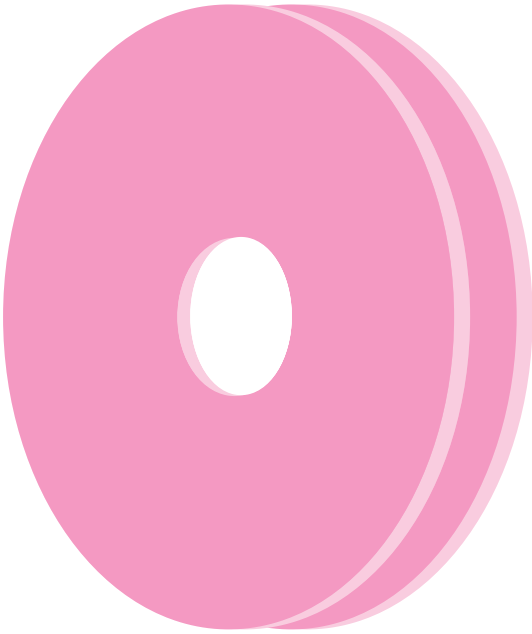
Pair Monitor

as a beam profile monitor



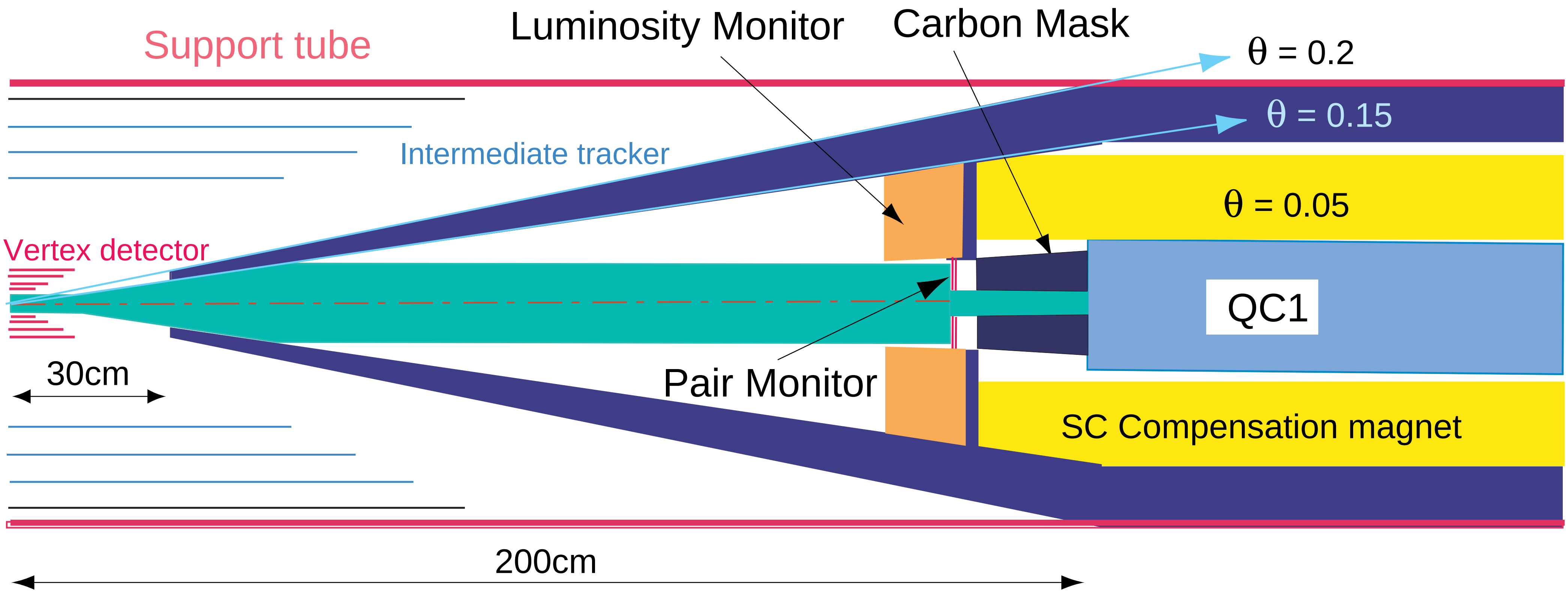
Active Pixel Sensor

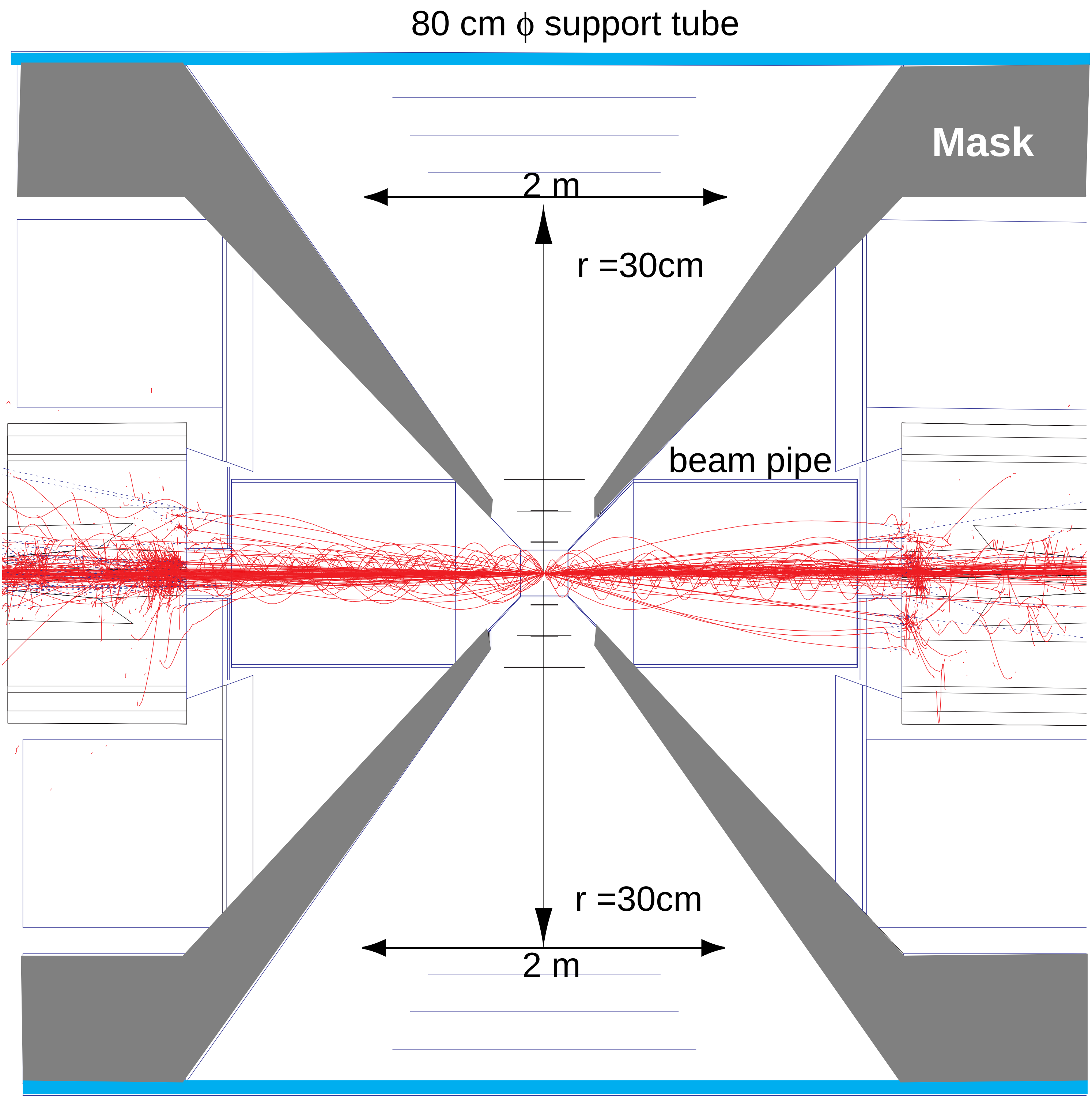
double layer of silicon disks

pixel size	100 x 100 μm^2
thickness	300 μm
inner radius	2 cm
outer radius	8.5 cm
