Background Issues

S.Uno, KEK
97/Jan/23

1. IR design

2. Synchrotorn Radiation Background

3. Particle Background

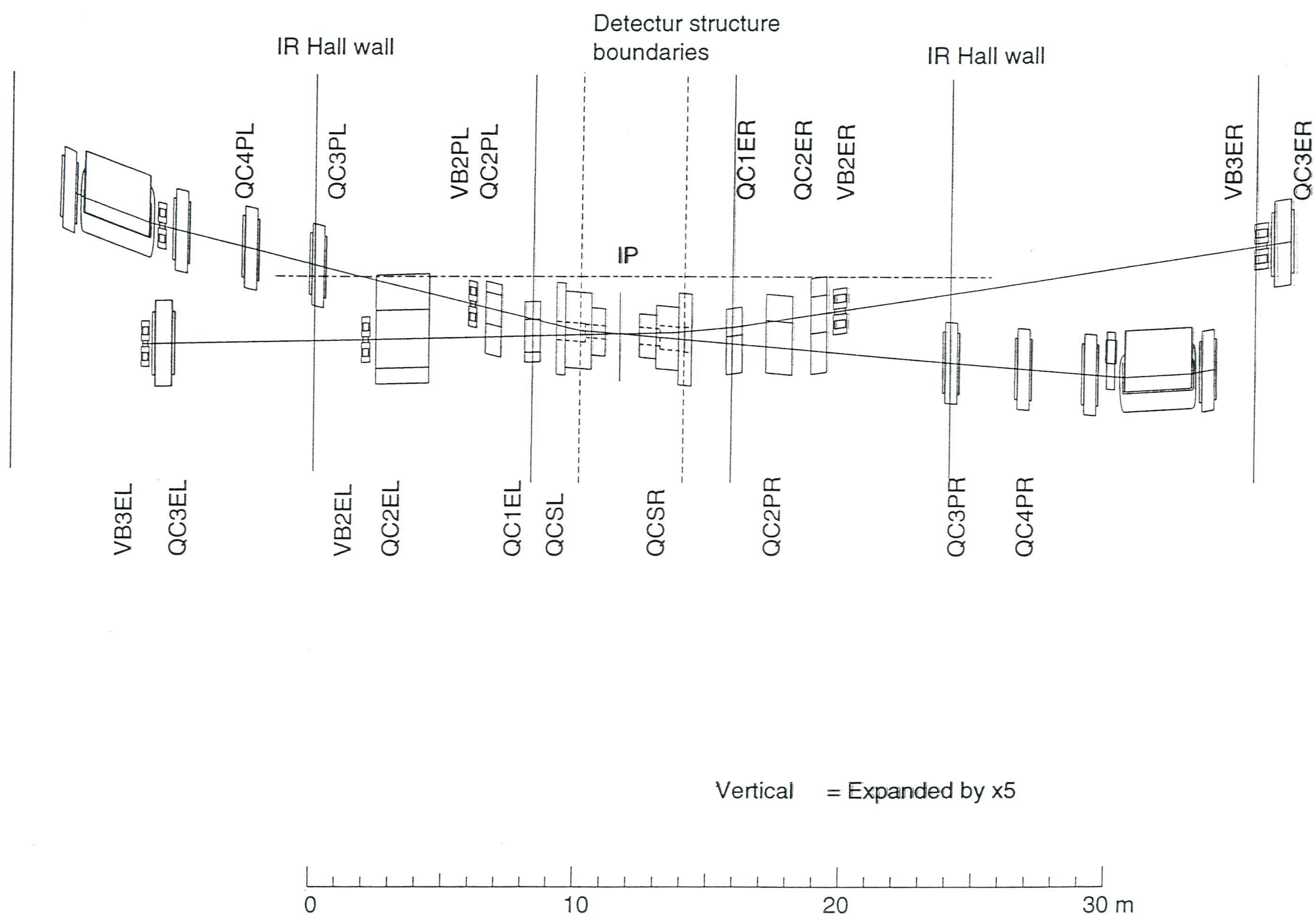
IR design from the viewpoint of the beam background

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

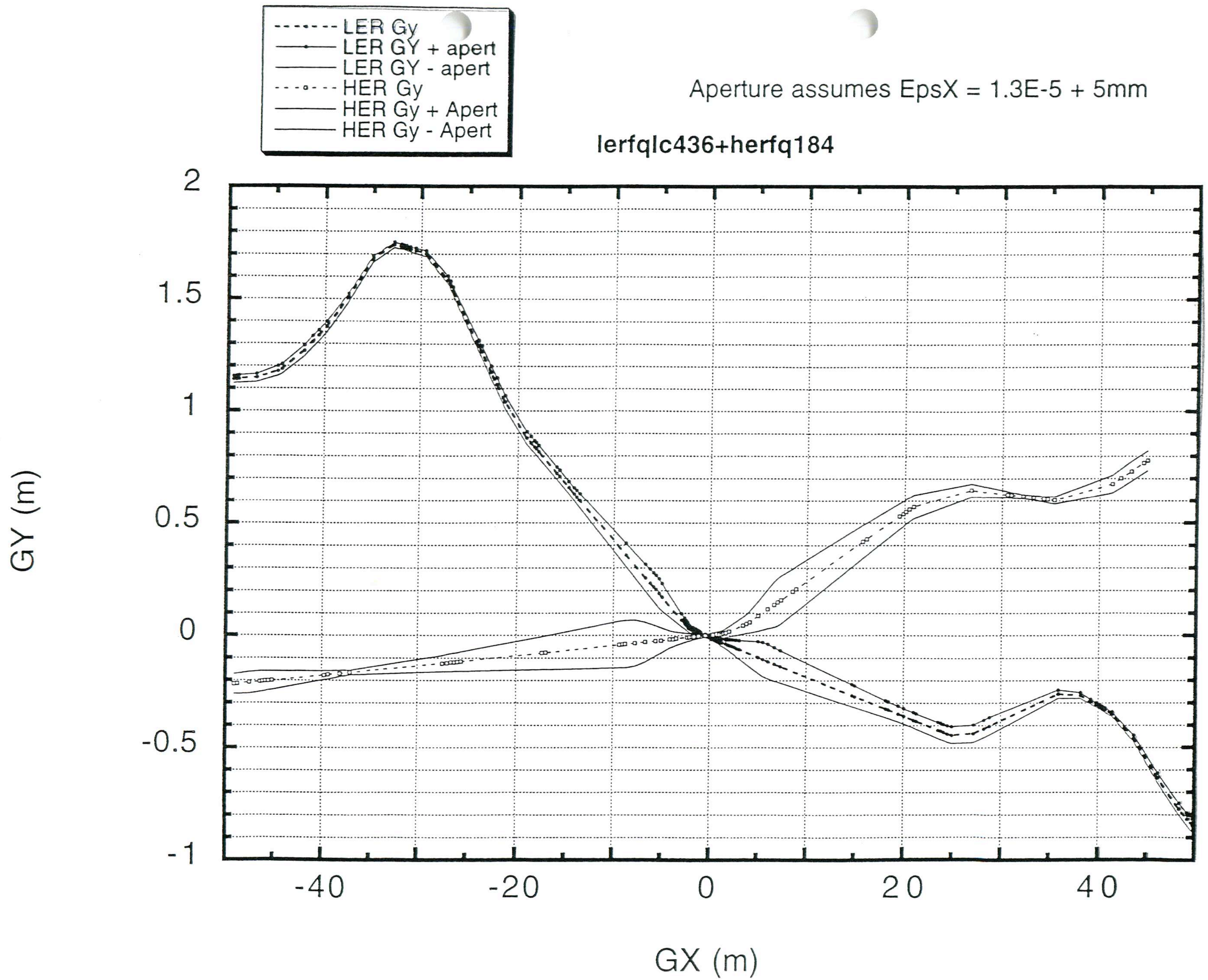
No strong synchrotron radiation sources
No strong seep magnets

Beam background is less severe.

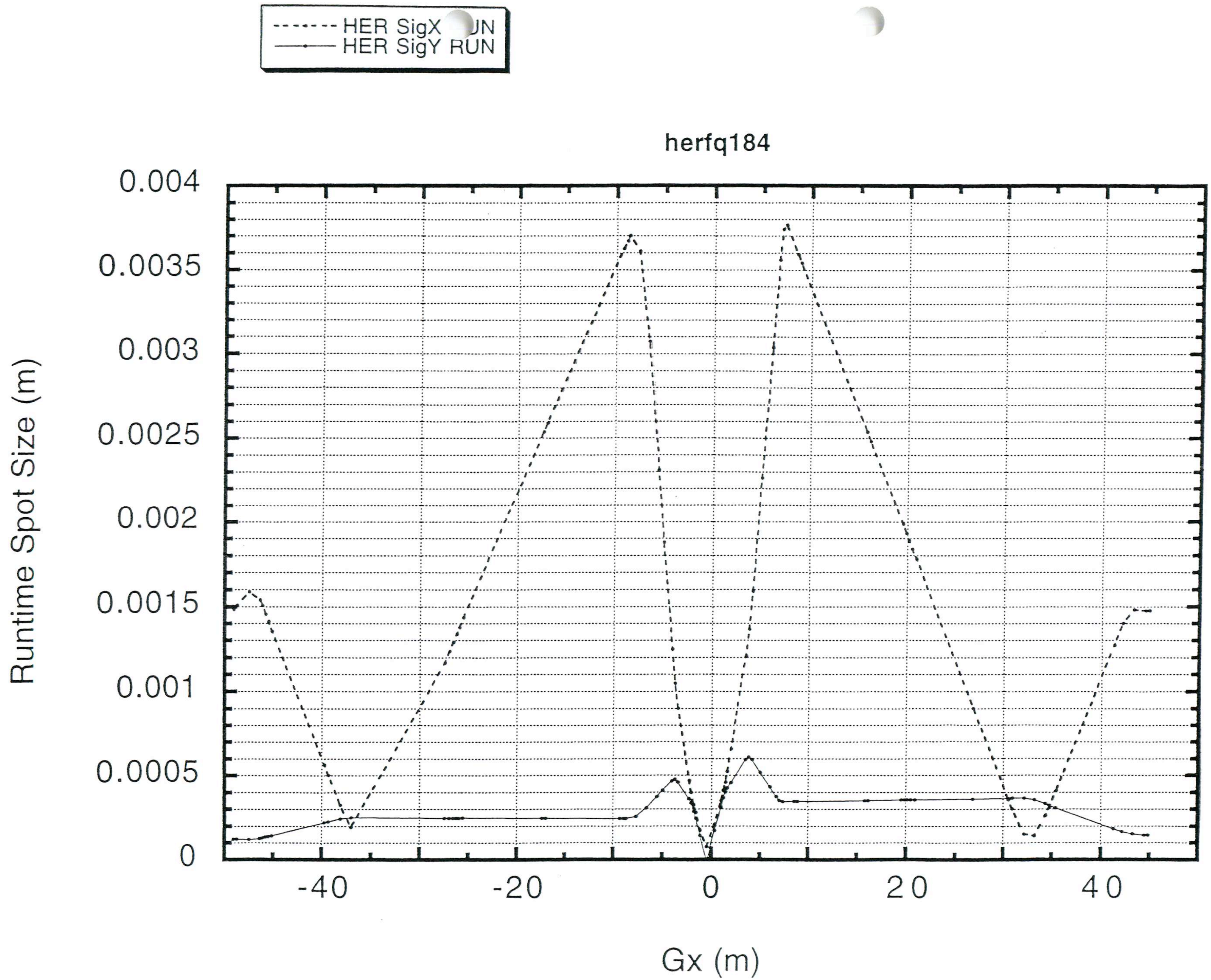
Large horizontal beam size at QC2 may cause some troubles.

