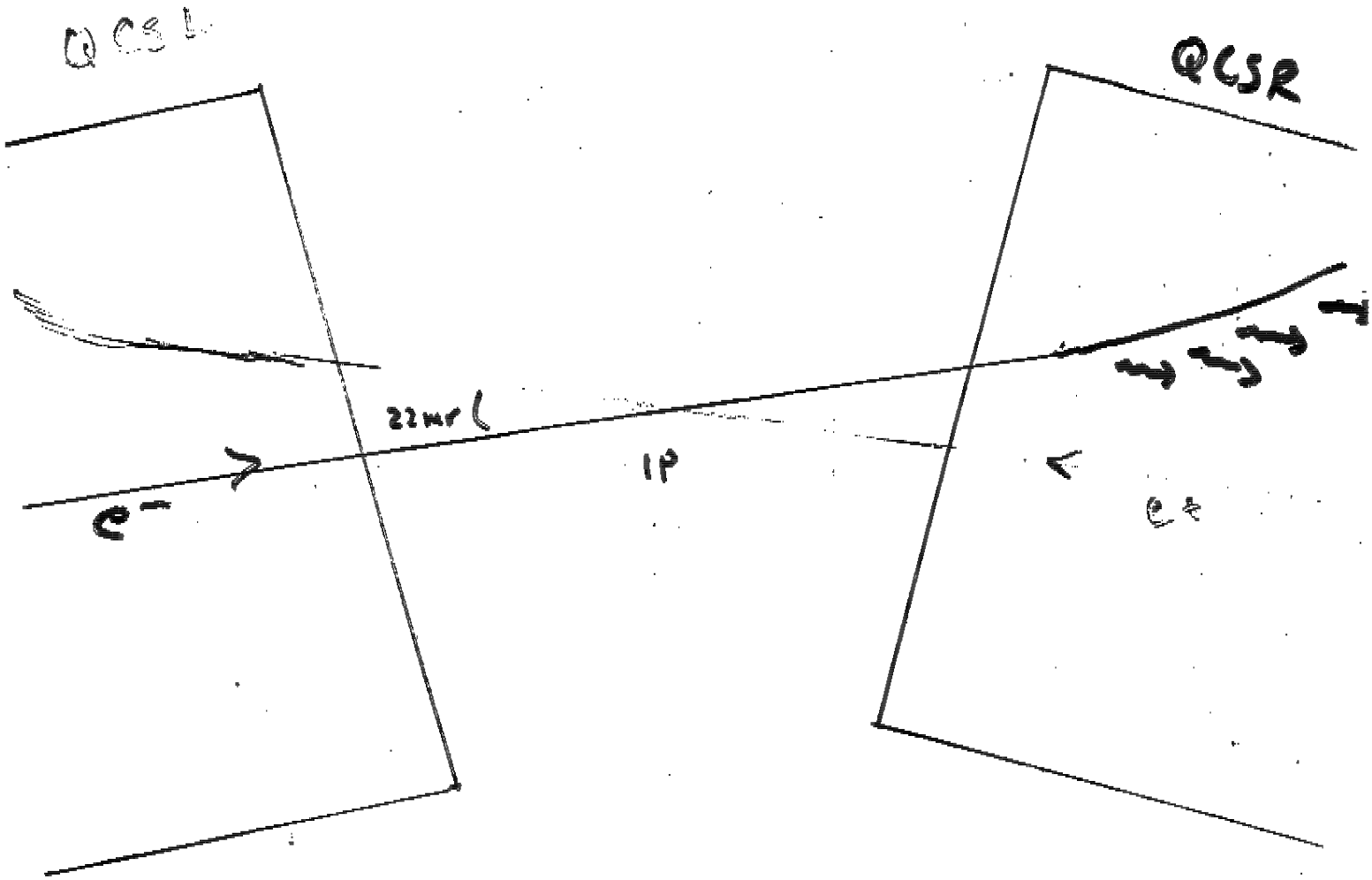


$E_\gamma \approx 30-40$ keV

If the "5-keV line" in the CDC are from Synchrotron X-rays, they must be 30 ~ 40 keV.

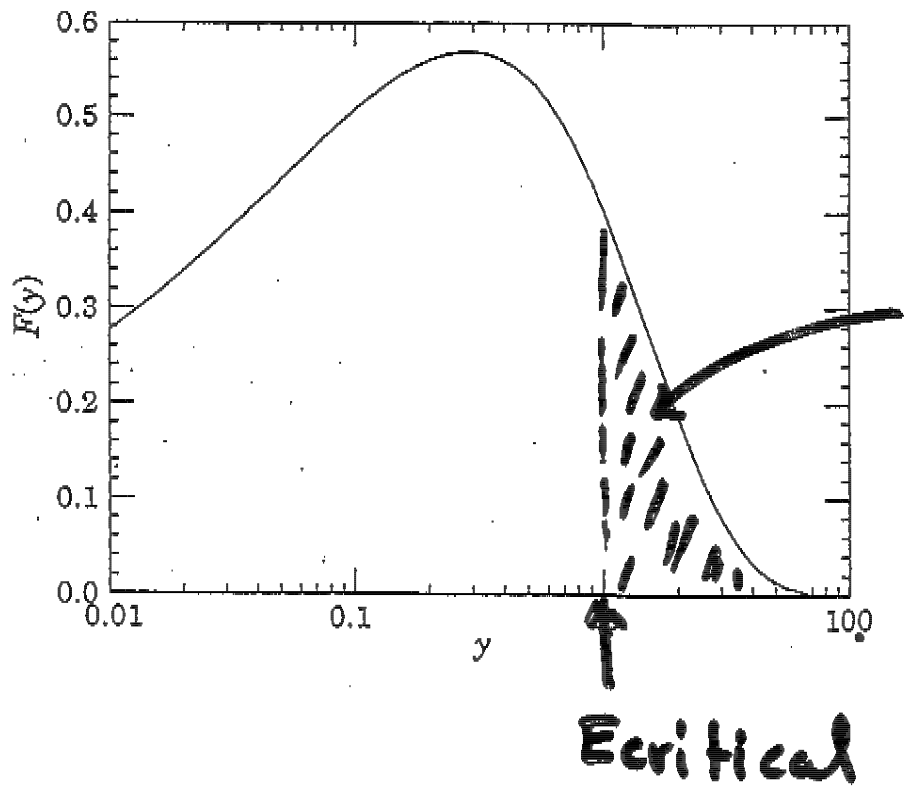
Where do the X-rays come from?

Only source of high energy X-rays near BELLE is QCSR



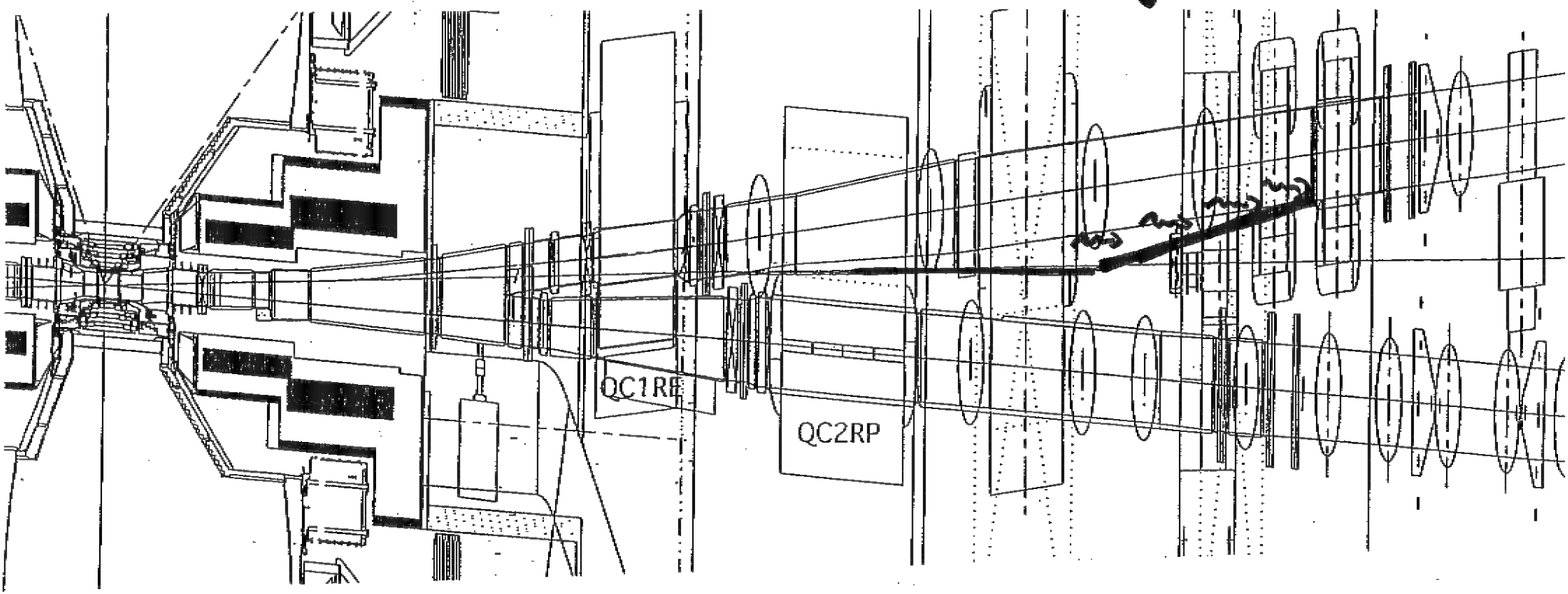
Critical Energy: ~ 13 keV at entrance
~ 27 keV at exit

How many are there?