location (z)	176 and 177 cm from IP

Measurement:

position and energy deposit

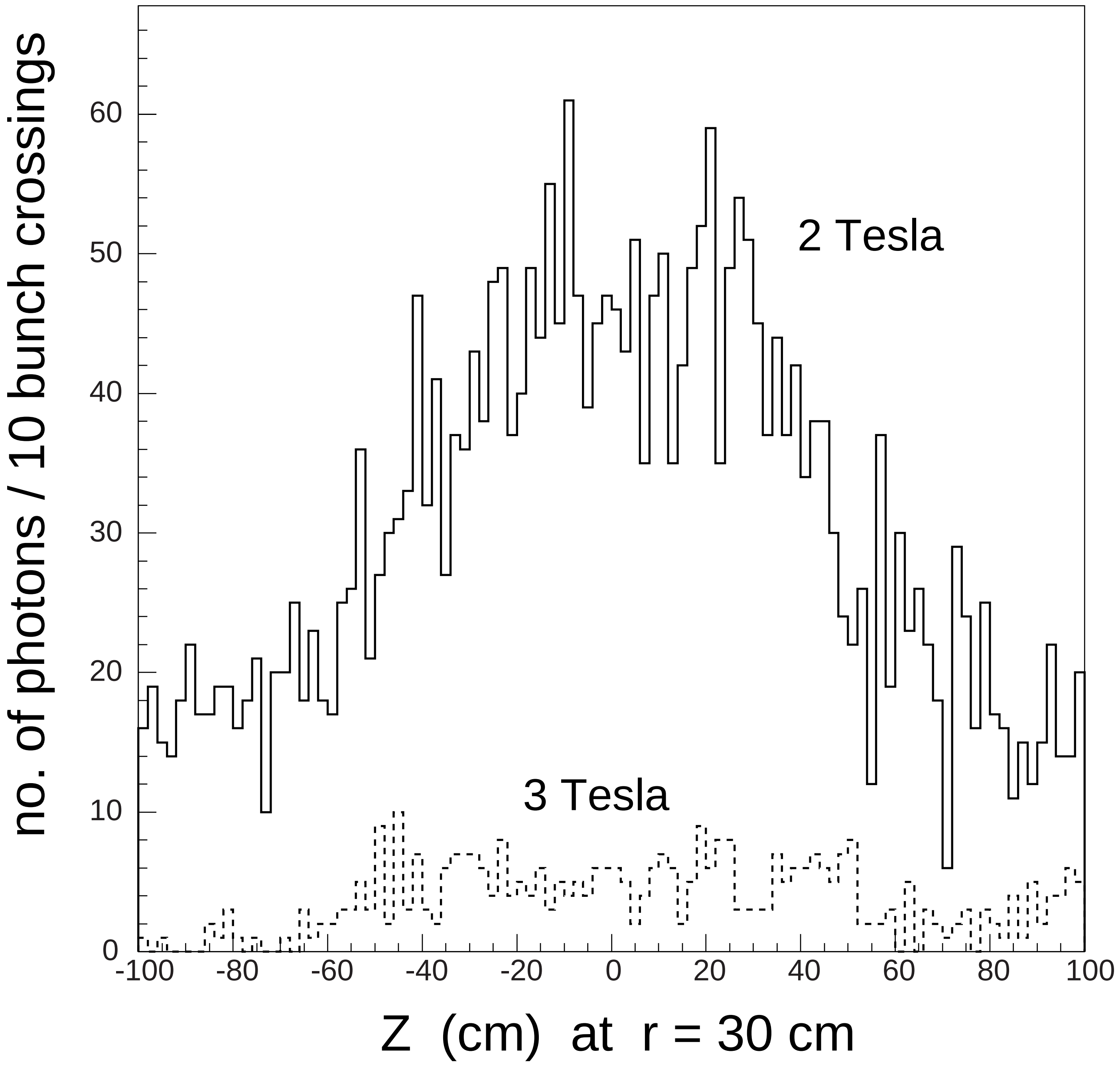

Support tube
Luminosity Monitor
Carbon Mask
θ = 0.2
θ = 0.15
Intermediate tracker
θ = 0.05
Vertex detector
QC1
30cm
Pair Monitor
SC Compensation magnet
200cm