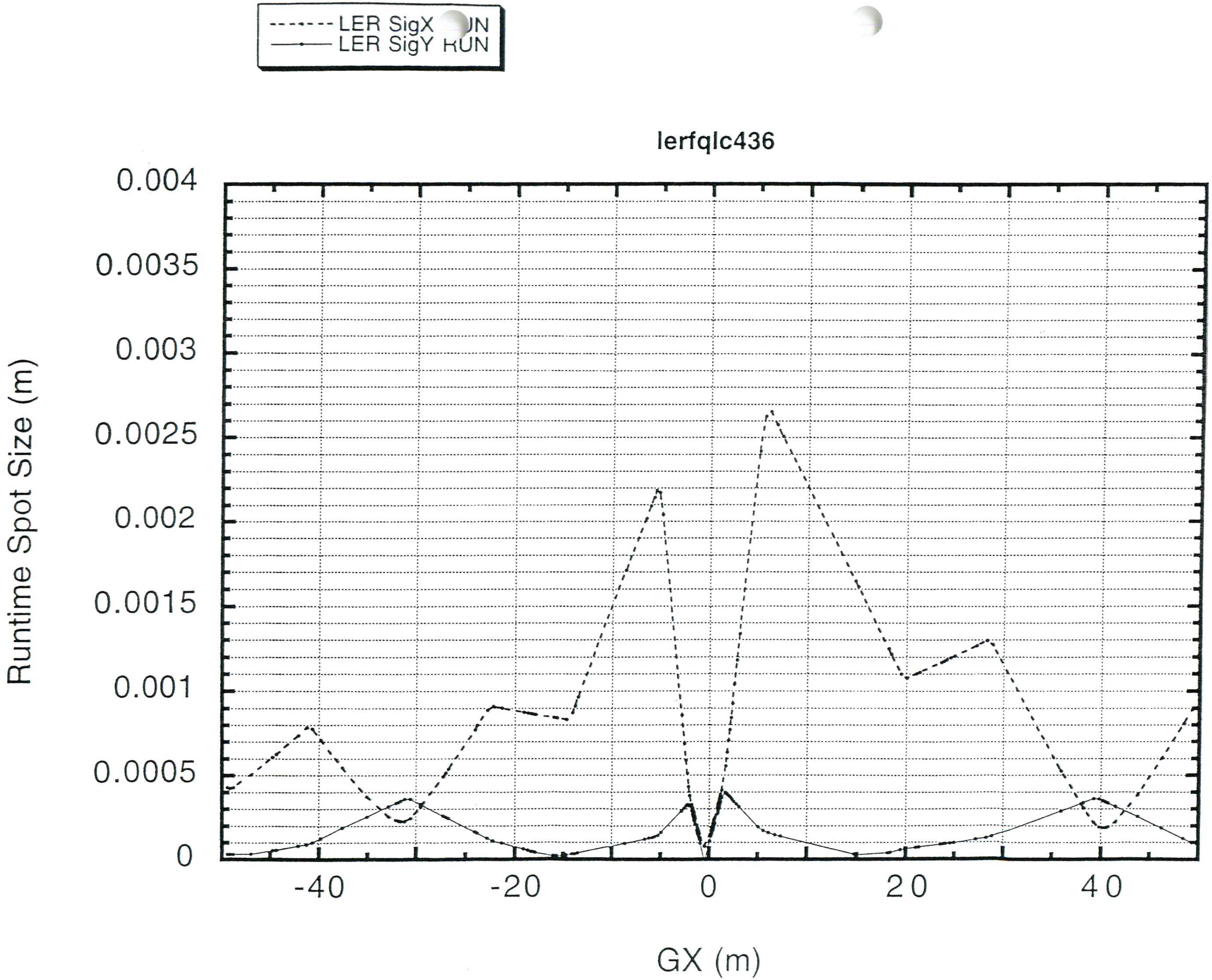


Detectur structure
boundaries
IR Hall wall
IR Hall wall
QC4PL
QC3PL
VB2PL
QC2PL
QC1ER
QC2ER
VB2ER
VB3ER
QC3ER
IP
VB3EL
QC3EL
VB2EL
QC2EL
QC1EL
QCSL
QCSR
QC2PR
QC3PR
QC4PR
Vertical = Expanded by x5
0
10
20
30 m



LER Gy
LER GY + apert
LER GY - apert
HER Gy
HER Gy + Apert
HER Gy - Apert
Aperture assumes EpsX = 1.3E-5 + 5mm
lerfqlc436+herfq184
GY (m)
GX (m)
2
1.5
1
0.5
0
-0.5
-1
-40
-20
0
20
40


HER SigX RUN
HER SigY RUN
herfq184
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)

2. Synchrotron Radiation Background

2-1 SR photons from QCS and QC1

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

2-2 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 be problem for SR photons from QC2.

No problem(EGS4 Simulation)

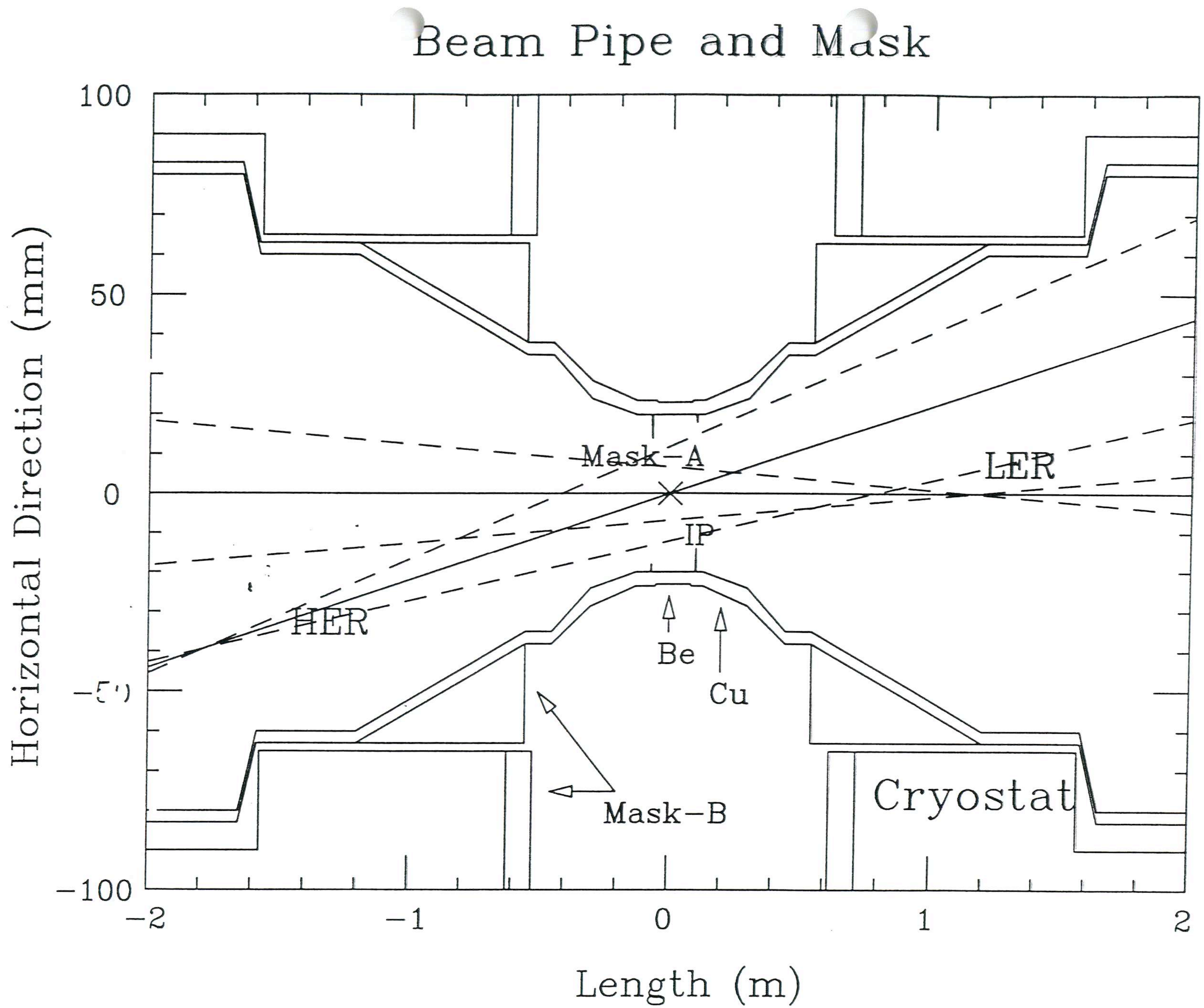
Critical energy for other magnets is small enough. SR photons can easily absorbed by Mask-A.

Critial 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

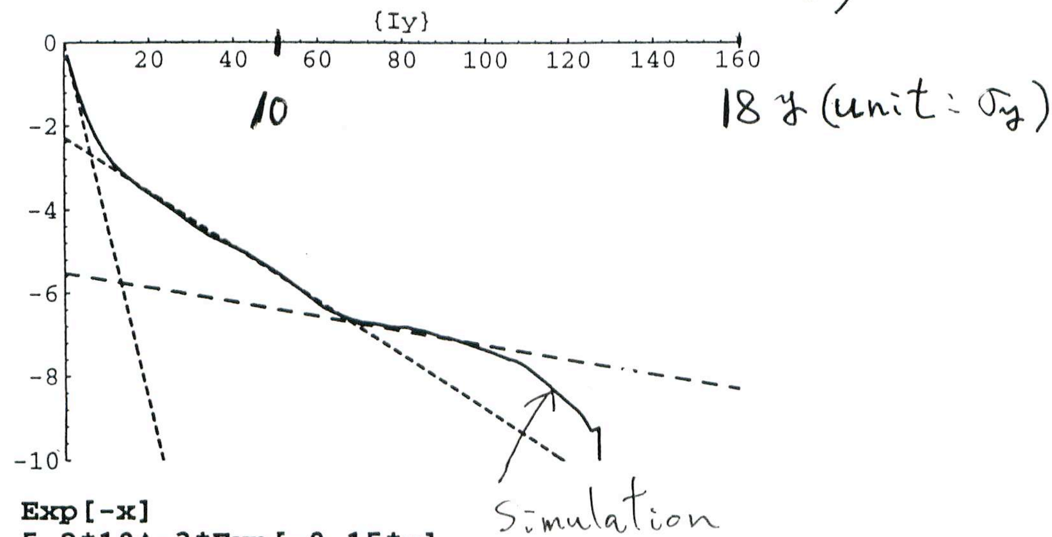
Critial Energy(LER)

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

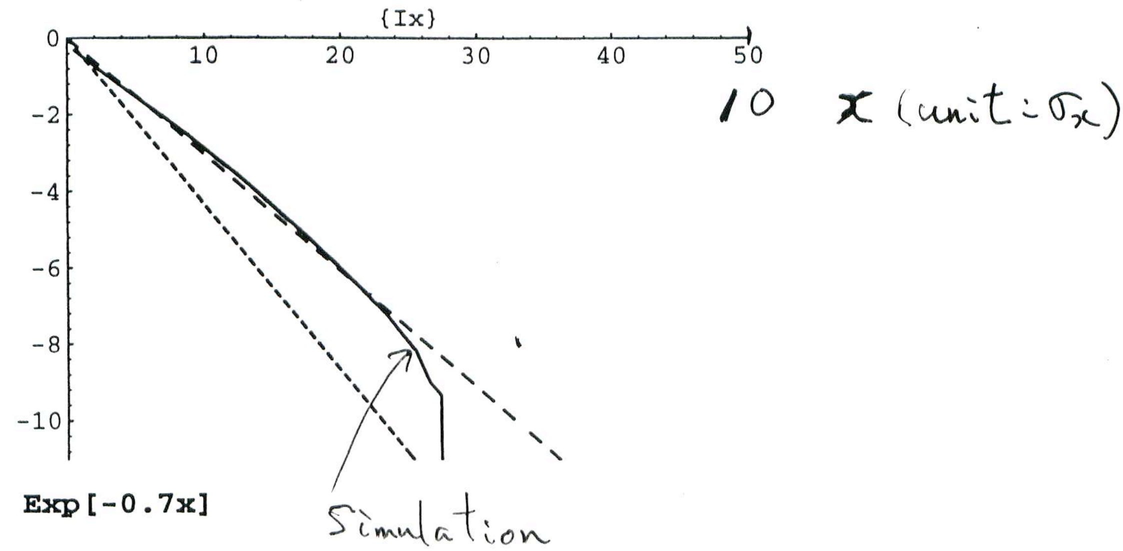

Beam Pipe and Mask
Horizontal Direction (mm)
100
50
0
-50
-100
Length (m)
-2
-1
0
1
2
Mask-A
LER
IP
HER
Be
Cu
Mask-B
Cryostat