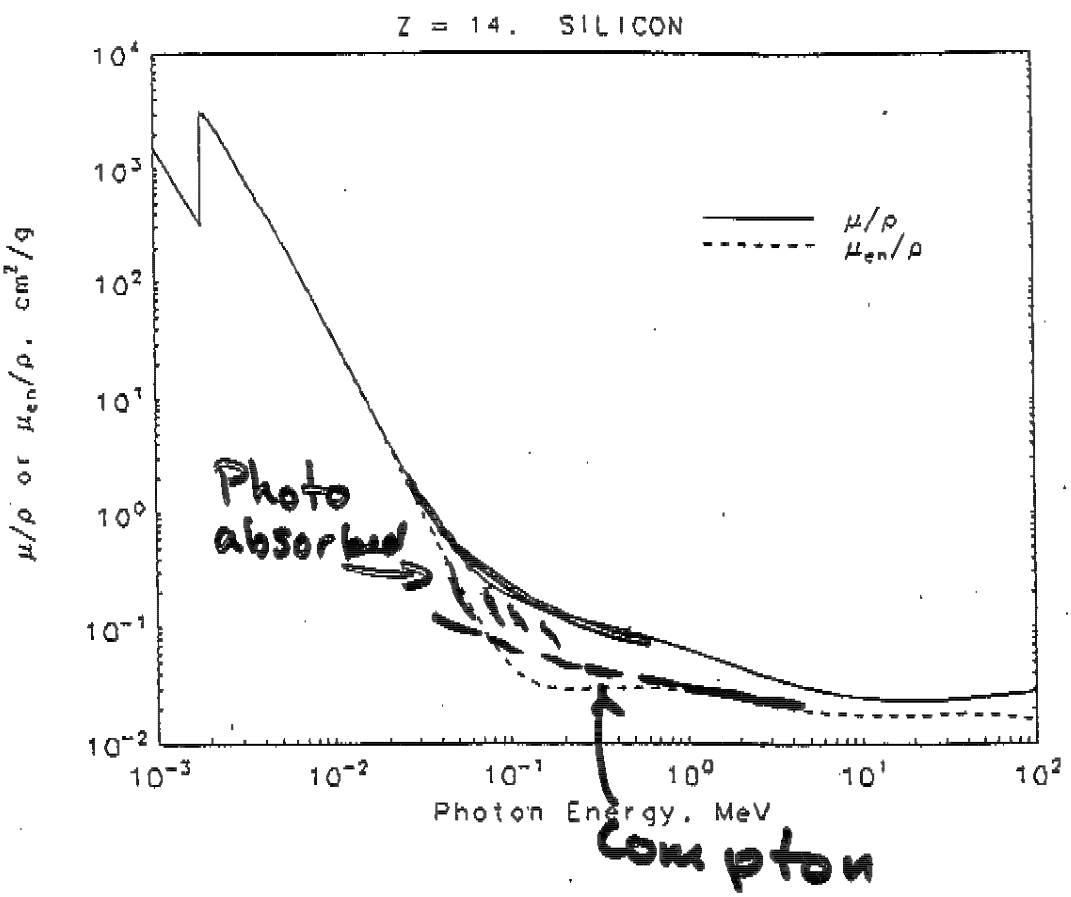
Where do they go?

They hit the Alum wall of the Vac. pipe here



99- 7-22;15:38 ;BELLE GROUP ;+81-298-64-5340 # 28/ 51

What happens to them there?



- Some are absorbed

- Others (≈ 10%) Compton Scatter (½ of which are directed back out of the Aluminum

How many end up converting in the CDC?

{ rough, rough estimate :

$$\text{Rate in CDC} = \text{Flux} \cdot \text{reflection} \times \frac{\Delta\Omega \text{ of beam pipe}}{4\pi} \times \text{Scatt prob into CDC} \times \text{Conversion Prob in CDC}$$

$$\sim 10^{18} \qquad \sim \underset{?}{10^{-1}} \qquad \sim 10^{-7} \qquad \underset{?}{\uparrow 10^{-1}} \qquad \times \qquad 5\times10^{-2}$$

$$\sim\sim\sim 5\times10^{7}\ \text{Hz} \ ] \ !$$

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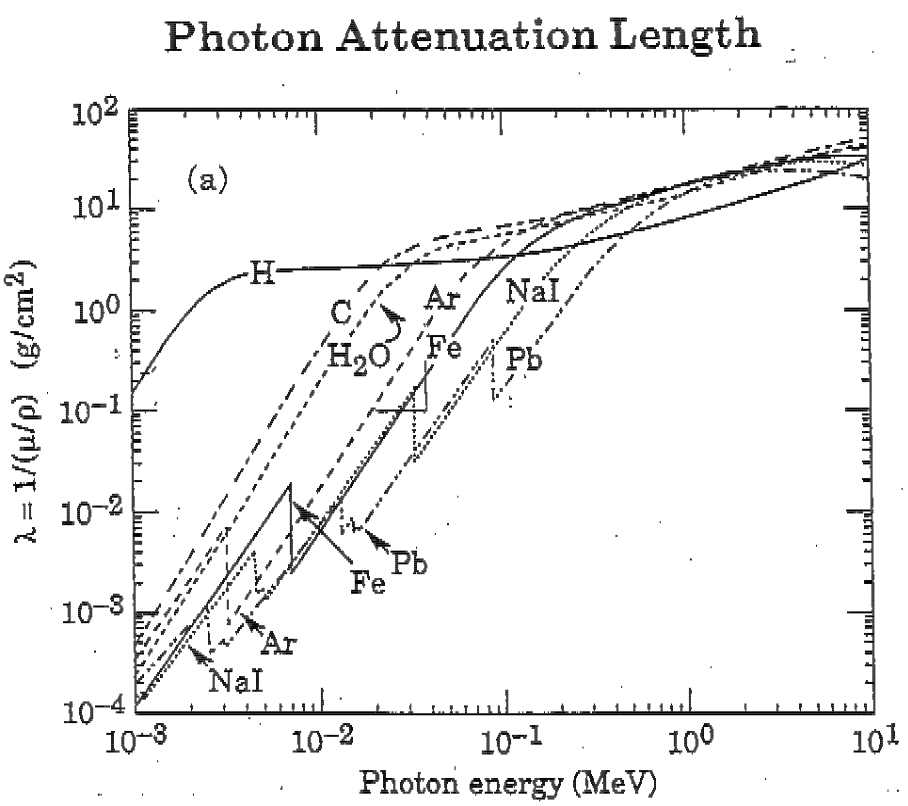
;+81-298-64-5340 # 30/ 51

How do we fix this ?

1) line the vacuum chamber where the X-rays hit with a higher Z absorber. (Cu ?)



Increase photo absorbtion relative to compton scat.

2) Cover the downstream edge of the beam pipe X-ray masks with thick High-Z absorber