1/100 bunch and E_γ>100MeV, E_e>10MeV for display purpose

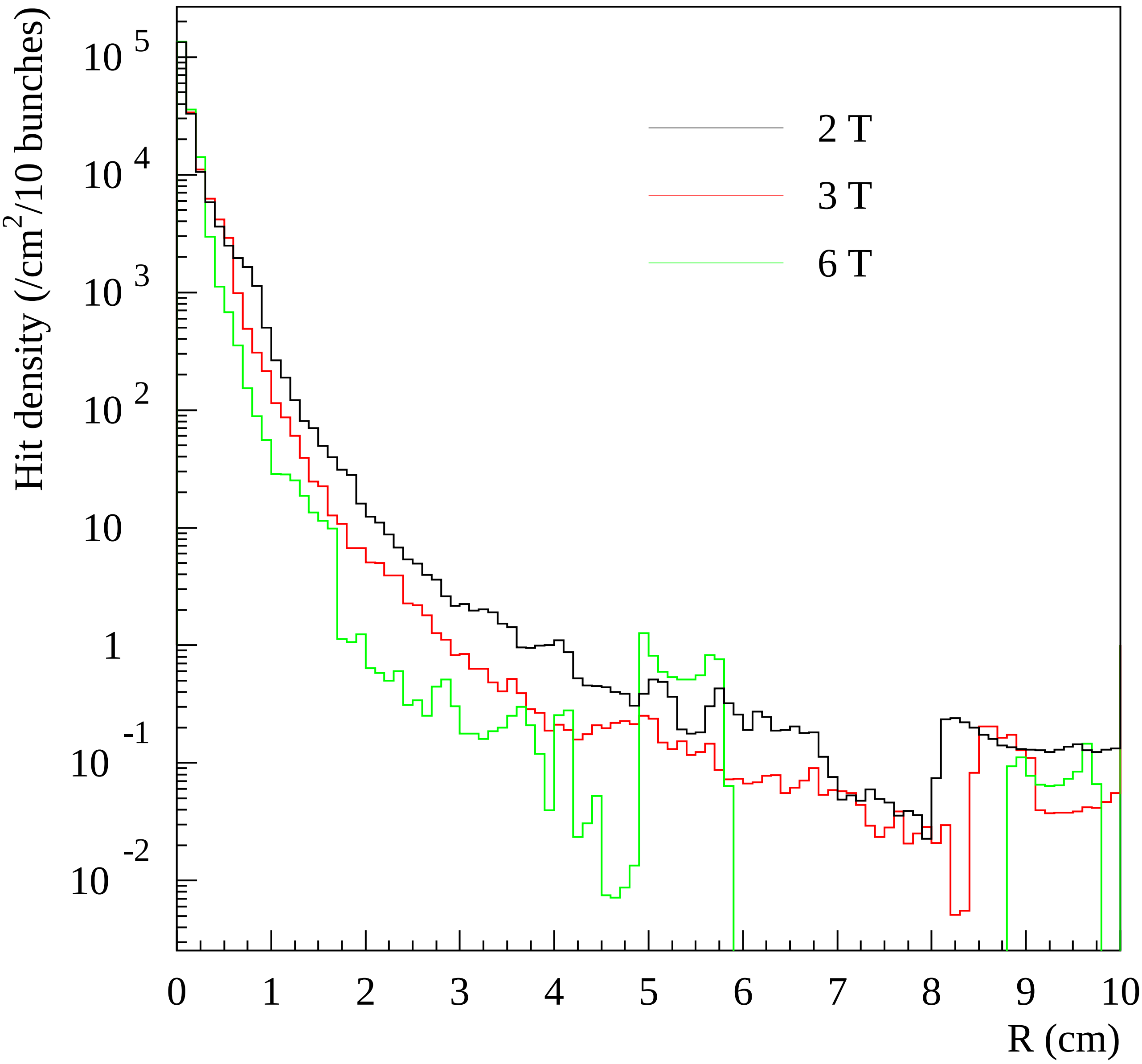
JIM simulation for E_γ>10keV, E_e>200keV

Photon Background



Vertex detector hit density in stronger B fields

$\cos\theta < 0.9$



Summary of pair backgrounds

Blue numbers are those of JLC parameter-Y.

name	r	z	B=2 Tesla	B=3 Tesla
	cm	cm	per 10 bunch	crossings*
no. of γ's	30.	±100	3076	371
			6082	946
hits:vtx-1	2.5	±7.5	2186,	900,
			0.9/mm^2/train	0.4/mm^2/train
			3279,	1205,
			2.8/mm^2/train	1.0/mm^2/train
vtx-2	5.0	±15.0	720	104
			920	306
vtx-3	7.5	±22.5	406	34
			545	138
CDC	45~230	±230	121 (101)	12 (9)
			235 (194)	37 (28)
			hit#(track#)	hit#(track#)

* 190 bunches/train for Y while 95 bunches/train for A.

Summary of pair backgrounds

Beam pipe with 1cm radius and Be-500 μm thickness at IP

name	r	z	B=2 Tesla	B=3 Tesla
	cm	cm	per 10 bunch	crossings
no. of γ's	30.	±100	11140	5857
				1626
hits:vtx-1	1.5	±4.5	10244,12/mm^2	3065,3.6/mm^2
	1.8	±5.4		1906,1.6/mm^2
vtx-2	2.5	±7.5	1988	680
				804
vtx-3	5.0	±15.0	600	402
				208
CDC	45~230	±230	420(375)	259(217)
				72(63)
			hit#(track#)	hit#(track#)

Green numbers with 3cmϕ beam pipe.

Background tolerance

(1) CDC   10 % occupancy / train

r_{min} \ B	2 tesla	3 tesla
2.5 cm hit#/train	△ 1.2 k (2.4 k)	◎ 0.12 k (0.37 k)
1.8 cm		○ 0.72 k
1.5 cm hit#/train	× 4.2 k	× 2.6 k

(2) VTX   1hit / mm^2 / train

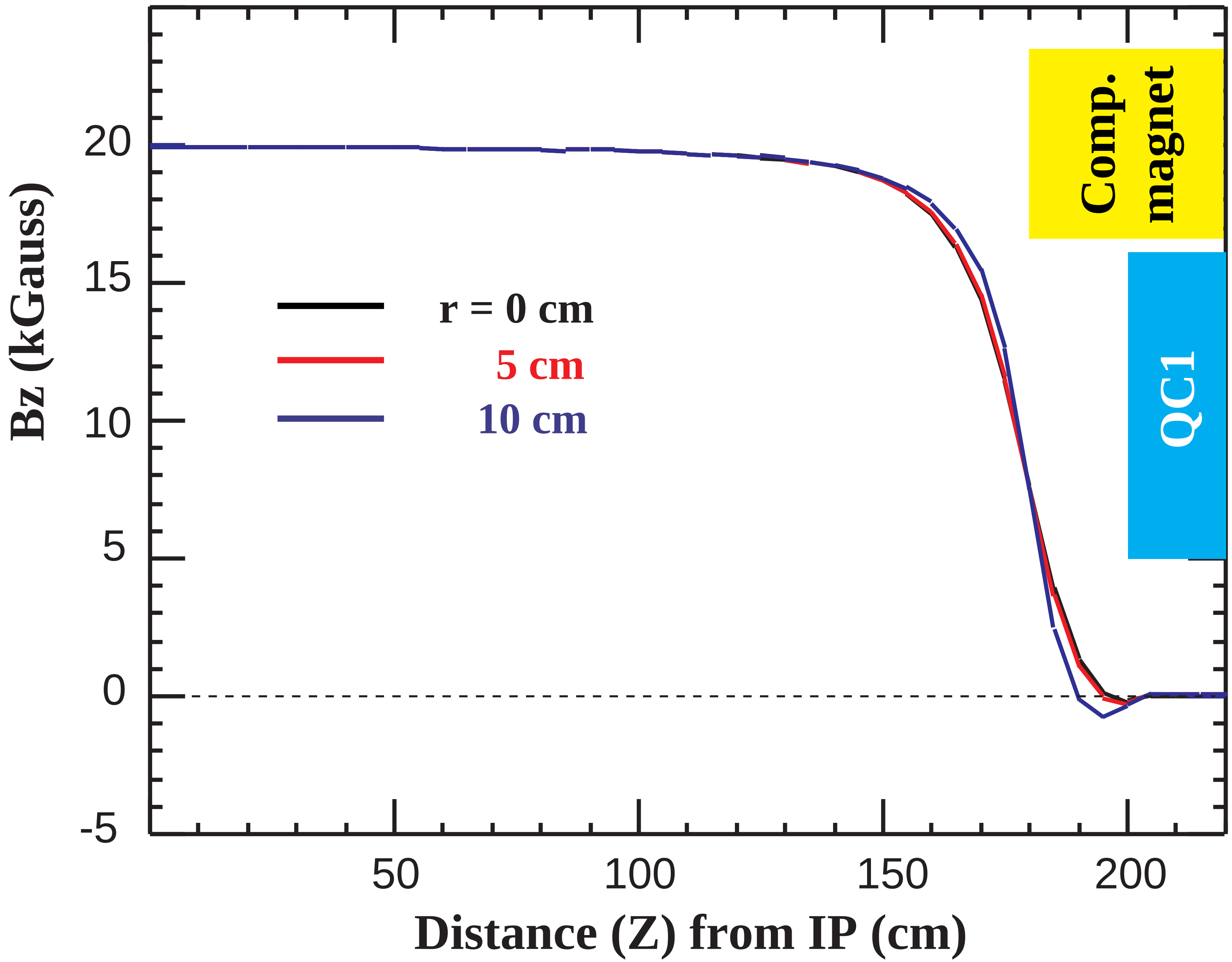
r_{min} \ B	2 tesla	3 tesla
2.5 cm hit#/mm^2/train	○ △ 0.9 (2.8)	◎ 0.4 (1.0)
1.8 cm		△ 1.6
1.5 cm hit#/mm^2/train	× 4.3	× 3.6