Tail simulation

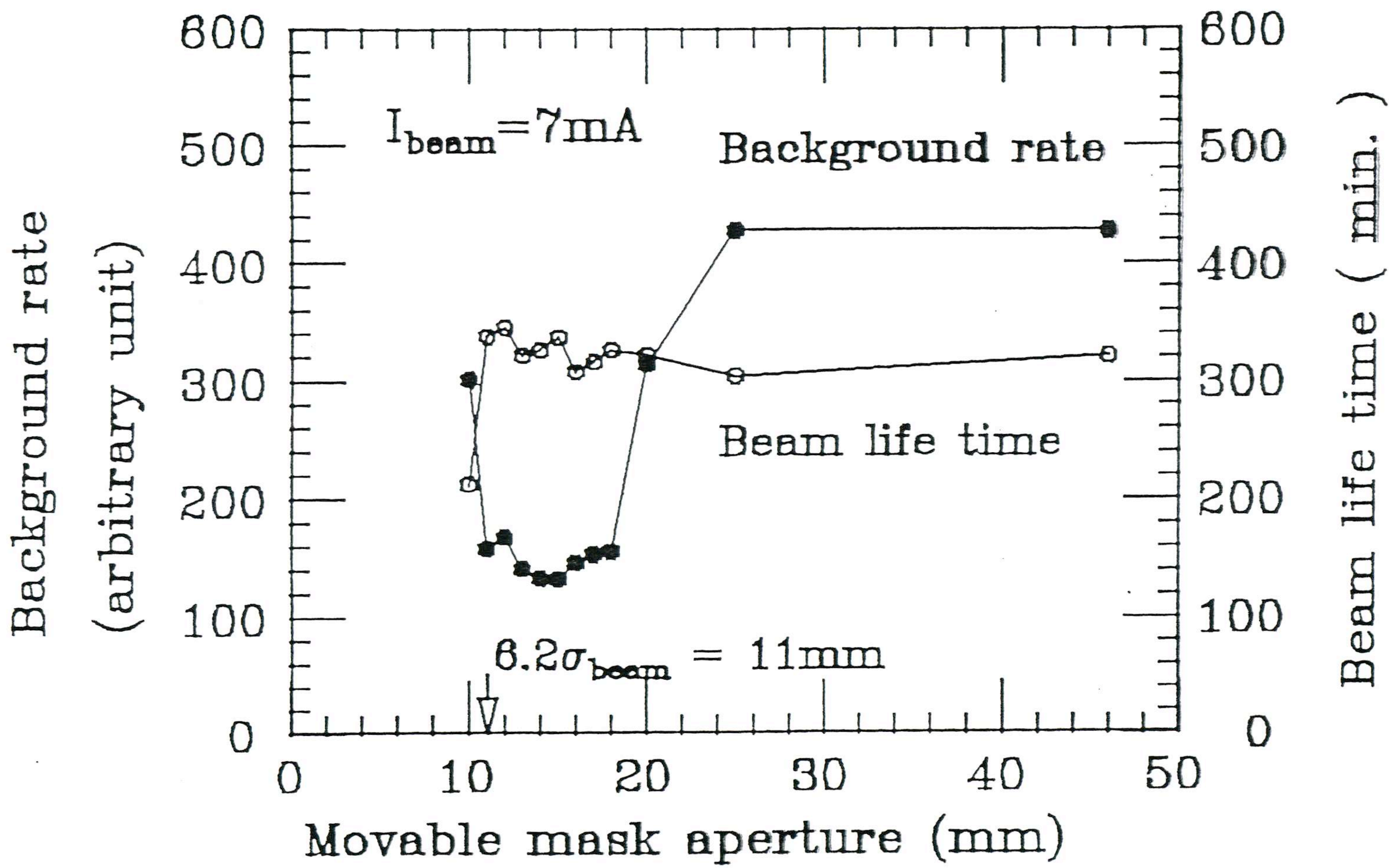
by Dr. Hirata



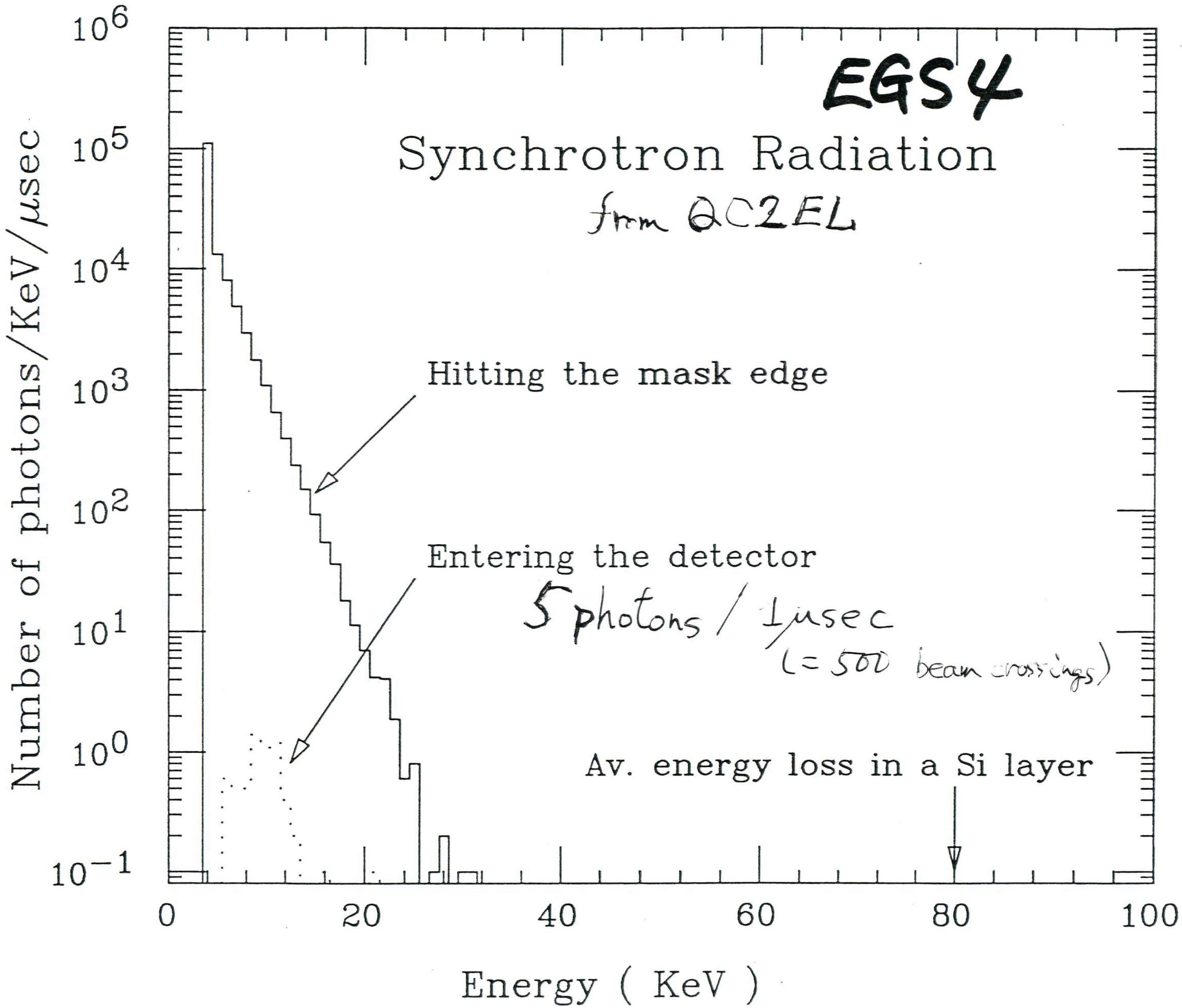
Exp[-x]
5.2*10^-3*Exp[-0.15*x]
3*10^-6*Exp[-0.04*x]



Exp[-0.7x]



I_{beam}=7mA
Background rate
Beam life time
$6.2\sigma_{beam}$ = 11mm
Background rate (arbitrary unit)
Beam life time (min.)
Movable mask aperture (mm)
0
100
200
300
400
500
600
0
10
20
30
40
50



~800 hits
for electronic noise
in Si UTX.

2-3 SR photons from bending magnets arc section and local correction

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

3. Particle Background

Physics process

Bremsstralung : Energy change
Coulomb scattering : Angle change

Decay turtle swims particles upto the entrance of QCS.

GEANT simulates QCS, solenoid and detector.