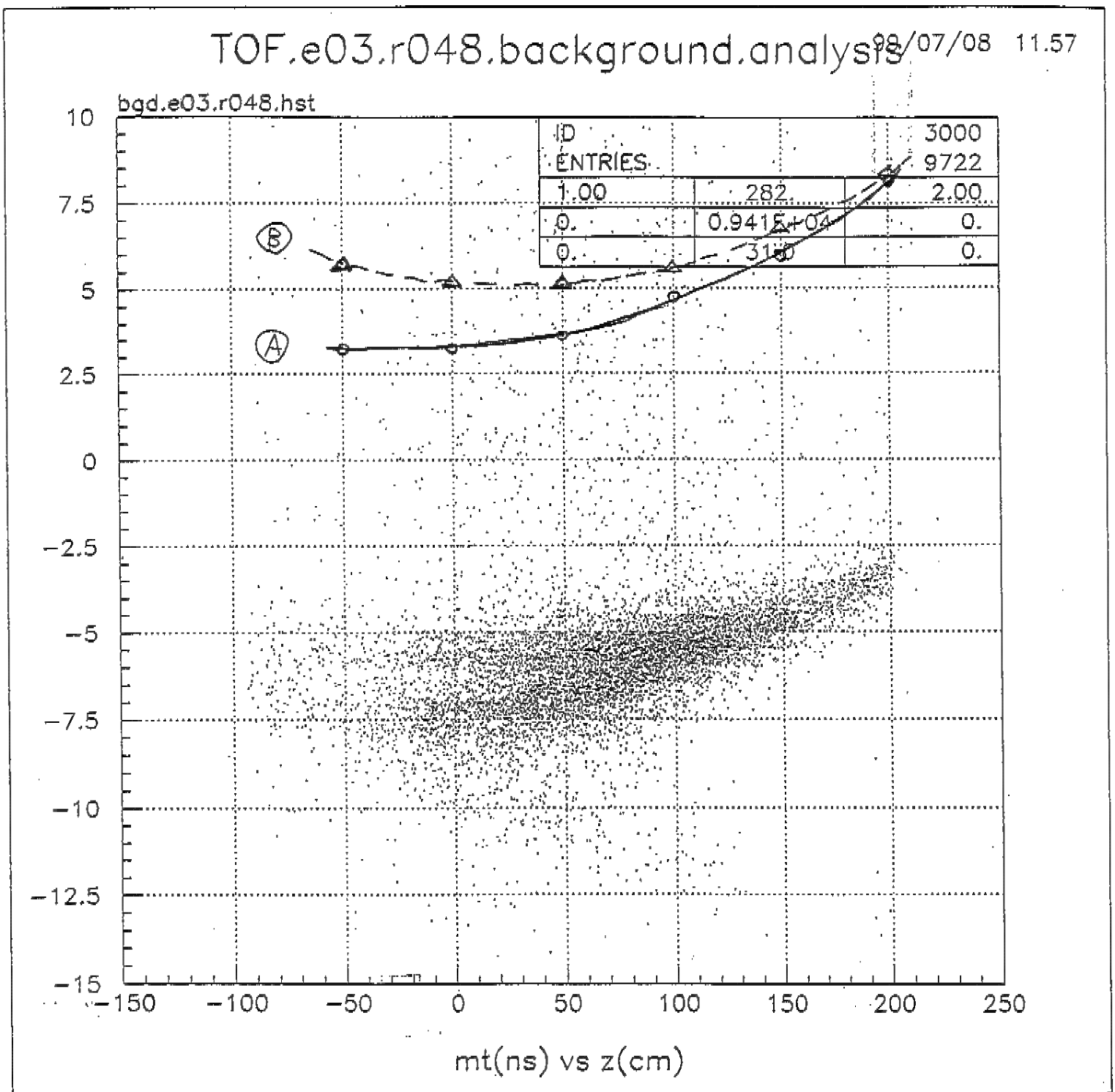
↑
~ 100μ

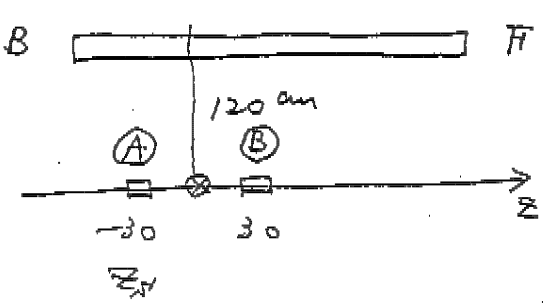
3) Coat inner surface of Be with ~ 5μ Au.