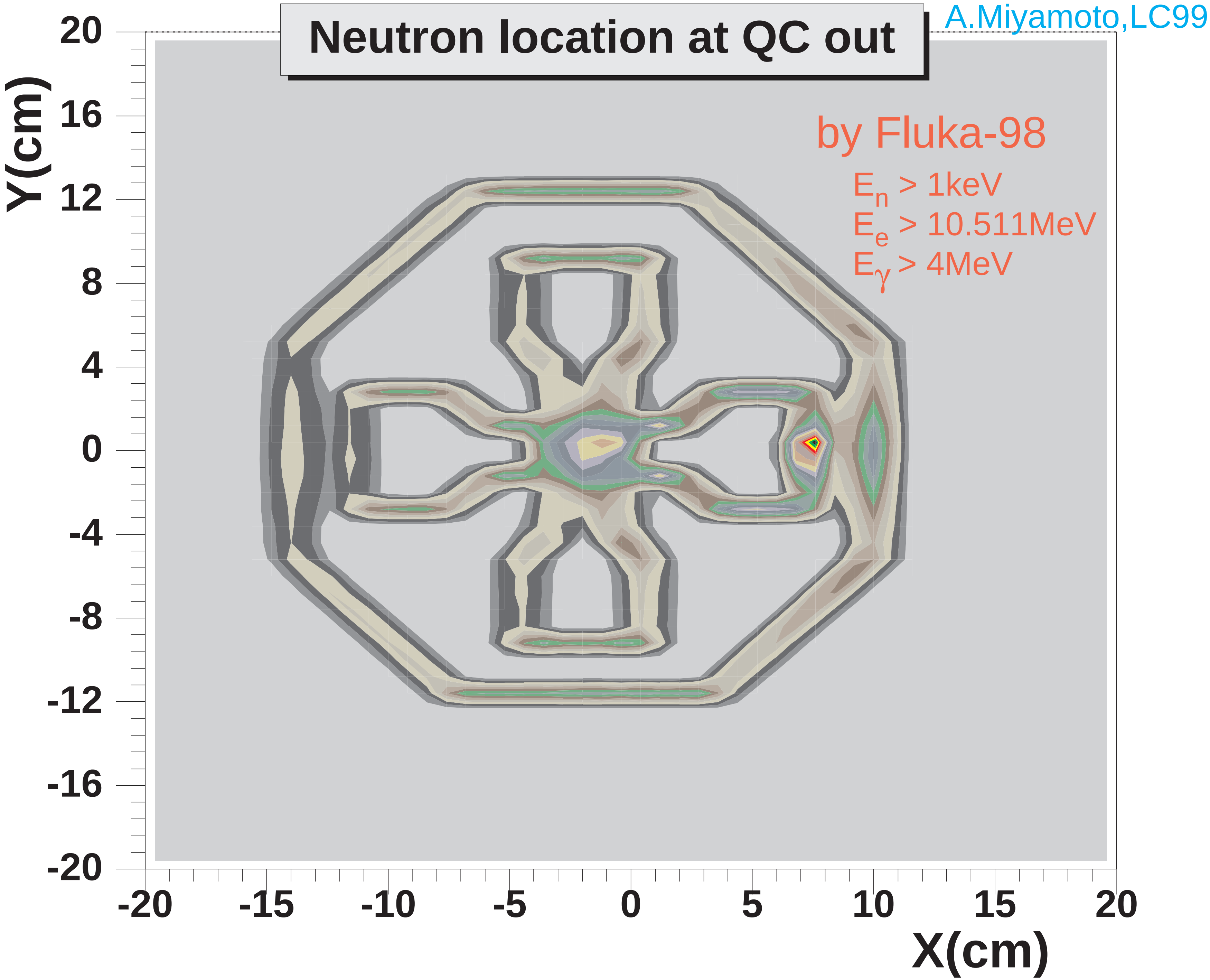
Values in ( ) are those of JLC-Y (high luminosity).

4,3 and 2cmϕ beam pipes for r_{min}=2.5,1.8 and 1.5 cm, respectively.