Assumption

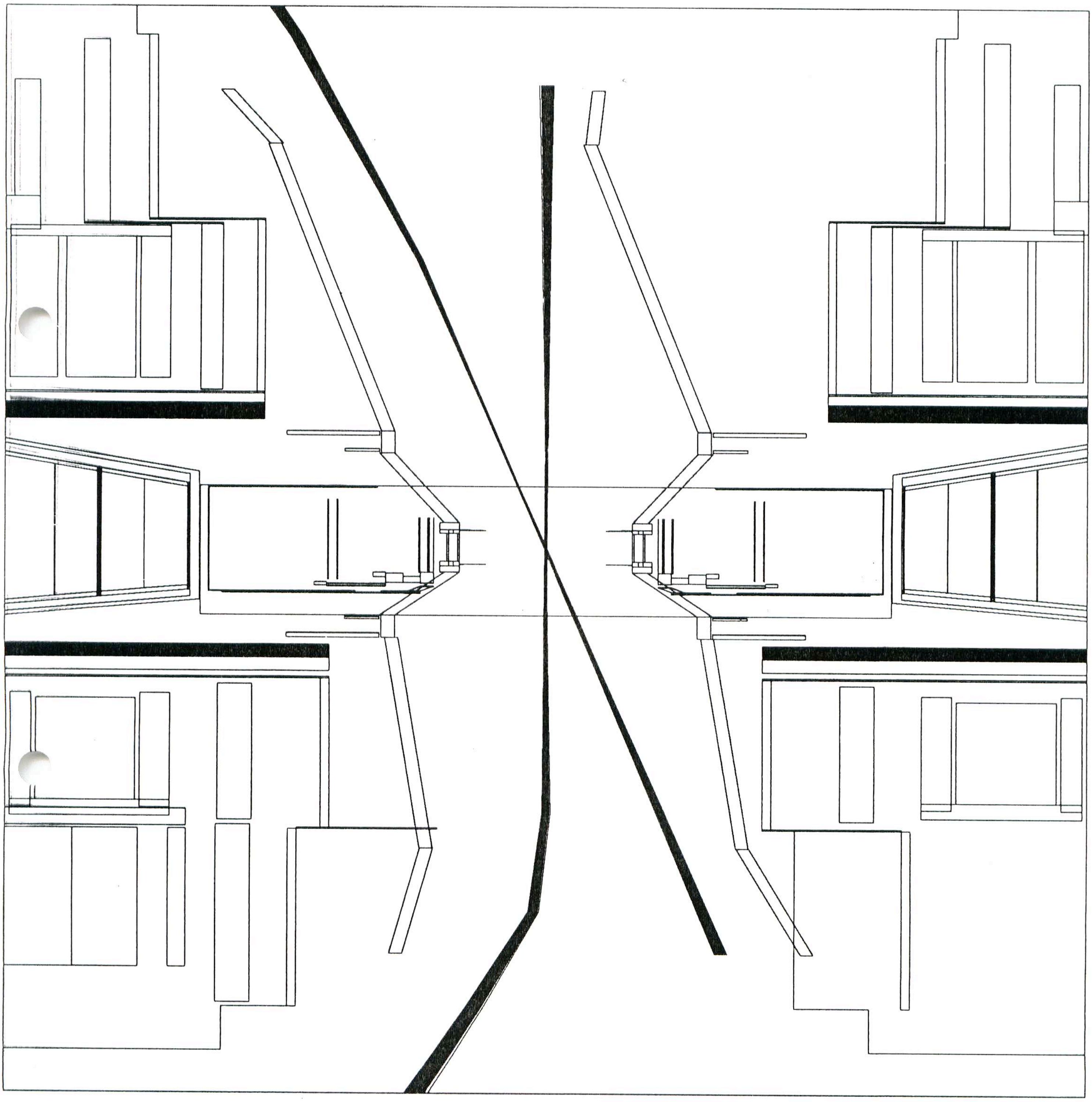
Vacuum Pressure : 1 ntorr

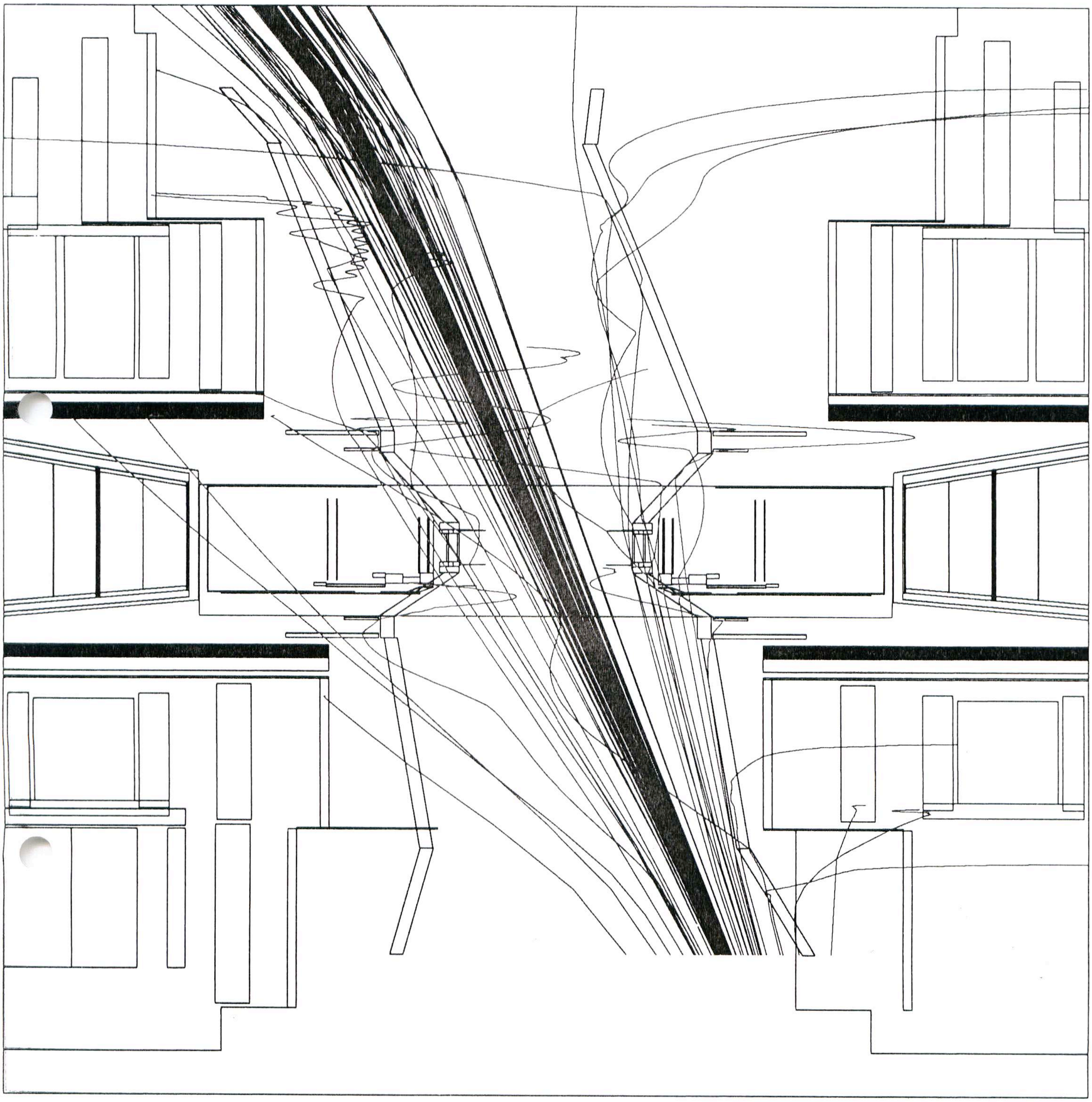
Full current (I (LER) = 2.6A
I (HER) = 1.1A)

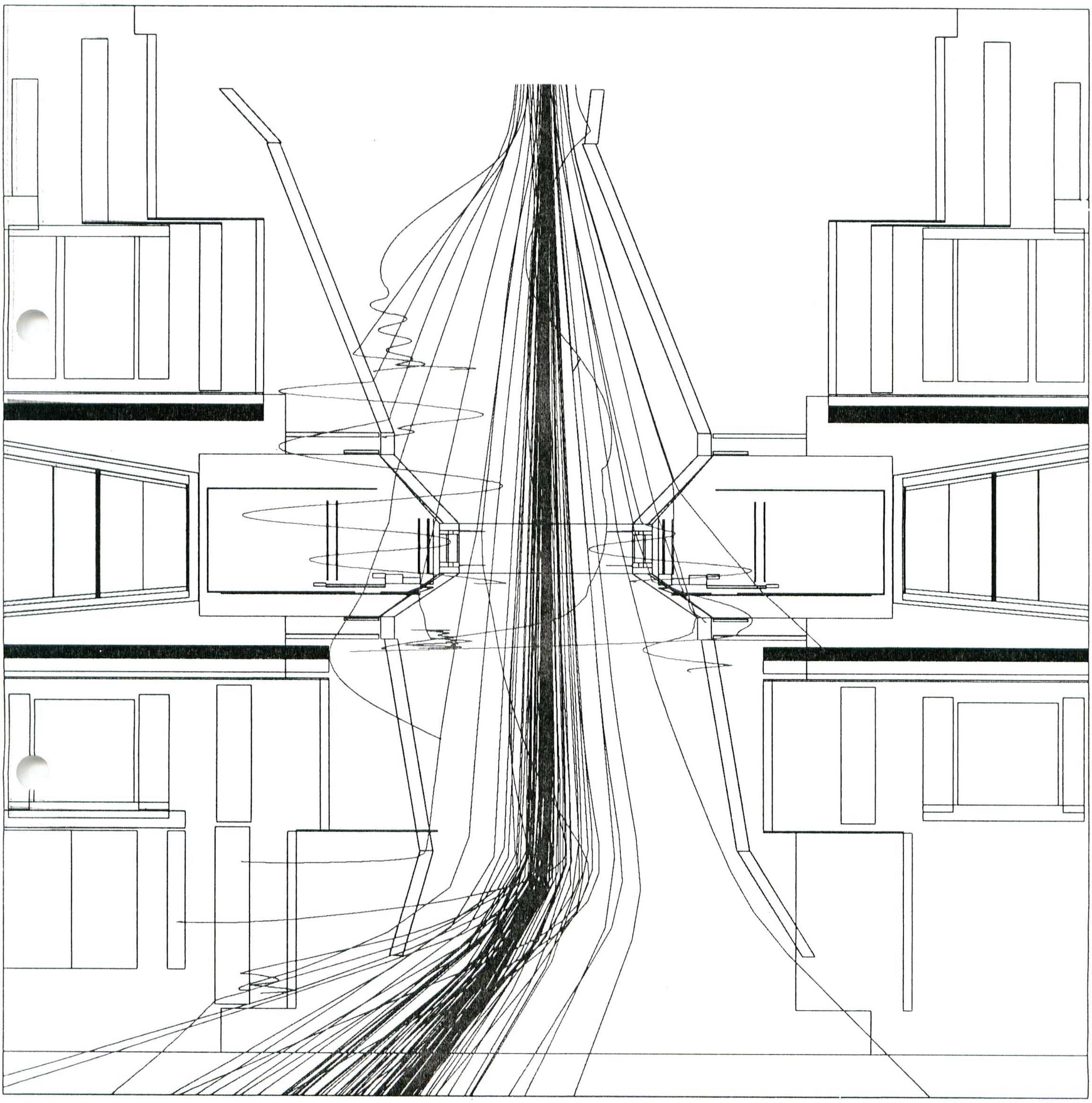
1 year = 10^7 sec

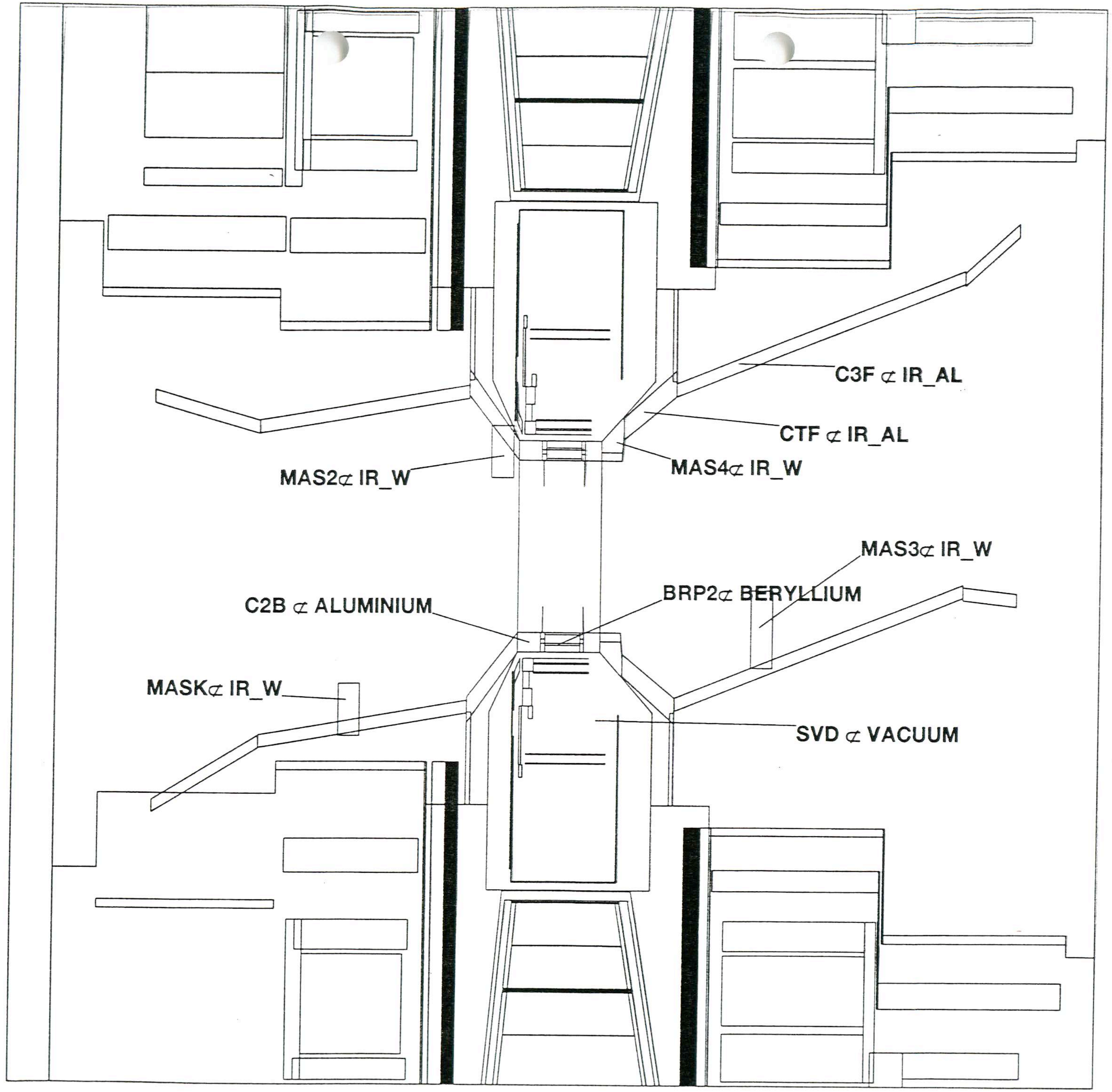
⇓

100 fb^{-1}/year









C3F ⊄ IR_AL
CTF ⊄ IR_AL
MAS2⊄ IR_W
MAS4⊄ IR_W
MAS3⊄ IR_W
BRP2⊄ BERYLLIUM
C2B ⊄ ALUMINIUM
MASK⊄ IR_W
SVD ⊄ VACUUM

Hit rates for Particle Background

Process	Hit Rates(MHz)
e^+ Brems.	0.26
e^+ Coul.	0.19
e^- Brems.	0.44
e^- Coul.	0.05

Trigger rate

Hit rate ~ 1MHz

TOF+TSC

Two hits ~ 10 kHz (< 70 kHz)