Other Background Sources

HER ⊗ LER

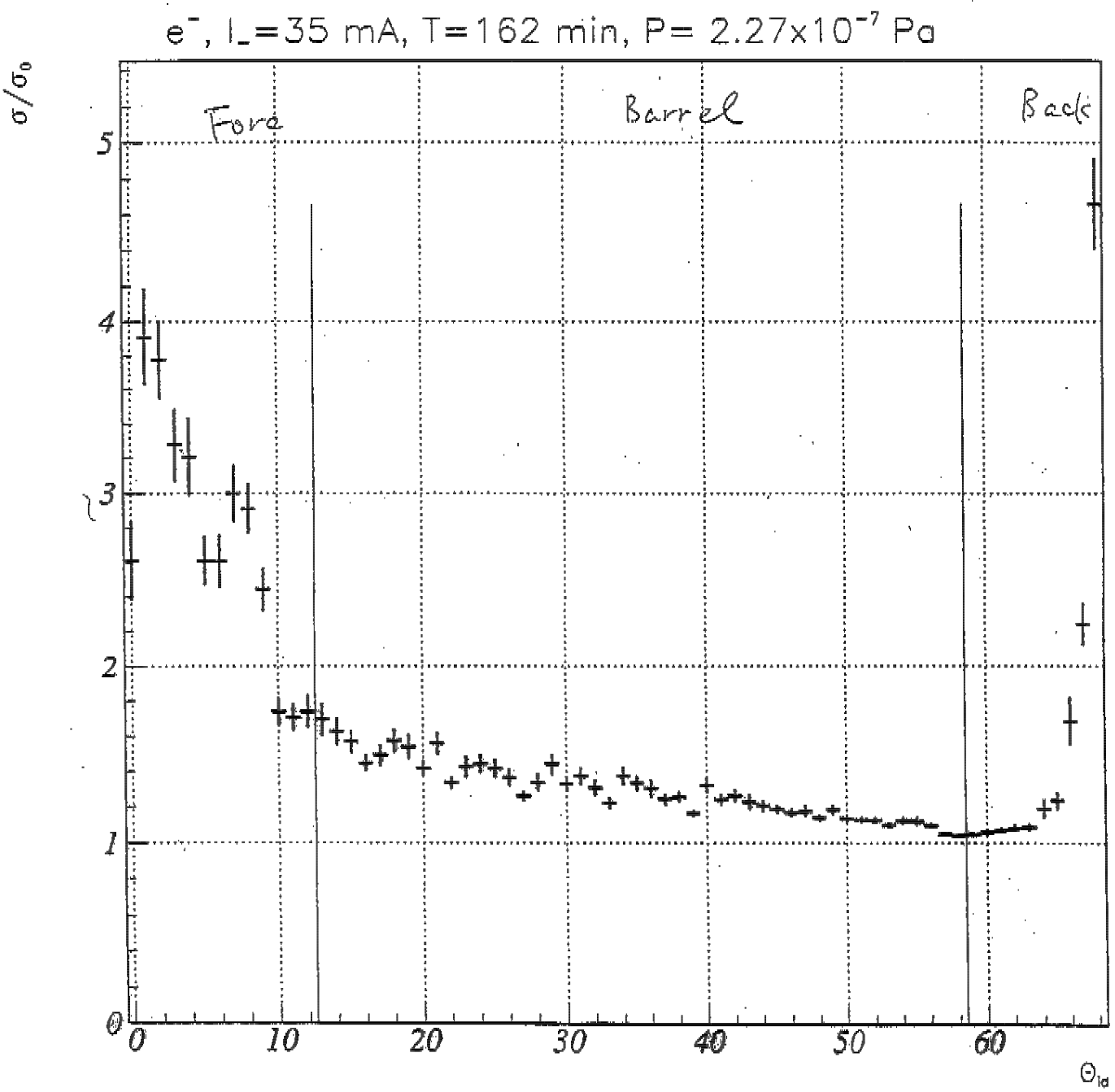
$Q < 250^{ch}$

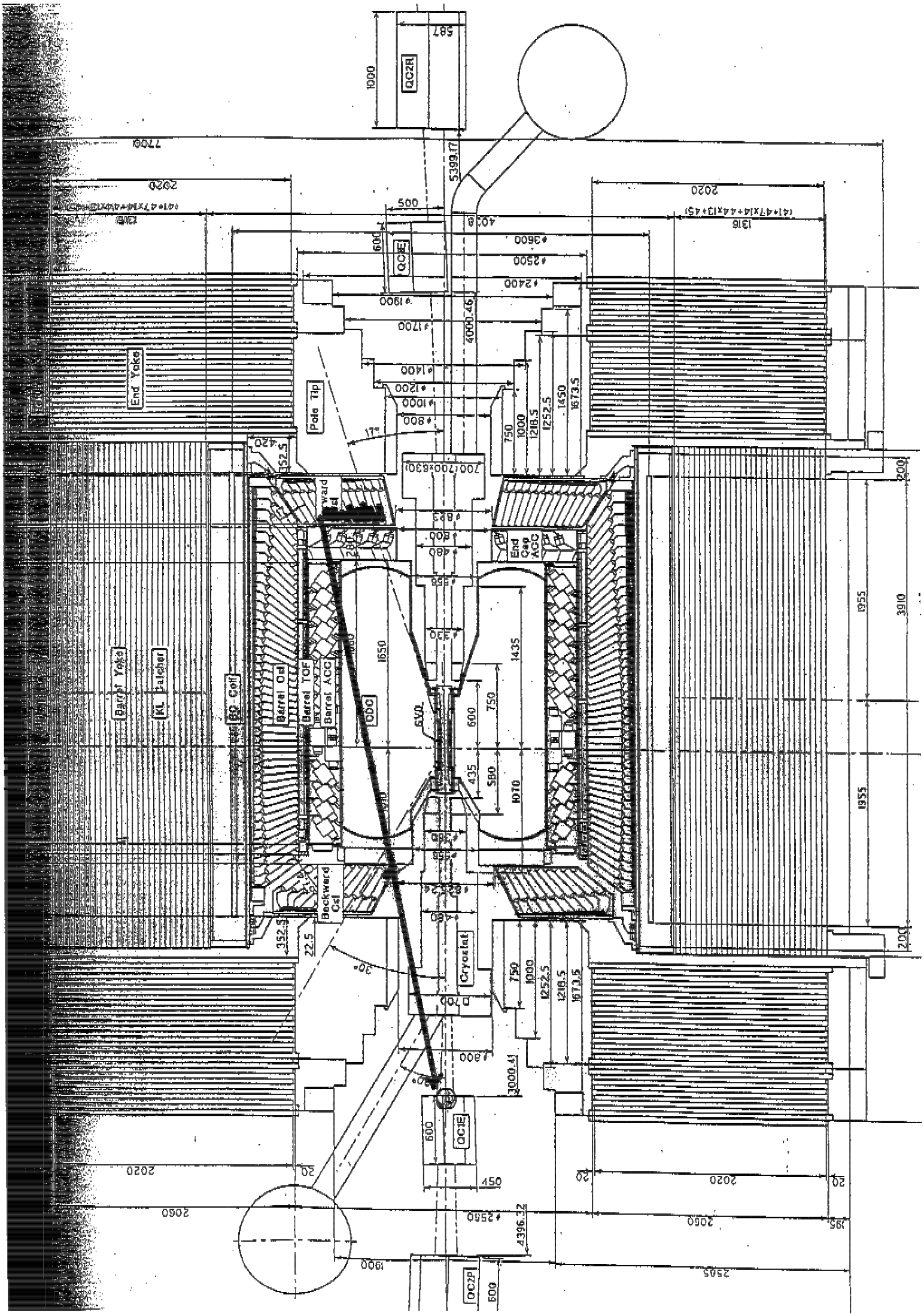




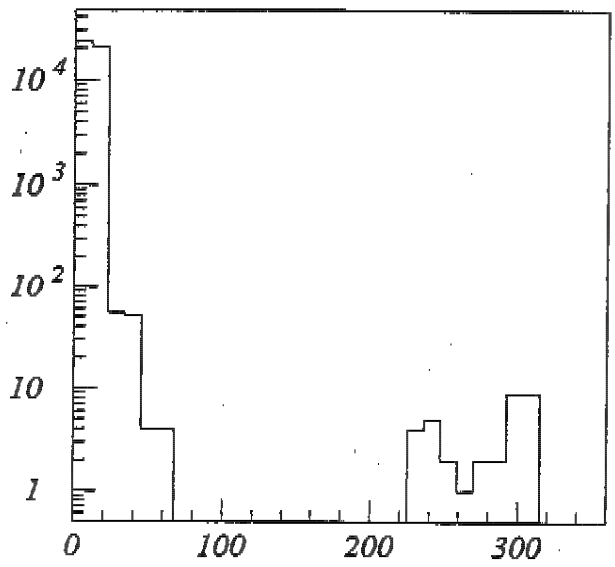
$$TOF = \left[z_{IP} + \sqrt{(z - z_{IP})^2 + (120)^2} \right] / \beta$$

[ns]

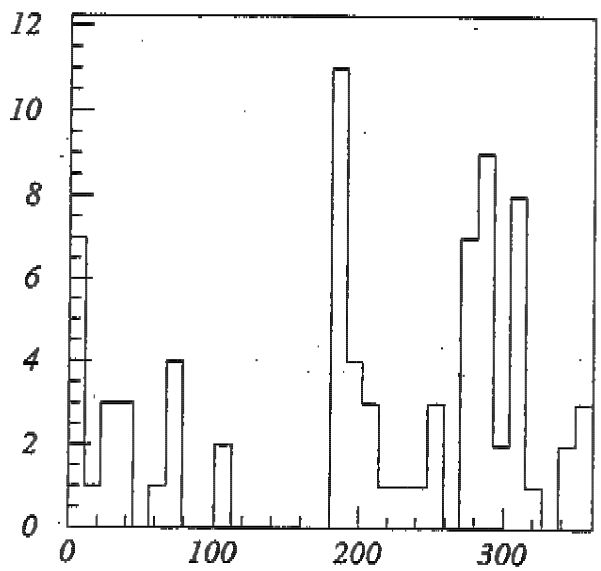

e⁻, I_=35 mA, T=162 min, P= 2.27x10⁻⁷ Pa
σ/σ₀
Fore
Barrel
Back
0
1
2
3
4
5
0
10
20
30
40
50
60
θ_la


QC2R
QC1E
QC1E
QC2P
End Yoke
Pole Tip
End Cap ACC
Barrel Yoke
KL Catcher
BC Coil
Barrel Csl
Barrel TOF
Barrel ACC
ODC
Backward Csl
Cryostat
5399.17
4000.46
3000.41
4396.32
3910
1955
1955
2020
2020
2020
2020
2060
2060
2585
1900
1900
1650
1435
1070
750
600
580
435
750
1000
1218.5
1252.5
1450
1673.5
750
1000
1252.5
1218.5
1673.5
700(700x630)
17°
30°
22.5
352.5
352.5
1000
587
500
600
600
450
200
200
195
20
20
20

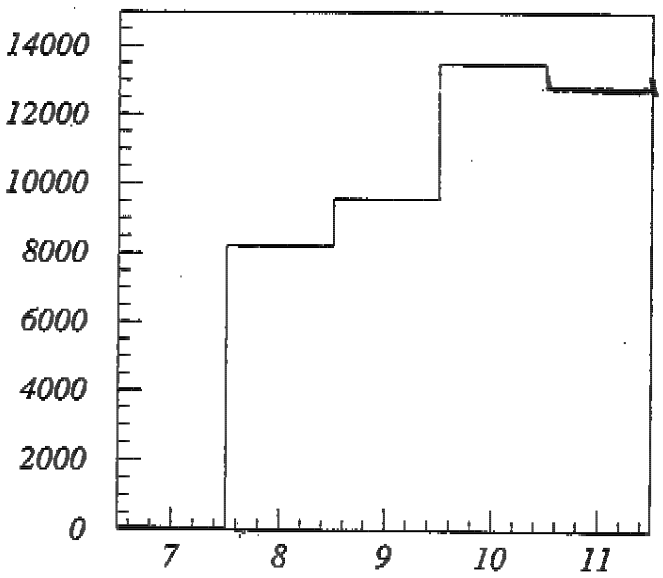
Background Hit Distribution



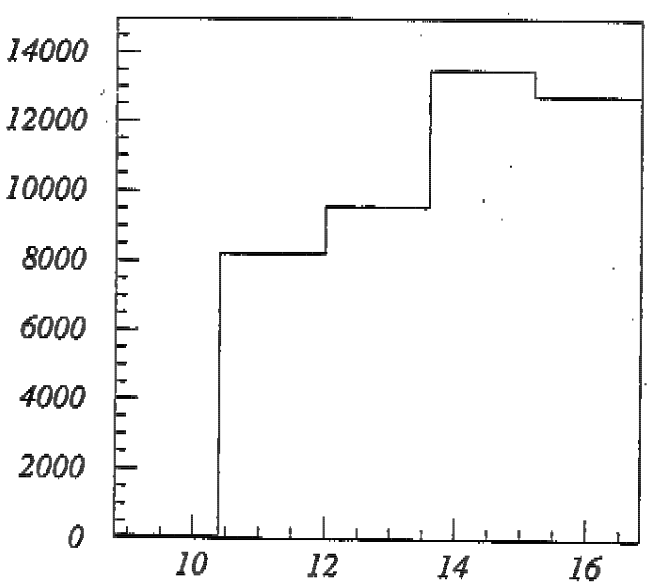
Forward Phi Dist.



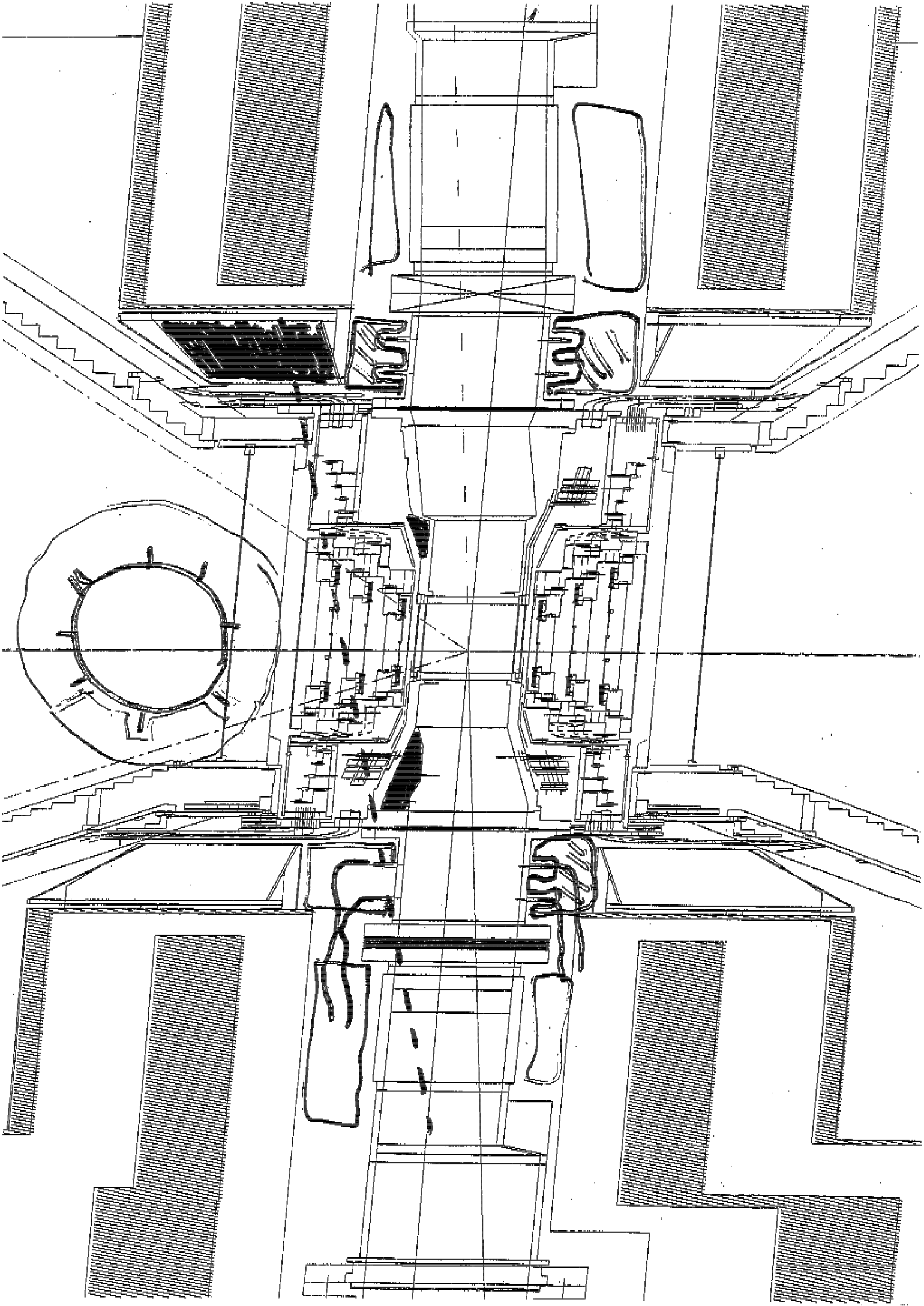
Backward Phi Dist.