Magnetic field(Bz) distribution

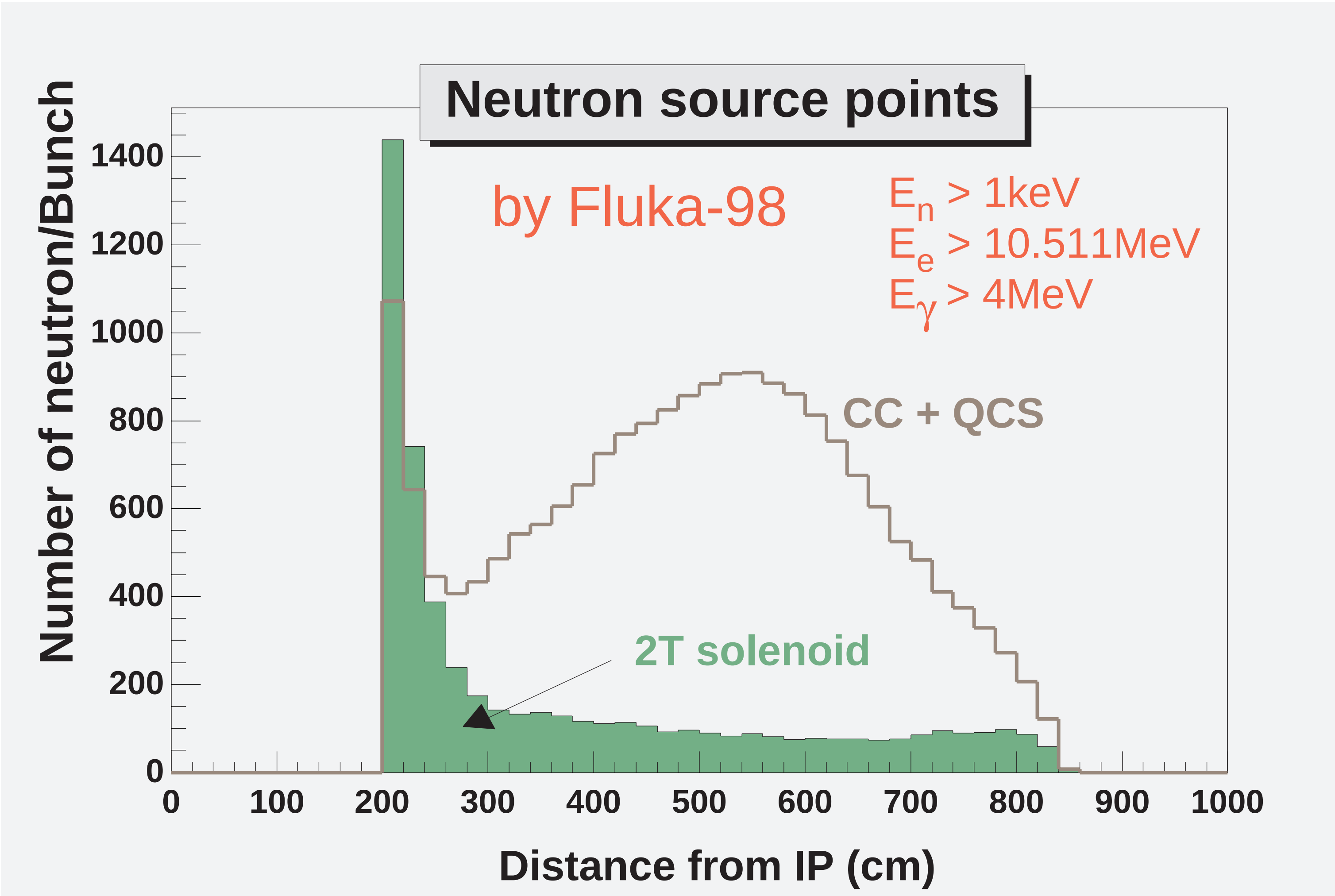
A.Miyamoto, LC99, Oct.,1999





Neutron location at QC out
A.Miyamoto,LC99
by Fluka-98
E_n > 1keV
E_e > 10.511MeV
E_γ > 4MeV
Y(cm)
X(cm)
20
16
12
8
4
0
-4
-8
-12
-16
-20
-15
-10
-5
5
10
15

A.Miyamoto, LC99, Oct.,1999



A.Miyamoto, LC99, Oct.,1999

Summary of Neutron Background in VTX

		Neutron yield at IP($/cm^2$ /year)
e^+e^-:	Old (GEANT)	$3x10^7$
	New(Fluka98) w 2T solenoid	$5\ x10^7$
	New(Fluka98) w. CC and QC	$7\ x10^7$
beamstrahlung: from beam dump(340kW) (300m from IP)	Old(GEANT)	$1x10^7$
	New(Fluka98)	$2.5x10^7$

Statistical error of new estimate is roughly a few x 10^7 (guess)

New estimatebased on Fluka98 is well below the requirement,

$< 1.5x10^{10}\ n/cm^2$

for the CCD vertex detector

Neutron background from other sources in dump line are under study.

Pair Monitor

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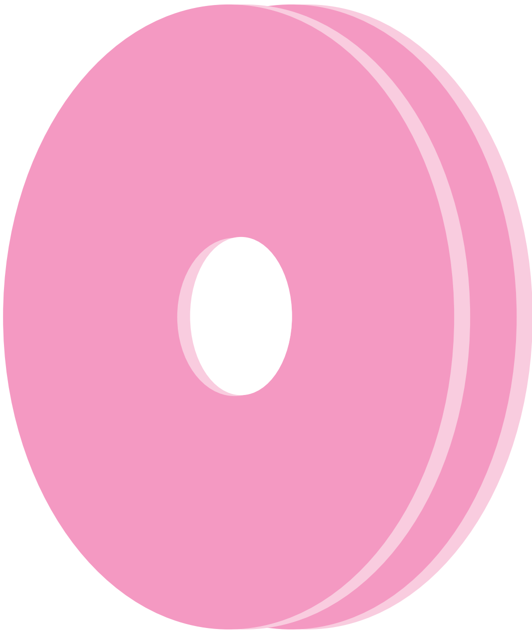