Charged tracks in CDC

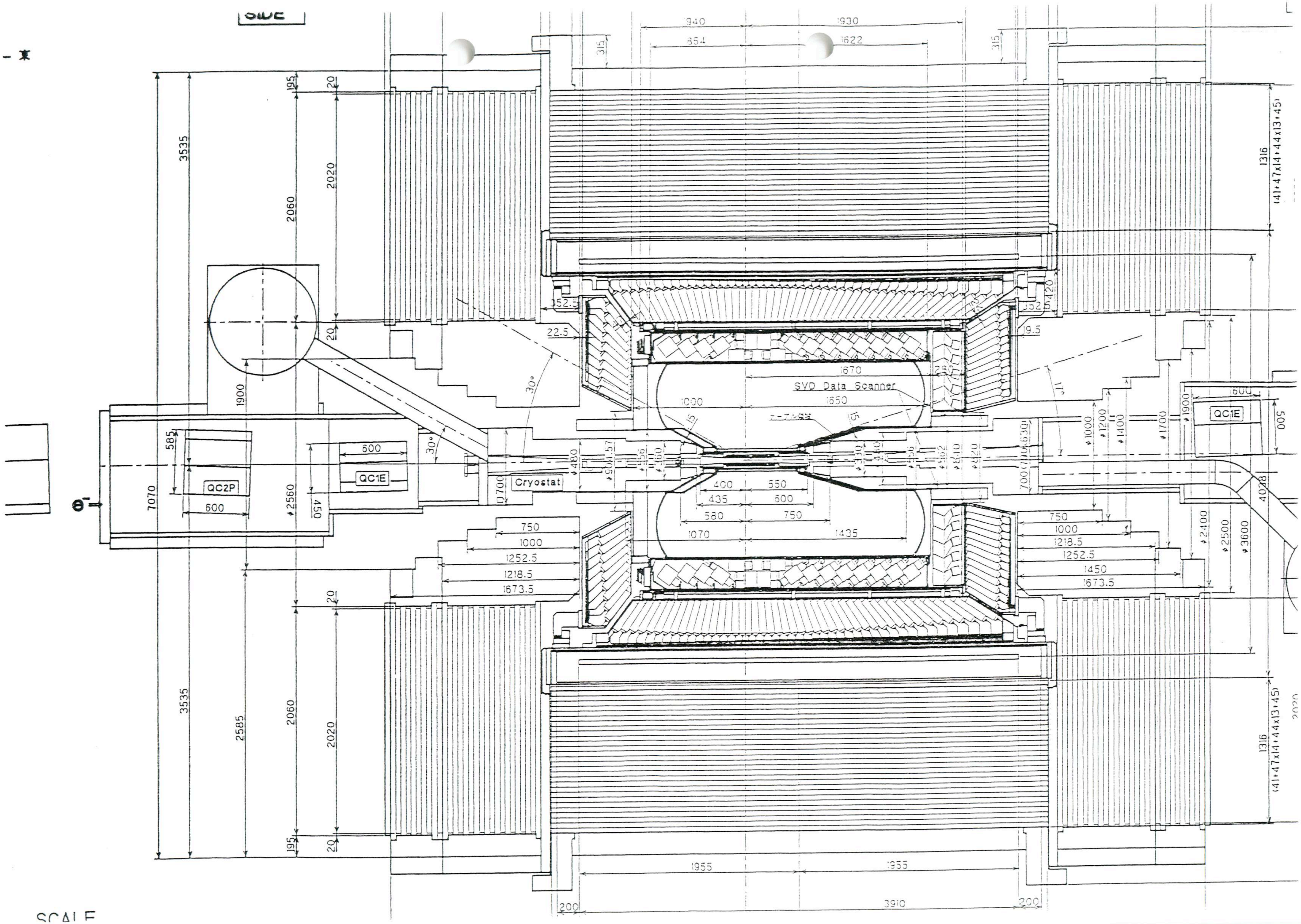
Pt > 0.2 GeV/c

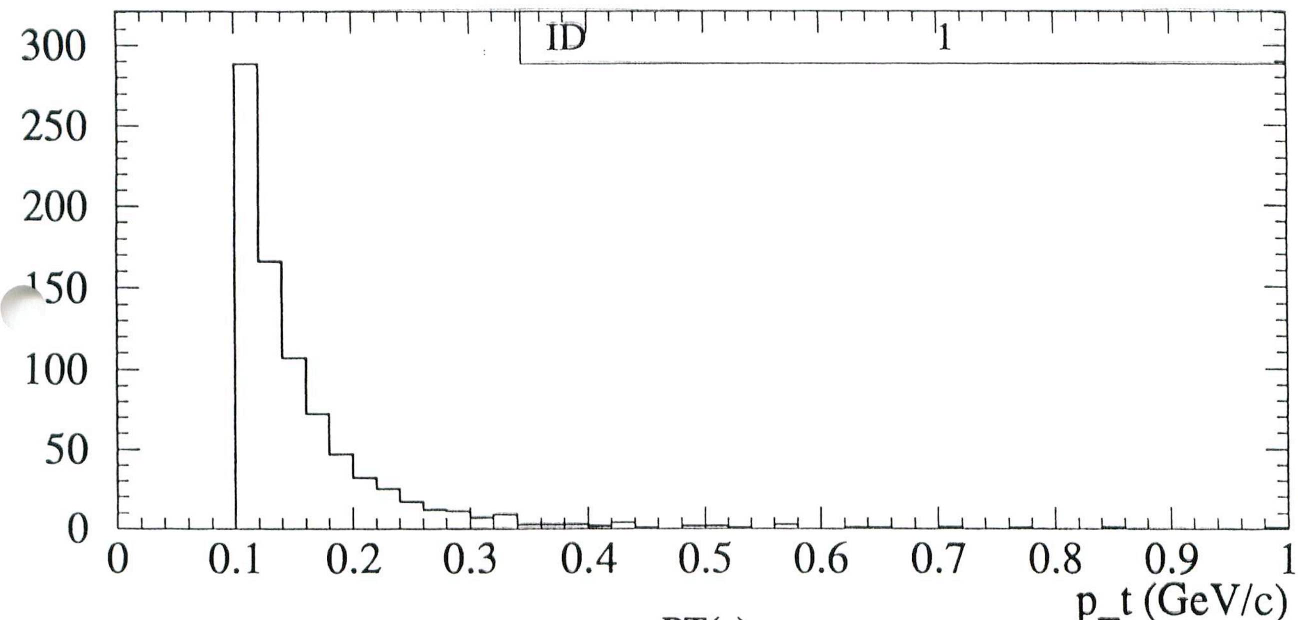
Two tracks ~200 Hz

|Z|< 10cm ~20 Hz (< 500 Hz)

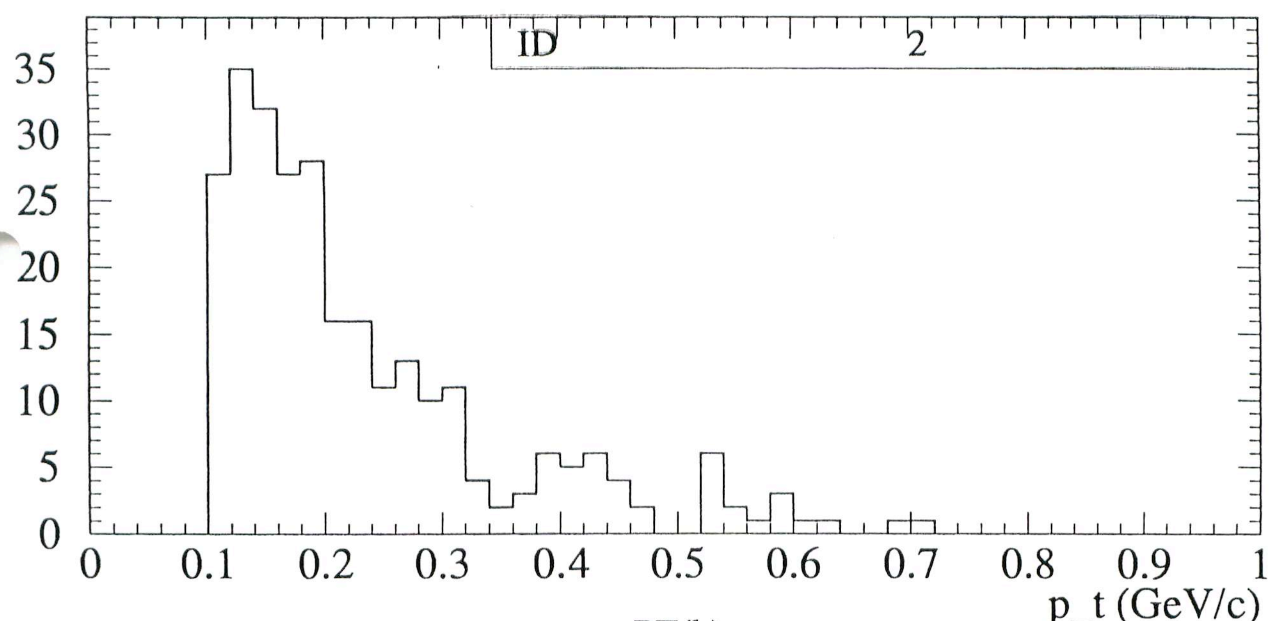
using CDC Z-trigger and

SVD Z-trigger

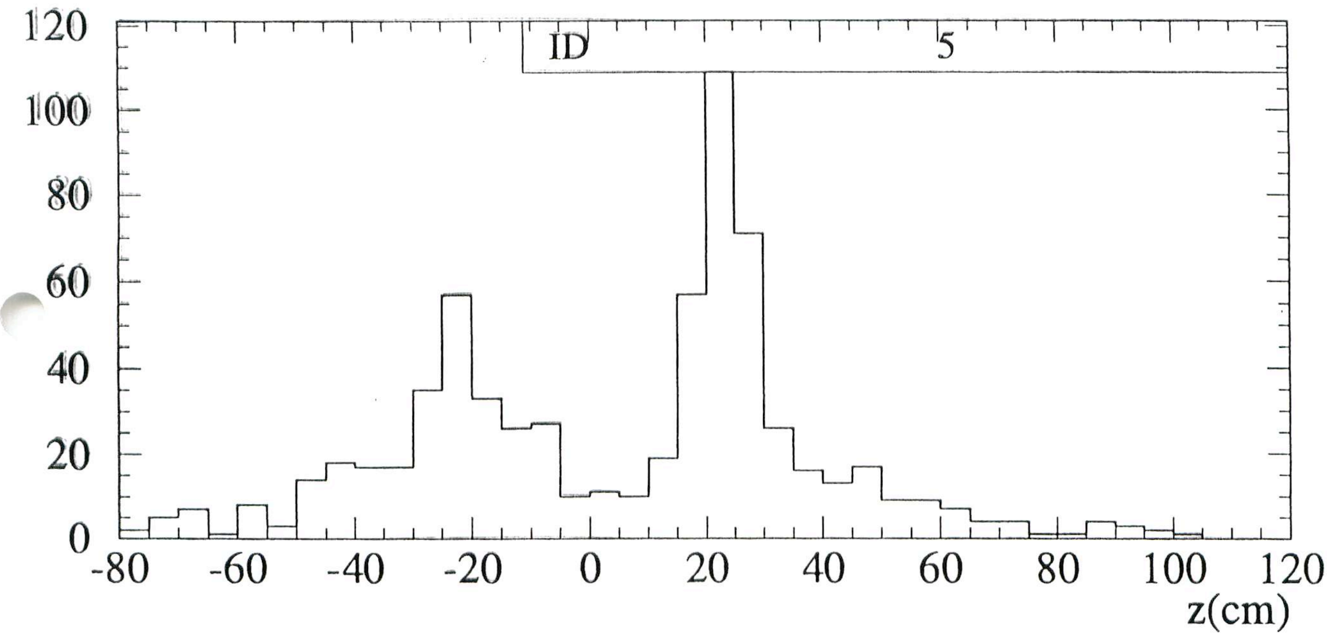

SIDE
SYD Data Scanner
Cryostat
QC1E
QC1E
QC2P
3535
2060
2020
2585
7070
1955
3910
1316
(41+47x14+44x13+45)
SCALE


ID
1
300
250
200
150
100
50
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
p_t (GeV/c)

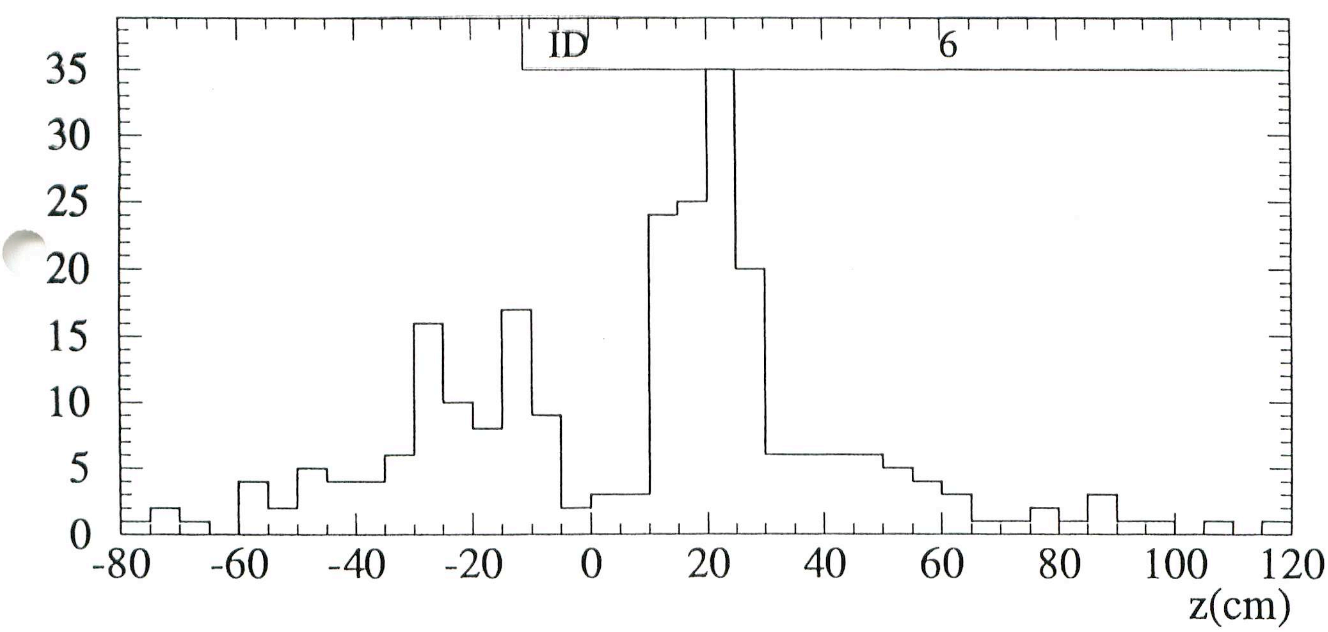
PT(e)


ID
2
35
30
25
20
15
10
5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
p_t (GeV/c)

PT(h)



120
100
80
60
40
20
0
ID
5
-80
-60
-40
-20
0
20
40
60
80
100
120
z(cm)



35
30
25
20
15
10
5
0
ID
6
-80
-60
-40
-20
0
20
40
60
80
100
120
z(cm)

Radiation dose on CsI calorimeter

A few MeV photons can reach CsI.