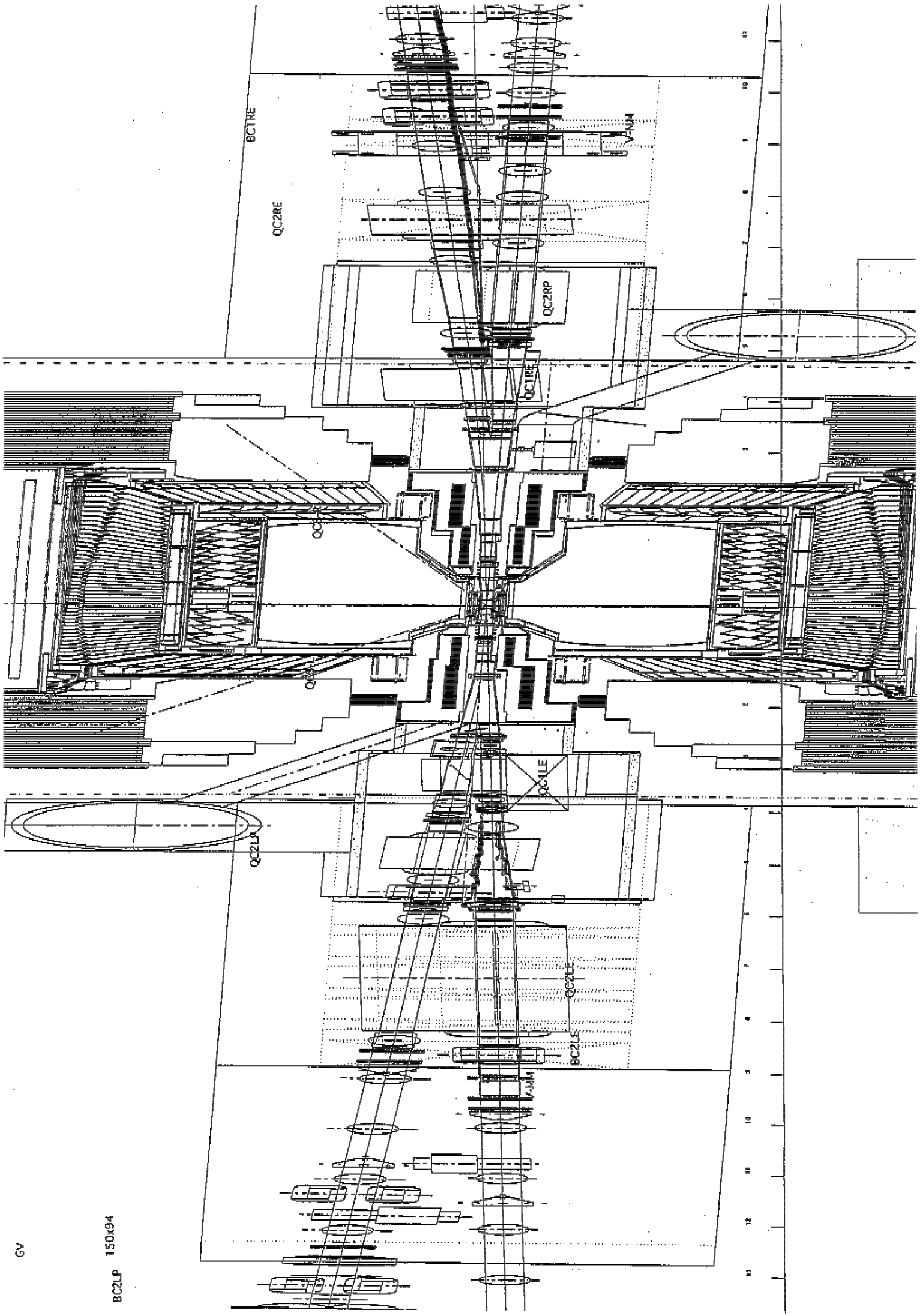


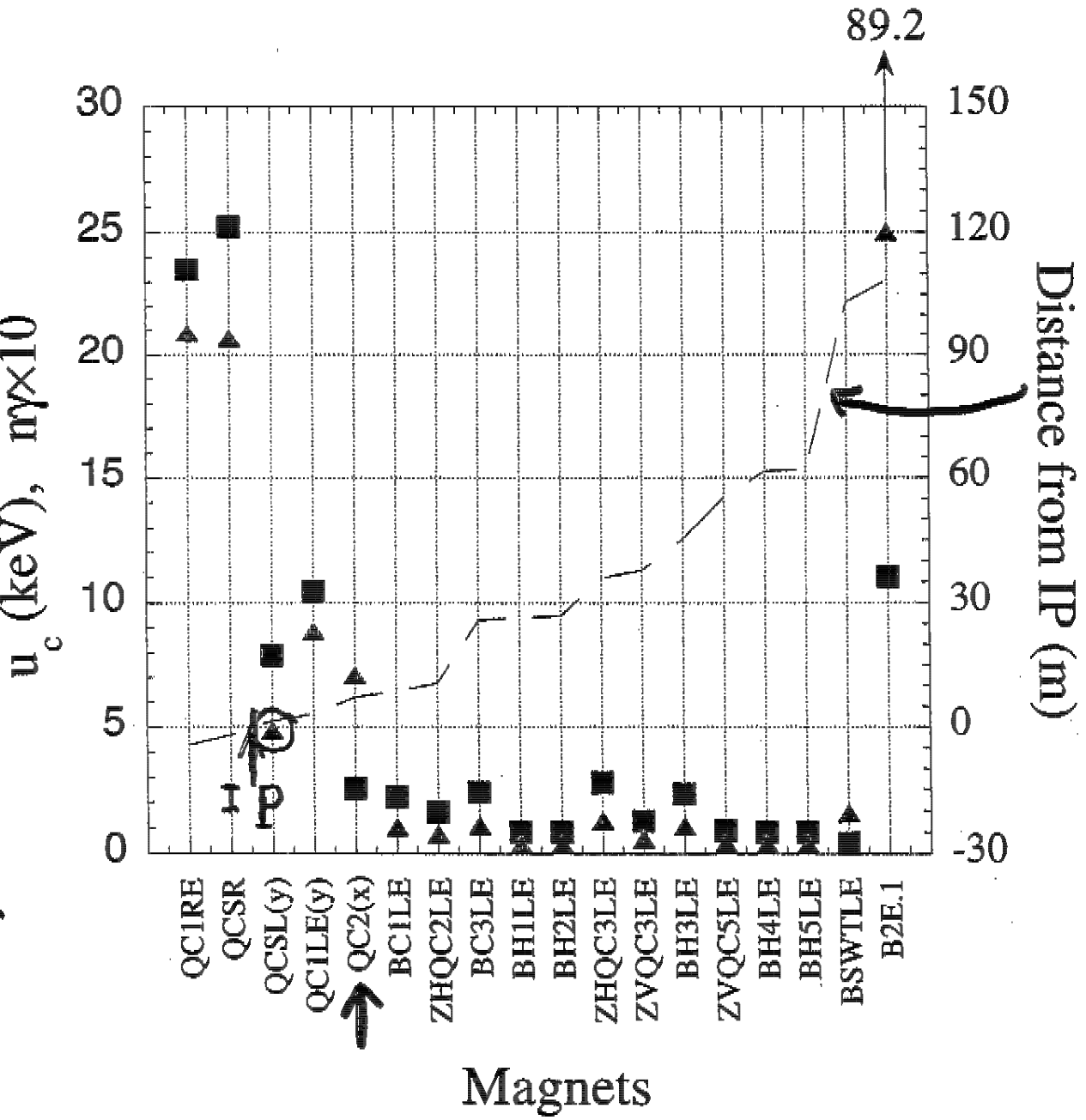
Forward Theta Dist.