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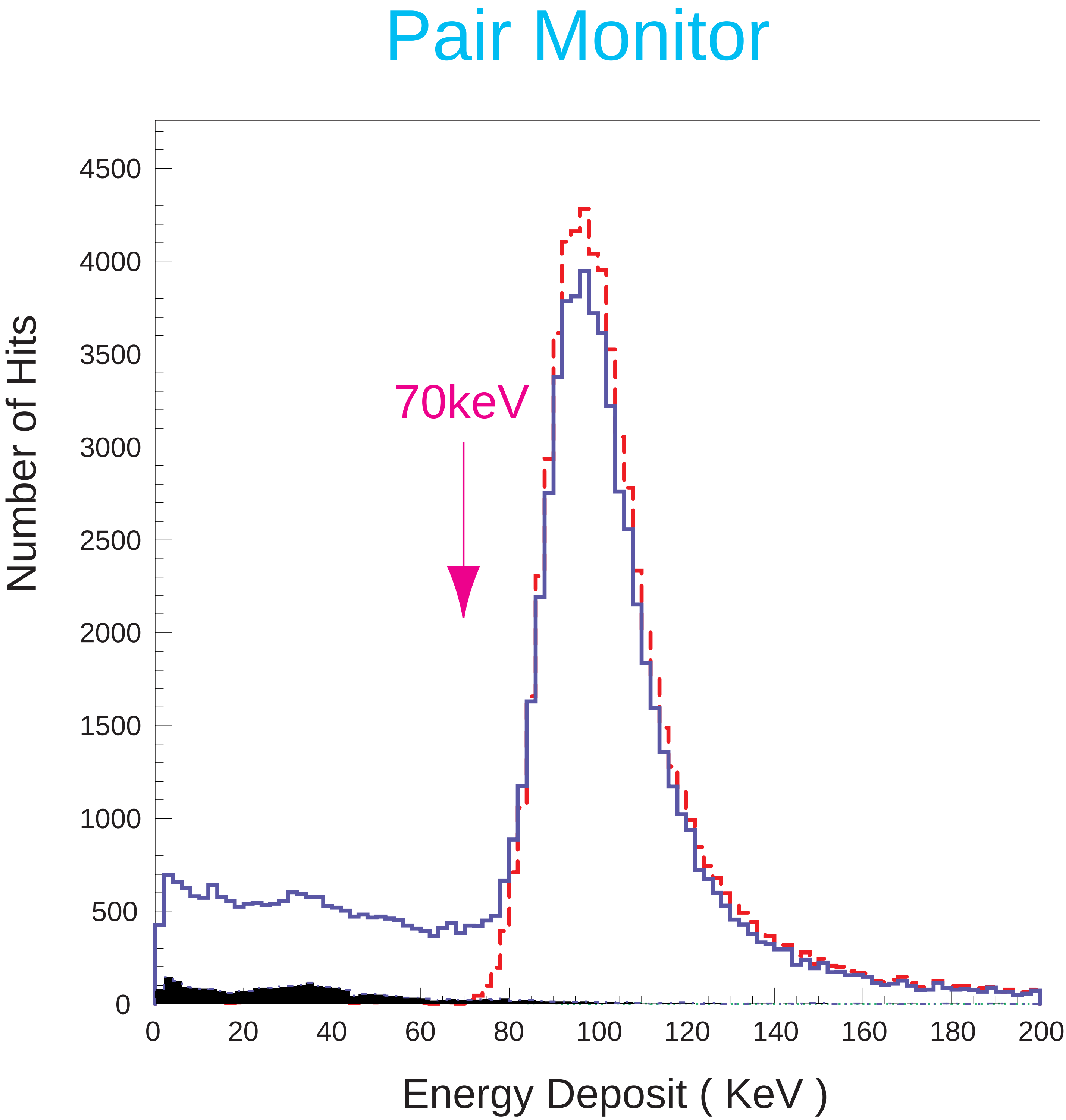
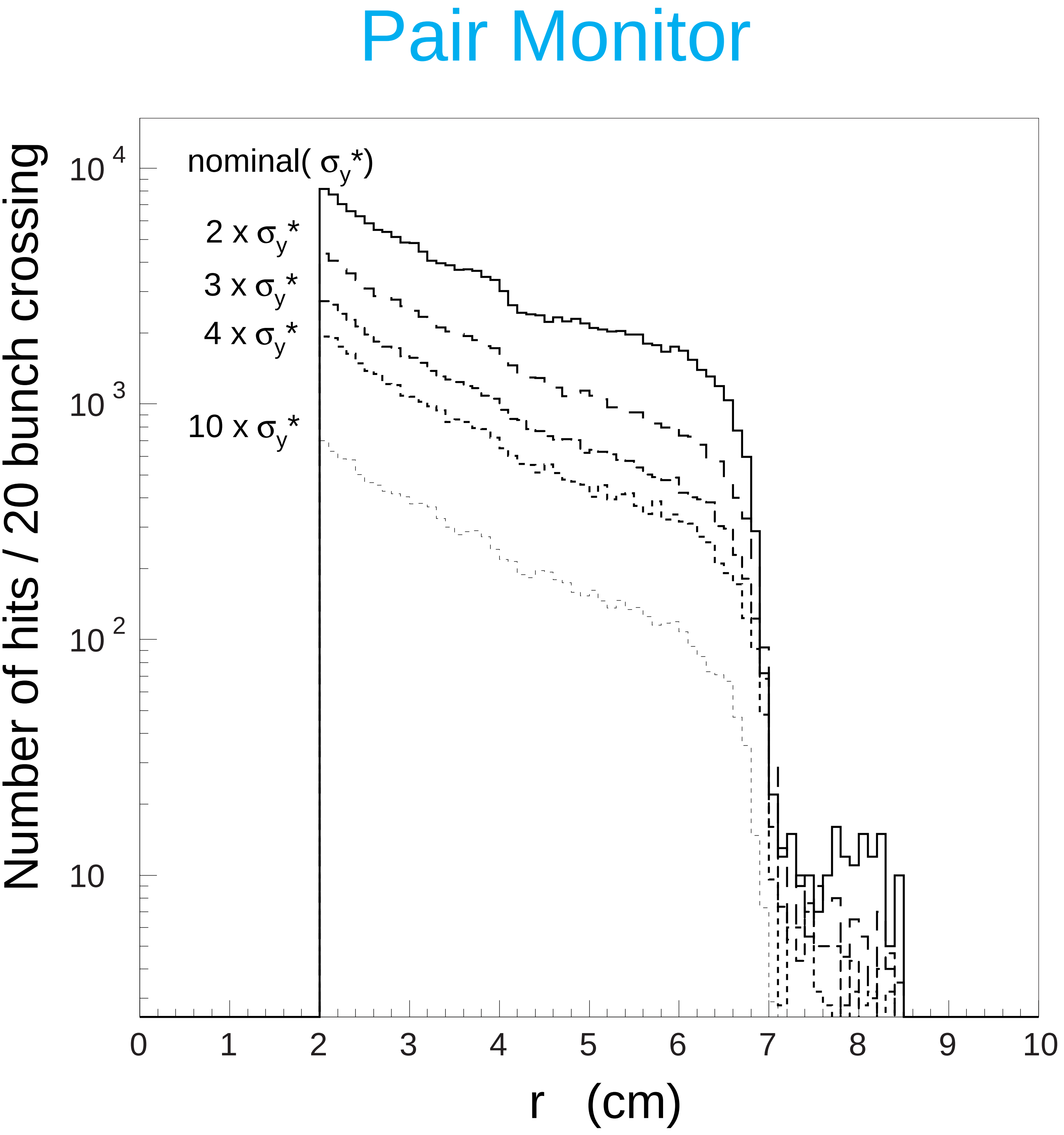
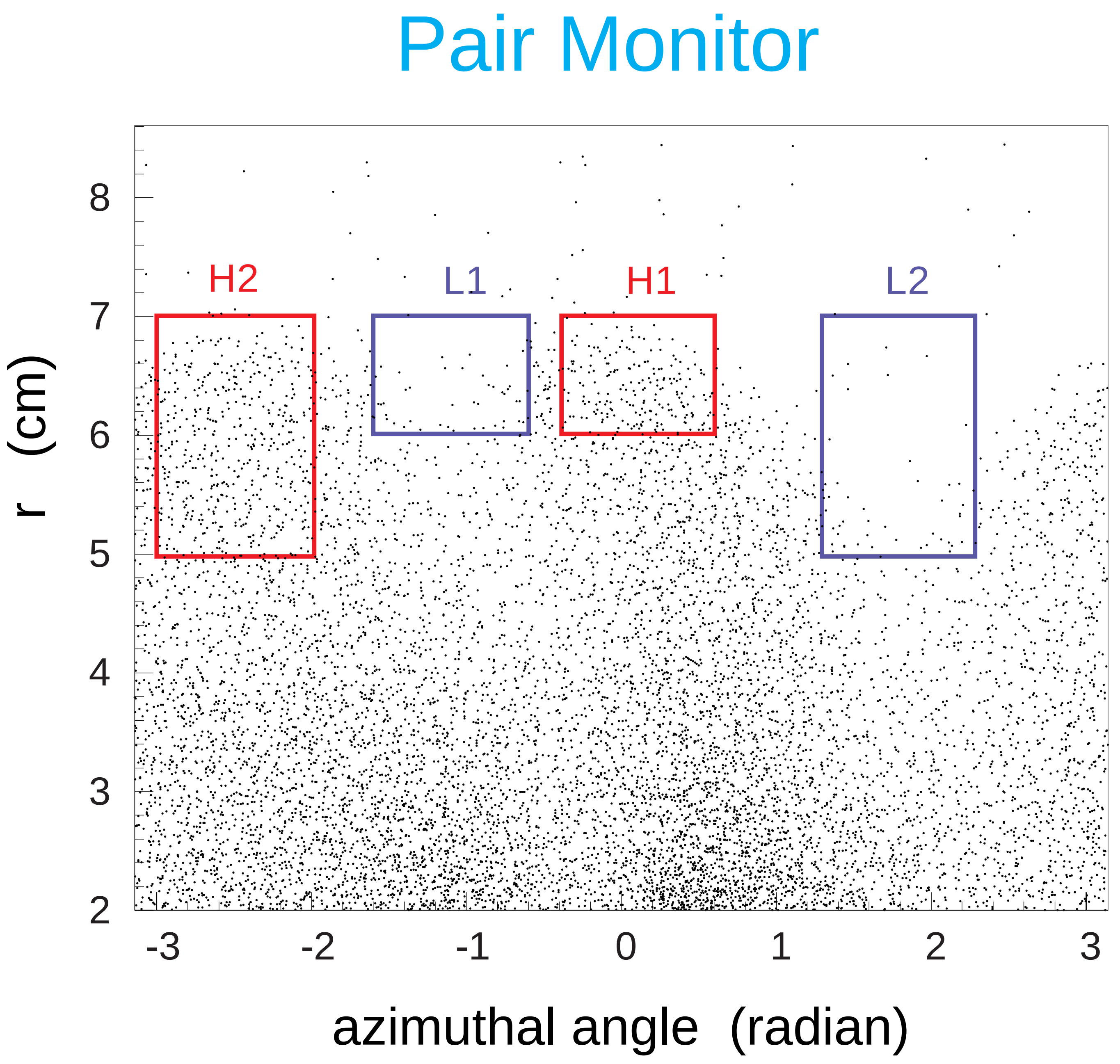