Radiation dose

~ 5 rad/year for Barrel
~50 rad/year for Endcap

Radiation hardness of CsI

~10% light loss at 1000 rad

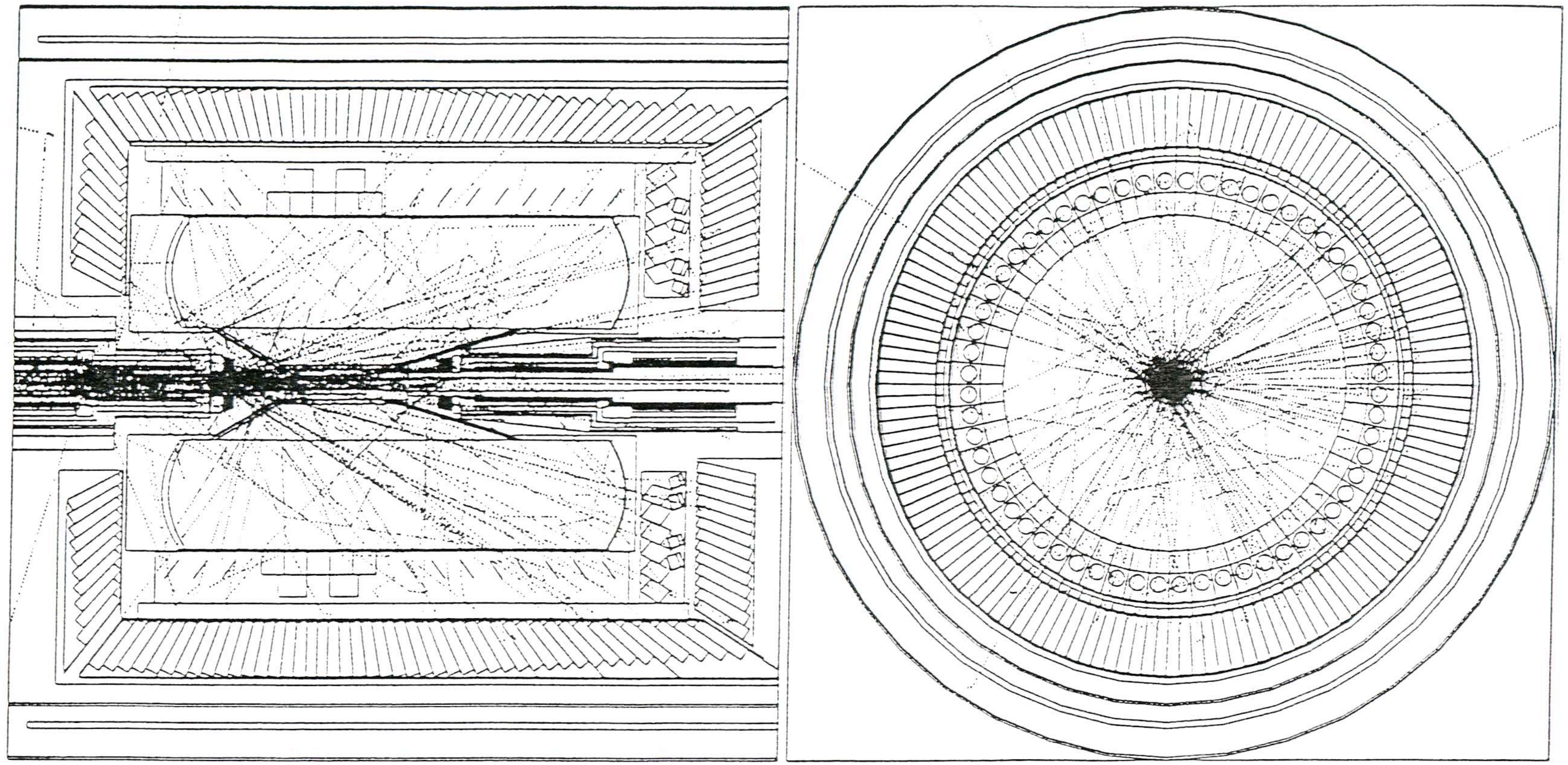
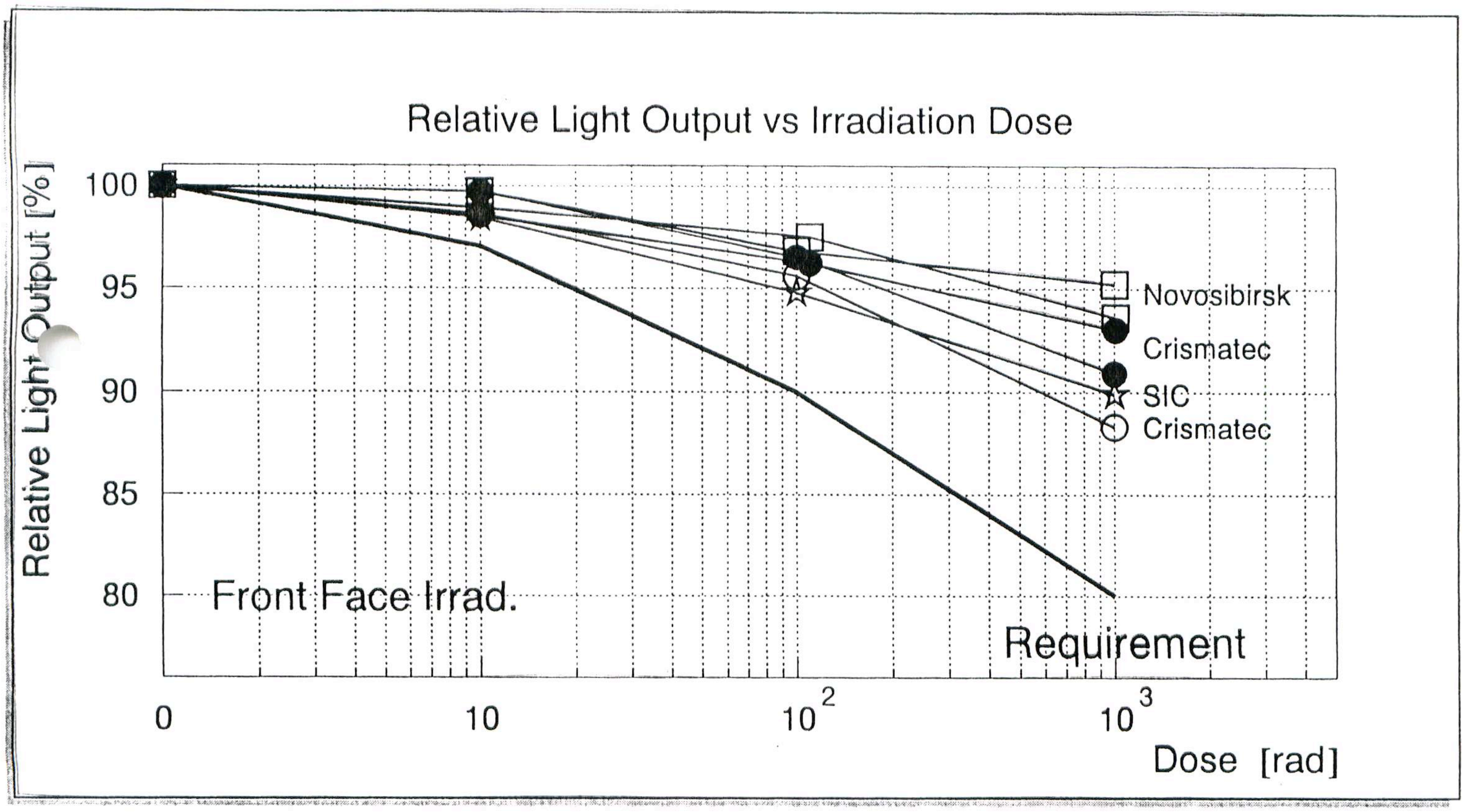


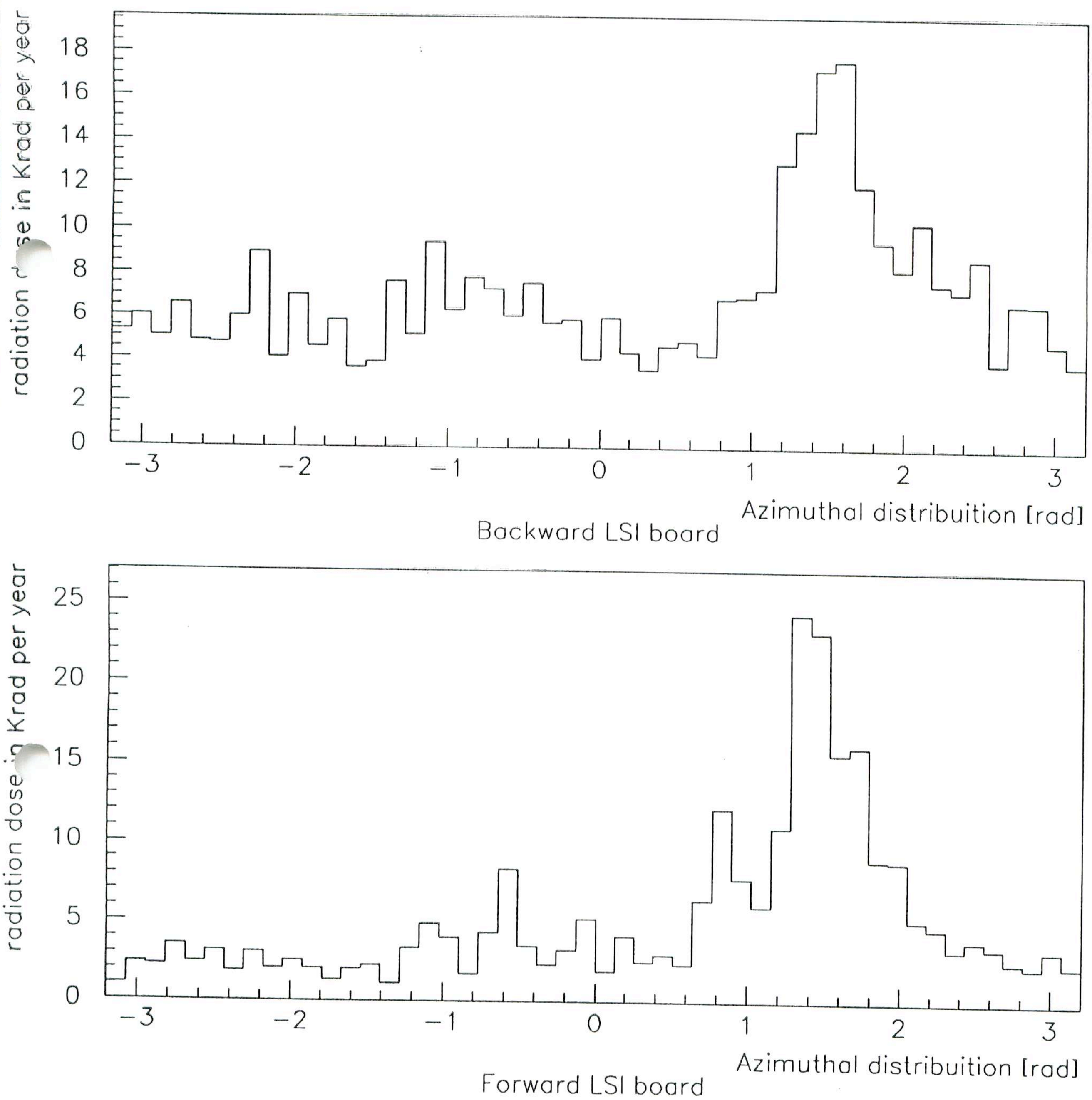
Figure 2: Scans of a background event in BELLE detector, with the SiW-EFC configuration. Photo on the left is the $x - z$ view and that on the right is the $r - \phi$ view of the same event. Dotted tracks are γ's and dot-dashed tracks are charged particles. Most of the tracks are γ's ($E_\gamma > 100\ keV$ cut was applied). The scans exhibit the enormous neutral track-multiplicity of a generic background event.