Backward Theta Dist.




BC1RE
QC2RE
V-MM
QC2RP
QC1RE
QC1LE
QC2LP
QC2LE
BC2LE
V-MM
BC2LP
150x94
GV


89.2
30
25
20
15
10
5
0
150
120
90
60
30
0
-30
u_c (keV), mγ×10
Distance from IP (m)
QC1RE
QCSR
QCSL(y)
QC1LE(y)
QC2(x)
BC1LE
ZHQC2LE
BC3LE
BH1LE
BH2LE
ZHQC3LE
ZVQC3LE
BH3LE
ZVQC5LE
BH4LE
BH5LE
BSWTLE
B2E.1
Magnets

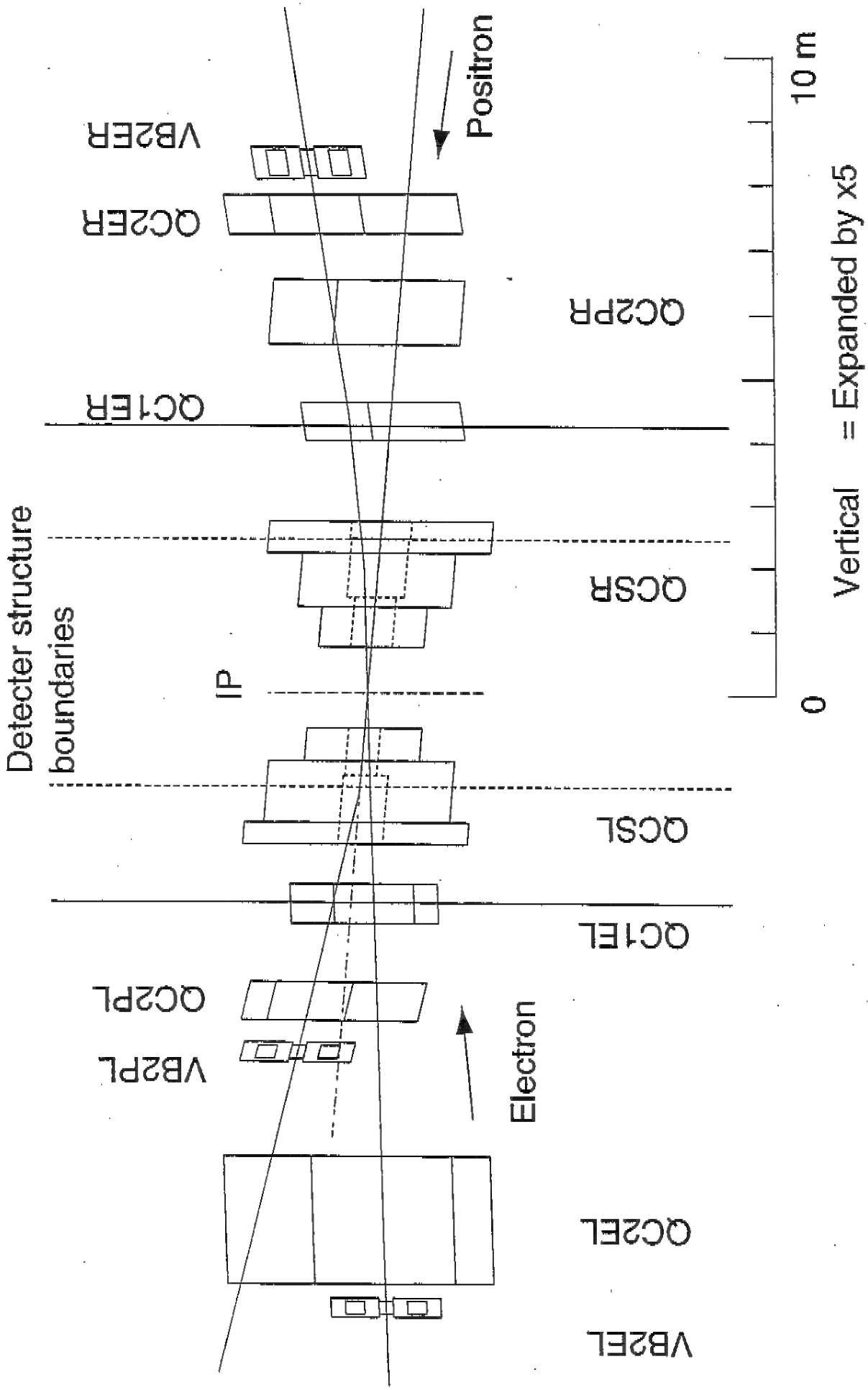
Q 106

IR design from the viewpoint of the beam background

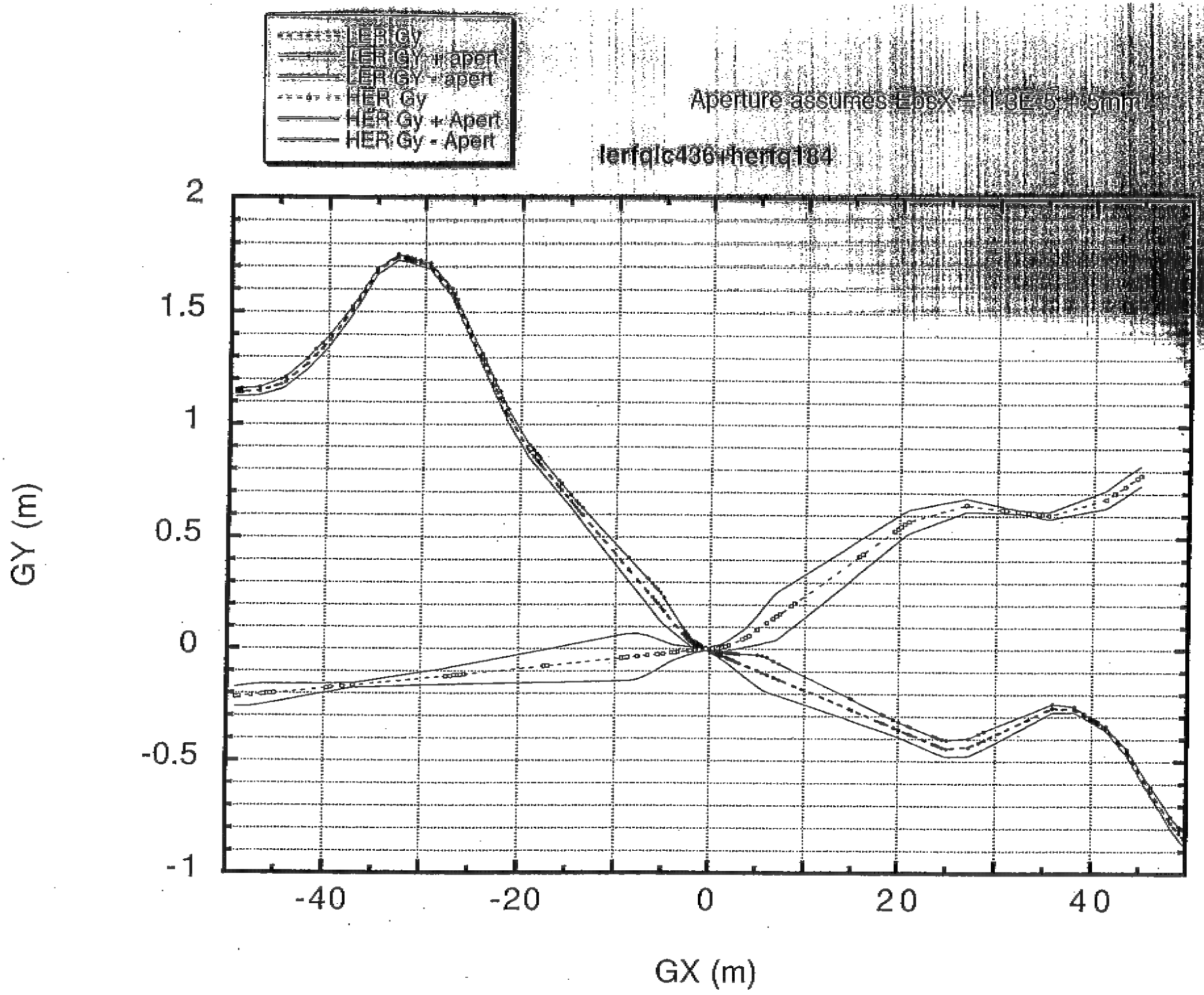
No bending magnets
No off-center Q magnets
for both incoming beams

No strong synchrotron radiation sources
No strong sweeping magnets

Beam background is less severe.