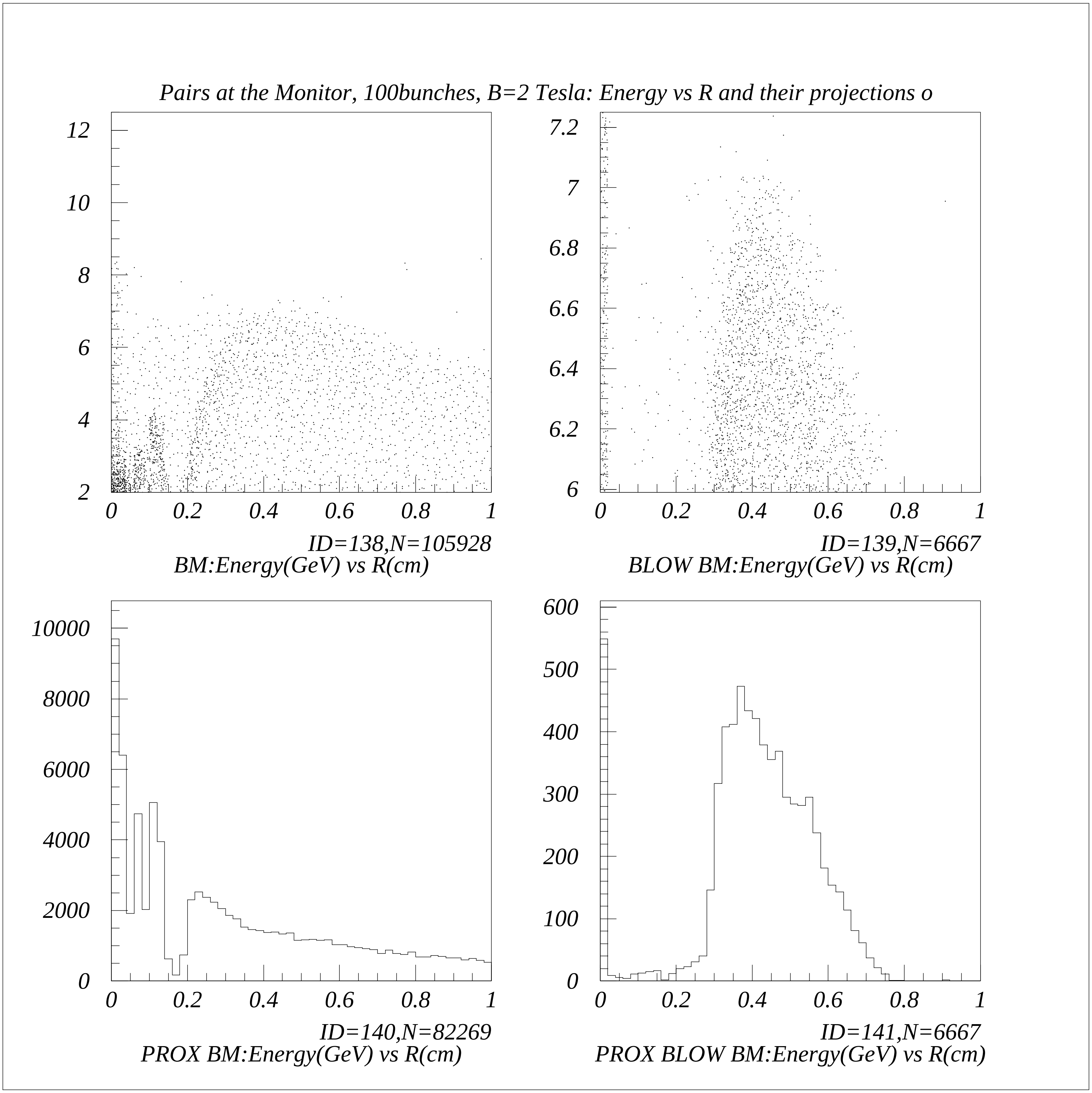
Pair Monitor
70keV
Number of Hits
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140
160
180
200
Energy Deposit (KeV)