Relative Light Output vs Irradiation Dose
Relative Light Output [%]
100
95
90
85
80
Front Face Irrad.
Novosibirsk
Crismatec
SIC
Crismatec
Requirement
0
10
10^2
10^3
Dose [rad]

Average Radiation Dose on SVD

layer number	Radiation dose(Krad/year)
1	6.2 ± 1.1
2	6.1 ± 0.9
3	3.4 ± 0.6
4	3.0 ± 0.1

96/10/11 13.59


radiation dose in Krad per year
18
16
14
12
10
8
6
4
2
0
−3
−2
−1
0
1
2
3
Azimuthal distribuition [rad]
Backward LSI board
radiation dose in Krad per year
25
20
15
10
5
0
−3
−2
−1
0
1
2
3
Azimuthal distribuition [rad]
Forward LSI board

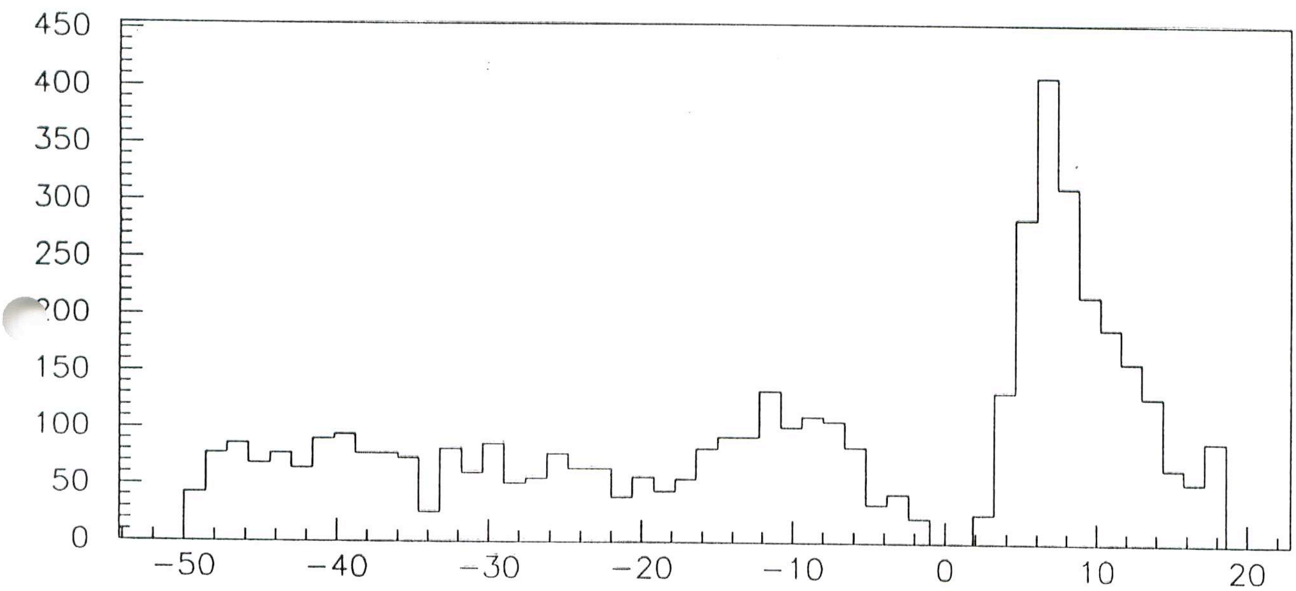
Radiation Hardness of SVD

20 krad	:	No problem
50 krad	:	S/N radio becomes worse (factor two). It is still usefull.

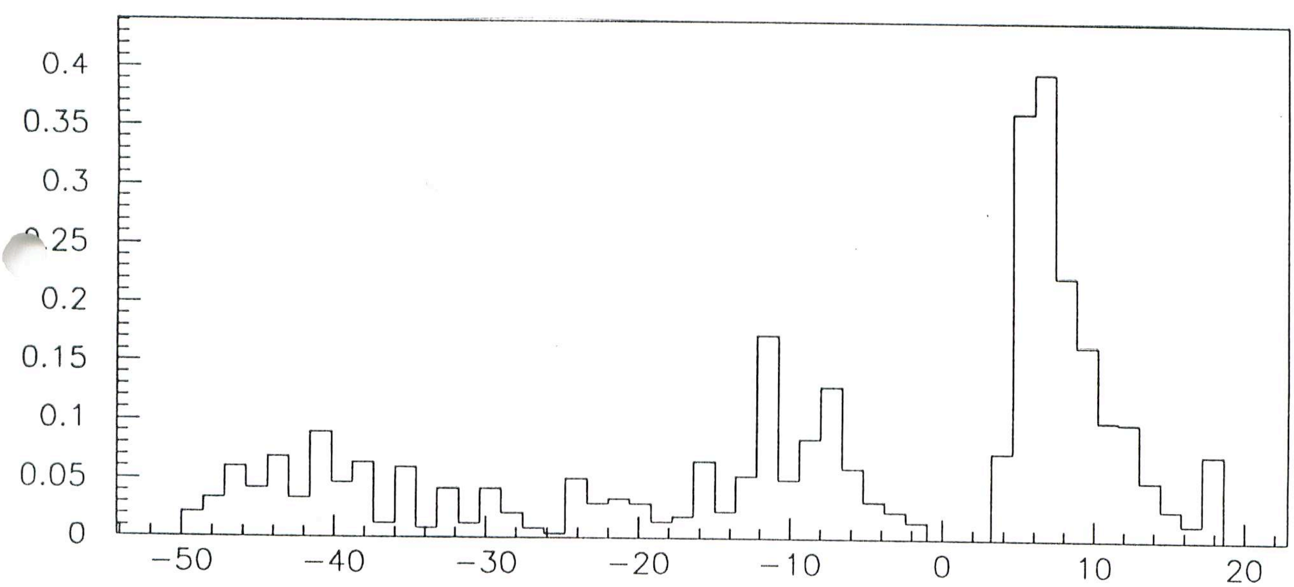
R&D of rad-hard chips already started.

We hope rad-hard chips will be available in a few years after the first experiment.

96/10/09 11.35

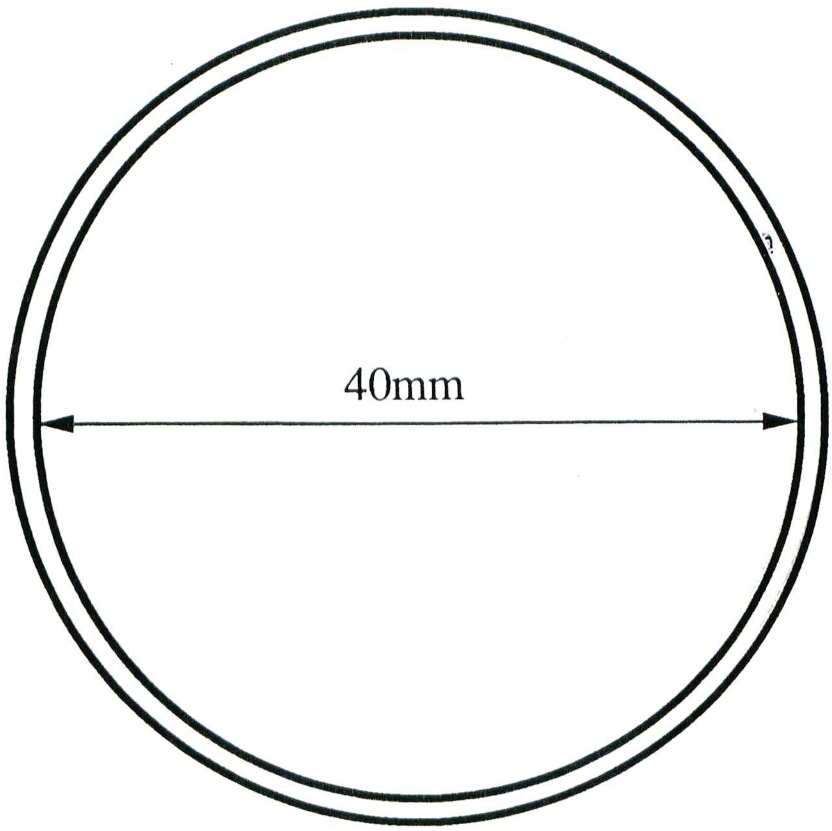


Z distribution of scattering point(LSI)

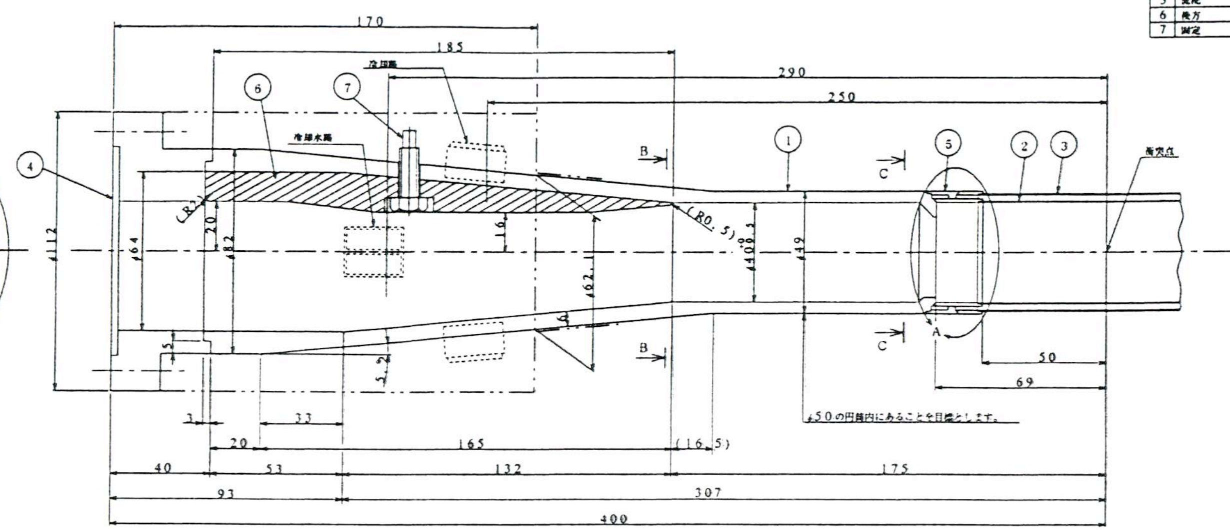


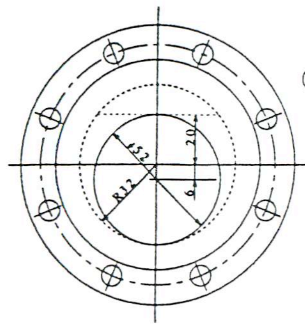
Z distribution of scattering point(LSI) weighted by energy loss

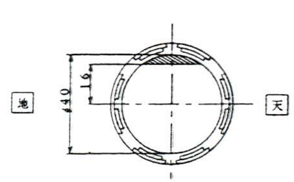
Beam Pipe



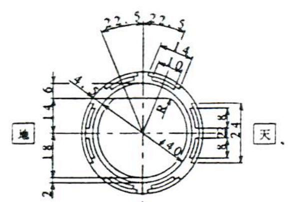
0.5mm^{t}Be + 2mm^{t}He + 0.5mm^{t}Be



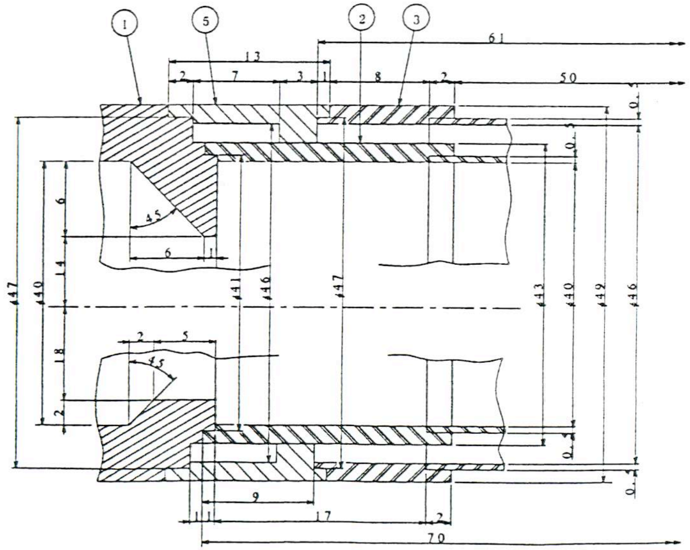




B－B 断面



C－C 断面



A 部詳細
(S=5倍)