Positron
VB2ER
QC2ER
QC2PR
QC1ER
QCSR
IP
Detecter structure
boundaries
QCSL
QC1EL
QC2PL
VB2PL
Electron
QC2EL
VB2EL
10 m
0
Vertical = Expanded by x5

99- 7-22;15:38 ;BELLE GROUP ;+81-298-64-5340 # 42/ 51



Critical Energy(HER)

Magnet	Critical Energy(KeV)	
	Horizontal at $x = 10\sigma_x$	Vertical at $y = 30\sigma_y$
QCS	5.4	12.4
QC1	7.0	8.0
QC2	4.9	1.2
QC3	0.2	0.5
QC4	2.2	0.5

$\varepsilon_x = 1.8 \times 10^{-8}$ mrad

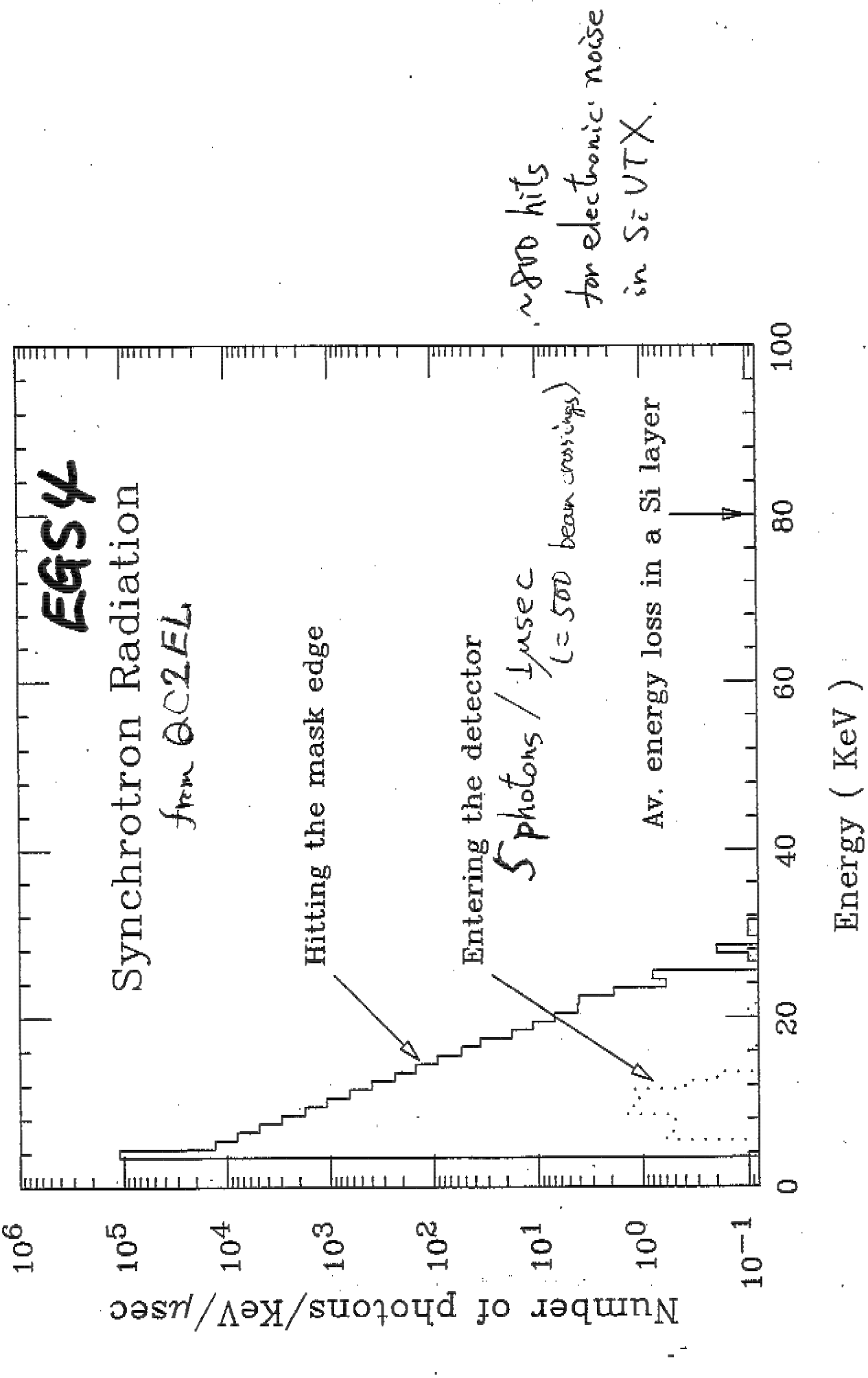
$\varepsilon_y = 3.6 \times 10^{-10}$ mrad

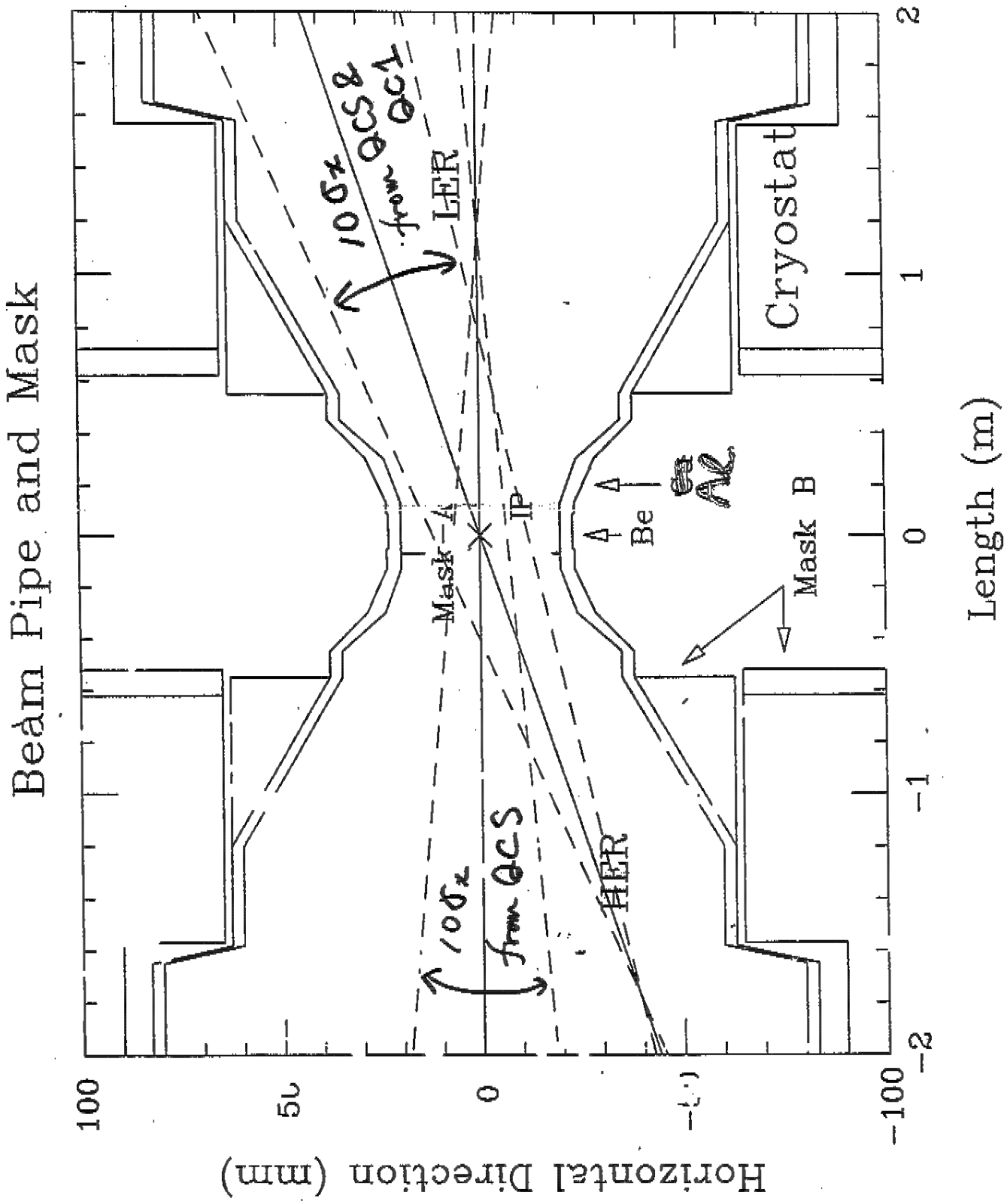
Critical Energy(LER)