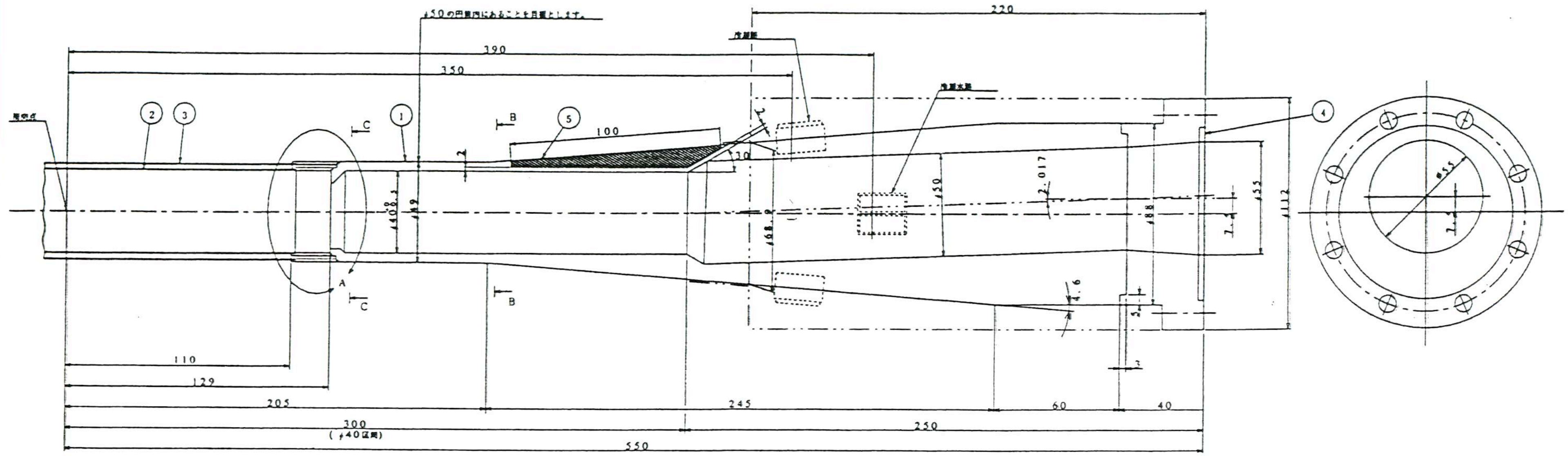
MARK	PARTICULARS	MATERIAL		NO. REQUIRED		MASS (Kg)		REMARKS
1	(前方側)	A3003		1		1.0		
2	[illegible]	A1100/	Be	1		0.04		
3	前方側	A1100/	Be	1		0.04		
4		A2219	T851	1		0.6		
5	[illegible]	A3003		1		0.01		
6	後方			1		0.8		
7	測定			2				M8

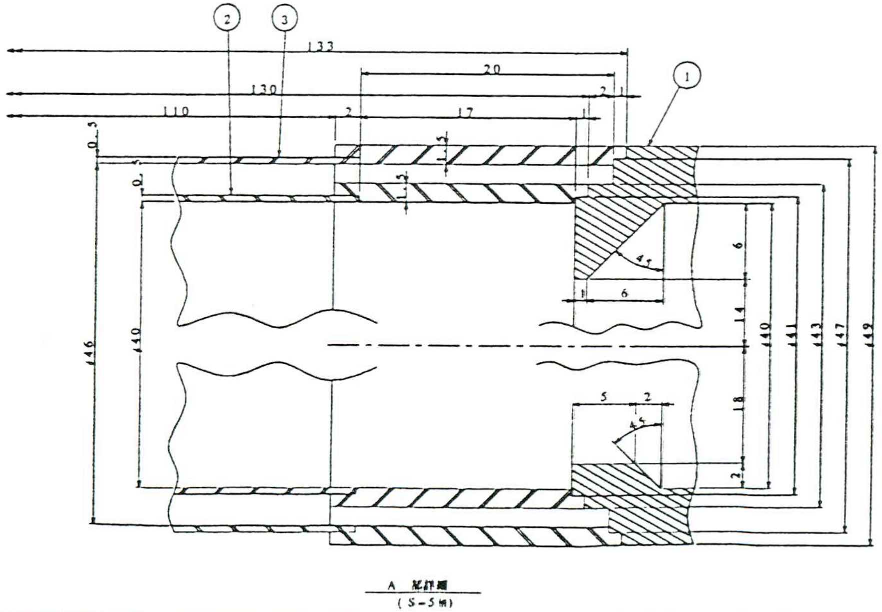
NO.	DATE	DESCRIPTION	DRAWN	DESIGNED	CHECKED	APPROVED
0		新規製図				

SCALE 1/1	高エネルギー物理学研究所殿	衝突点 後方側構造図 (検討用)
1ST ANGLE PROJECTION / 3RD ANGLE PROJECTION		
IHI開発設計部	JOB NO. 5761150	06BA8432
	DRAWING NO. 001K003	REV. 0 1/1

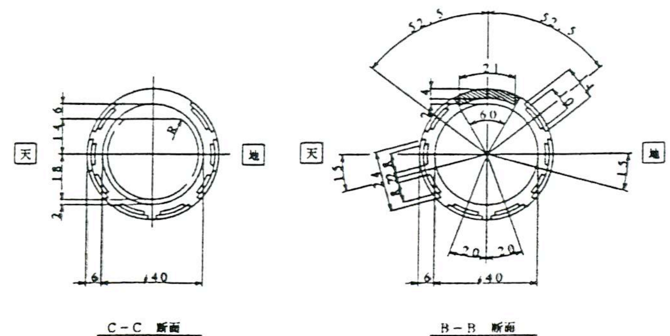
Ishikawajima-Harima Heavy Industries Co., Ltd.

MARK	PARTICULARS	MATERIAL	NO. REQUIRED				MASS (Kg)	REMARKS
							TOTAL	
1	([illegible]用)	A3003			1		2.0	
2	[illegible]	A1100/	Be		1		0.04	
3	[illegible]	A1100/	Be		1		0.04	
4		A2219	T851		1		0.7	
5	[illegible]				1		0.3	





A 部詳細
(S-5倍)



C-C 断面

B-B 断面

NO.	DATE	DESCRIPTION	DRAWN	DESIGNED	CHECKED	APPROVED
0		新規調製				

SCALE 1/1

高エネルギー物理学研究所殿

1ST ANGLE PROJECTION

3RD ANGLE PROJECTION

衝突点

前方側構造図

(検討用)

JOB NO. 5761150

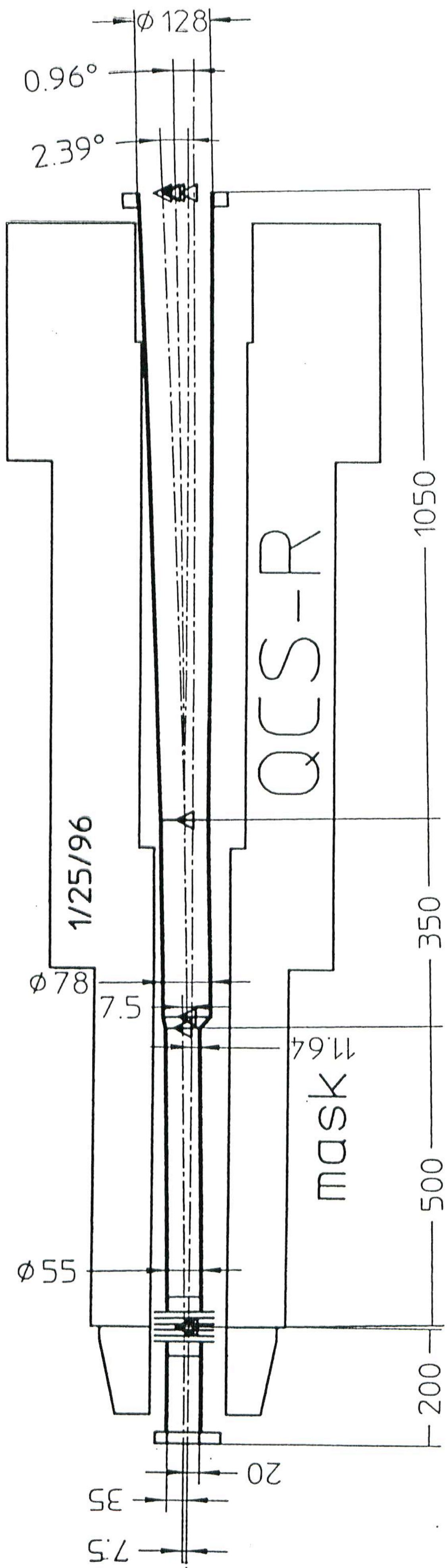
DRAWING NO.

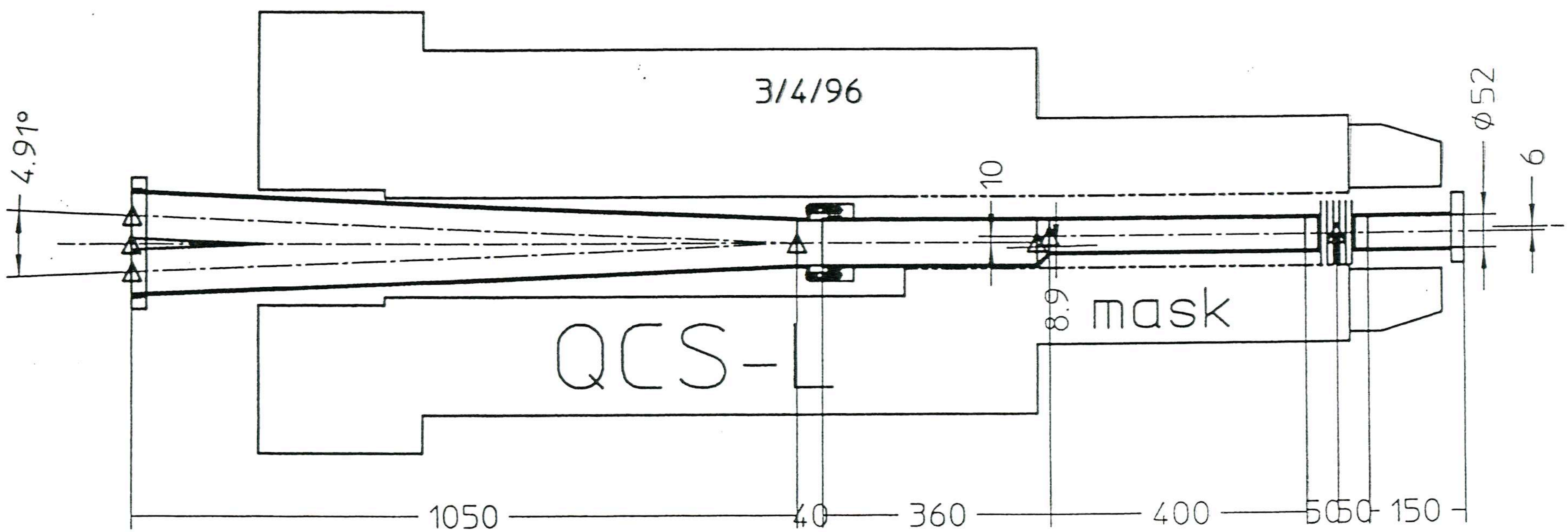
REV. 0

1/1

IHI開発設計部

Ishikawajima-Harima Heavy Industries Co., Ltd.


Ø 128
0.96°
2.39°
QCS-R
1/25/96
Ø 78
7.5
11.64
mask
Ø 55
1050
350
500
200
20
35
7.5



3/4/96
QCS-L
mask
4.91°
10
8.9
φ52
6
1050
40
360
400
50
50
150

Summary

Synchrotron radiation background is no problem due to small critical energy.

Radiation dose on CsI is small enough.

Radiation dose on SVD is tolerable.
  Better vacuum pressure is welcome.
  R&D of rad-hard chips is necessary.