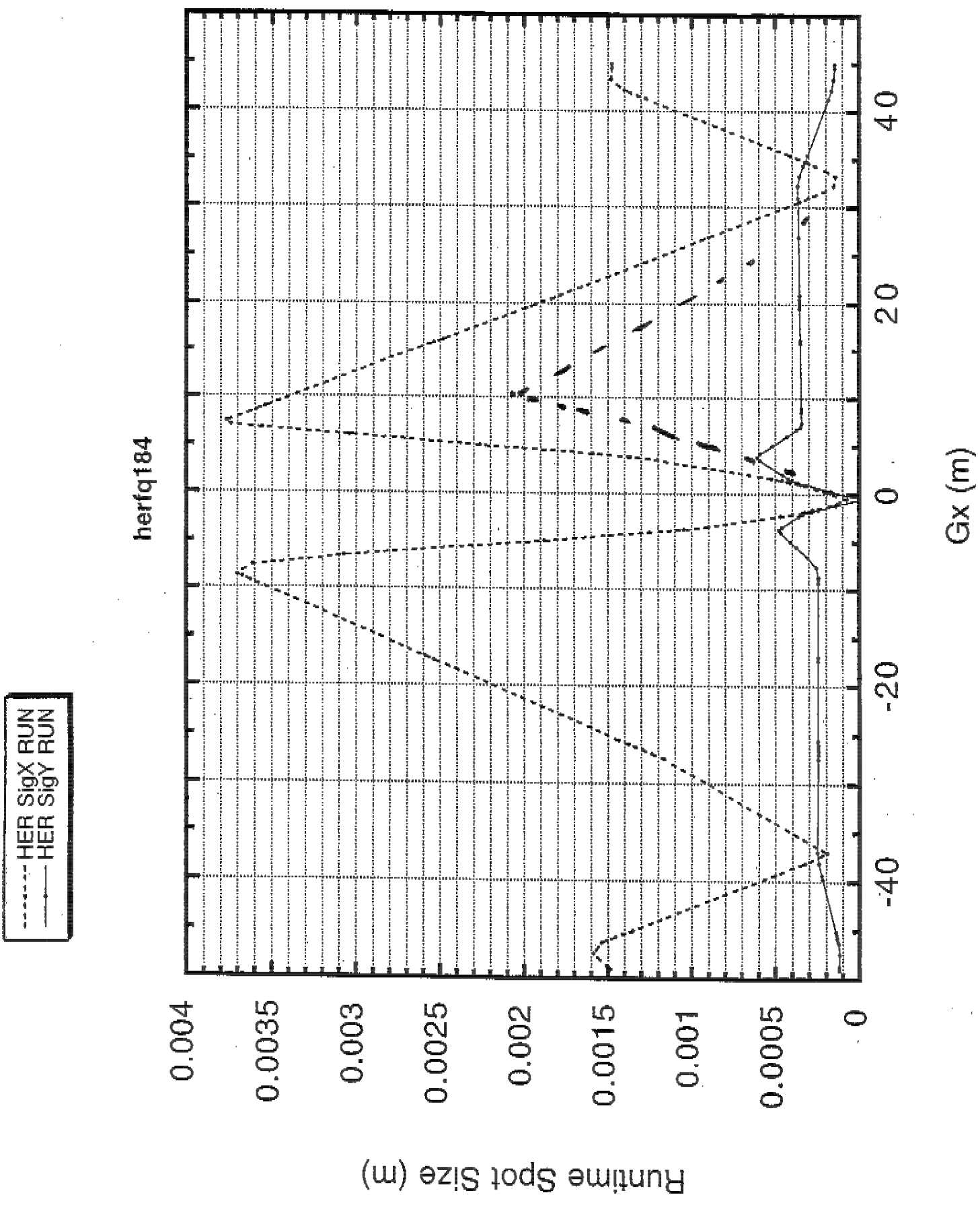
Magnet	Critical Energy(KeV)	
	Horizontal at $x = 10\sigma_x$	Vertical at $y = 30\sigma_y$
QCS	0.95	2.03
QC2	0.62	0.14
QC3	0.31	0.05
QC4	0.22	0.07

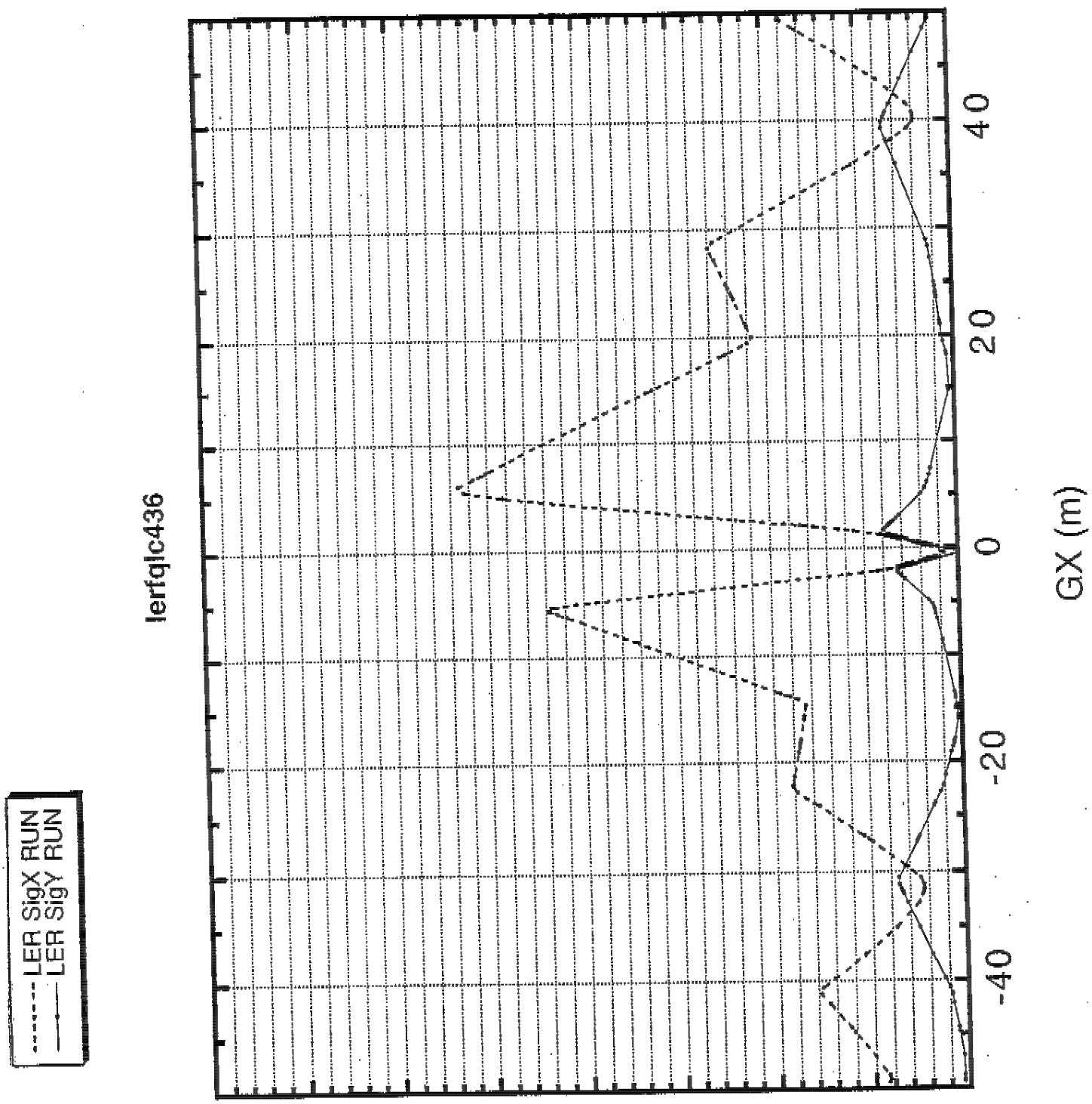
$\varepsilon_x = 1.8 \times 10^{-8}$ mrad

$\varepsilon_y = 3.6 \times 10^{-10}$ mrad


EGS4
Synchrotron Radiation
from PC2EL
Hitting the mask edge
Entering the detector
5 photons / 1μsec
(= 500 beam crossings)
Av. energy loss in a Si layer
~800 hits
for electronic noise
in Si VTX.
Number of photons/KeV/μsec
Energy (KeV)
10^6
10^5
10^4
10^3
10^2
10^1
10^0
10^{-1}
0
20
40
60
80
100


Beam Pipe and Mask
Horizontal Direction (mm)
Length (m)
100
50
0
-50
-100
2
1
0
-1
-2
Cryostat
LER
HER
IP
Mask A
Mask B
Be
Al
10σx from QCS2
10σx from QCS1
10σx from QCS


herfq184
HER SigX RUN
HER SigY RUN
Runtime Spot Size (m)
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
-40
-20
0
20
40
Gx (m)


LER SigX RUN
LER SigY RUN
lerfqlc436
Runtime Spot Size (m)
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
-40
-20
0
20
40
GX (m)

Synchrotron Radiation Background

1. SR photons from QCS and QC1

   Go through without hitting Mask-A and the beam pipe near the IP.

2. SR photons from other Q magnets

   Mask-A intercepts the photons from hitting the beam pipe, directly.

   Tip-scattering on the edge of Mask-A may cause a problem for SR photons from QC2.

   No problem(EGS4 Simulation)

   Critical energy for other magnets is small enough. SR photons can be easily absorbed by Mask-A.

3. SR photons from bending magnets in arc section and local correction

Weak magnets are installed for the last bending(kc < 1 keV).

SR photons from normal bending magnets can not reach IR region.

Summary

1. Strong radiation sources do not exist in KEKB IR.

2. Critical energy for Q magnets is low enough. Then, the radiation photons can be easily absorbed by the nearest masks.

3. Estimated hit rate on SVD is small.