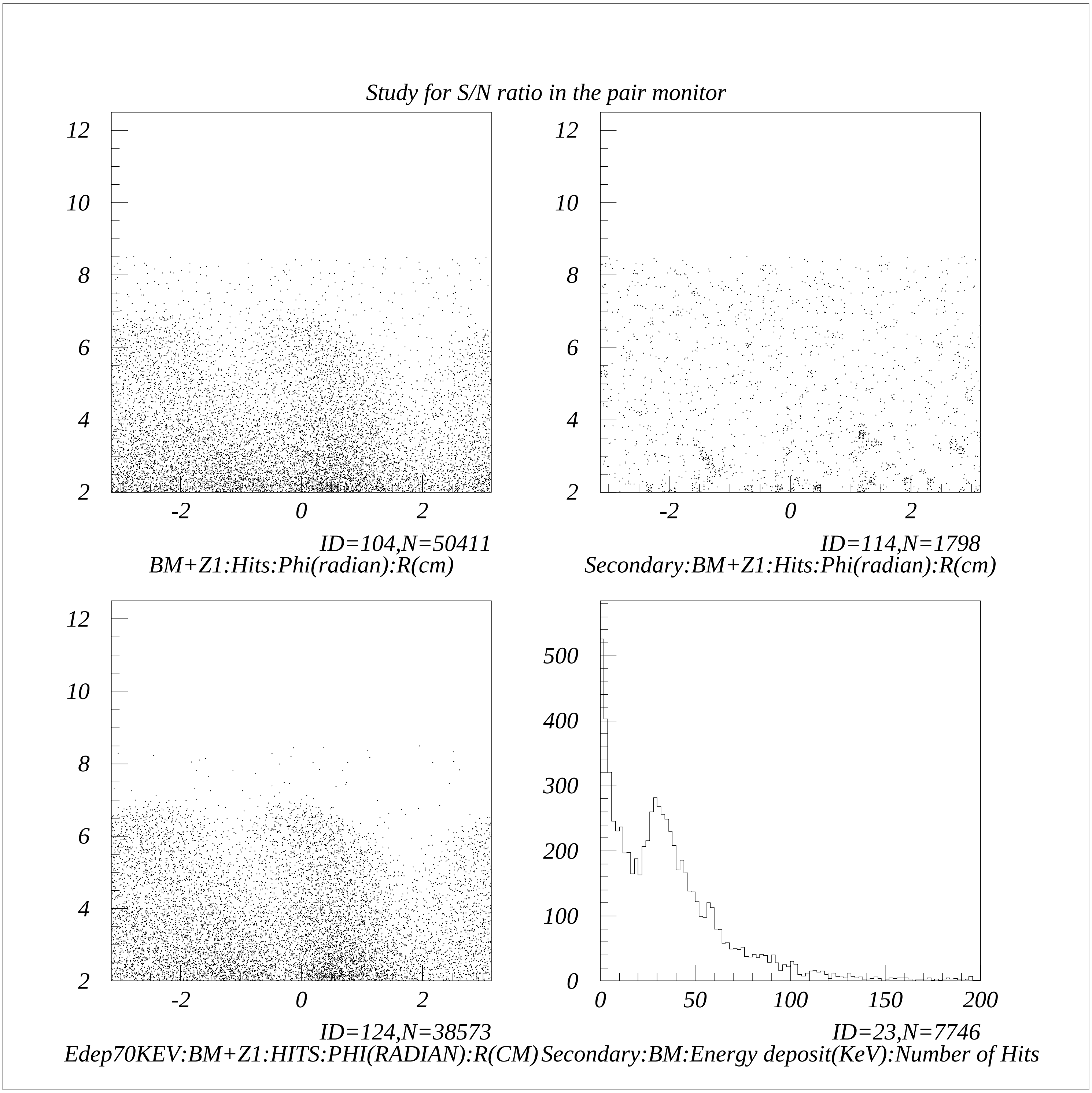
Pair Monitor
nominal(σ_y*)
2 x σ_y*
3 x σ_y*
4 x σ_y*
10 x σ_y*
Number of hits / 20 bunch crossing
r (cm)

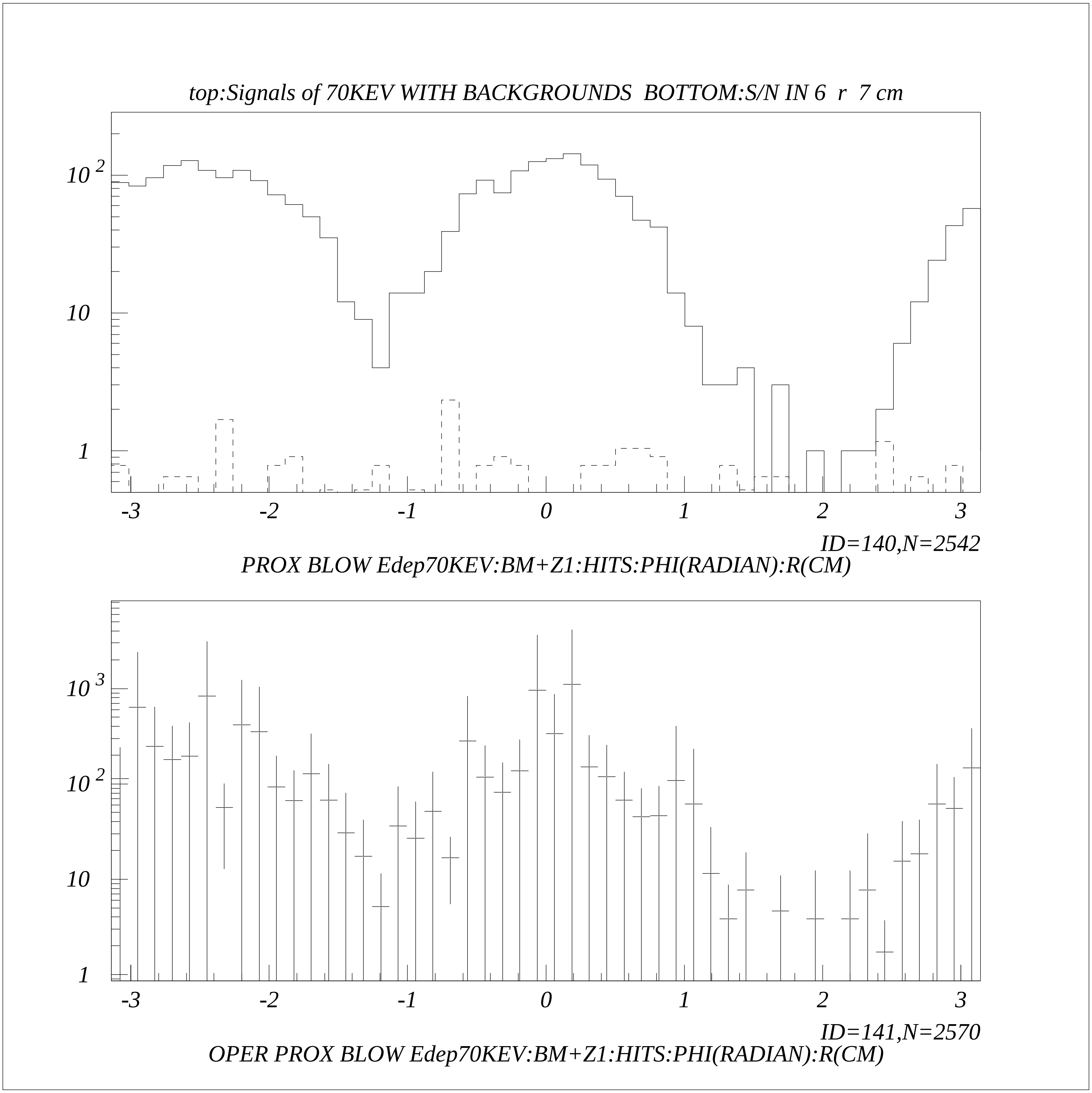


Pair Monitor
H2
L1
H1
L2
8
7
6
5
4
3
2
-3
-2
-1
0
1
2
3
r (cm)
azimuthal angle (radian)

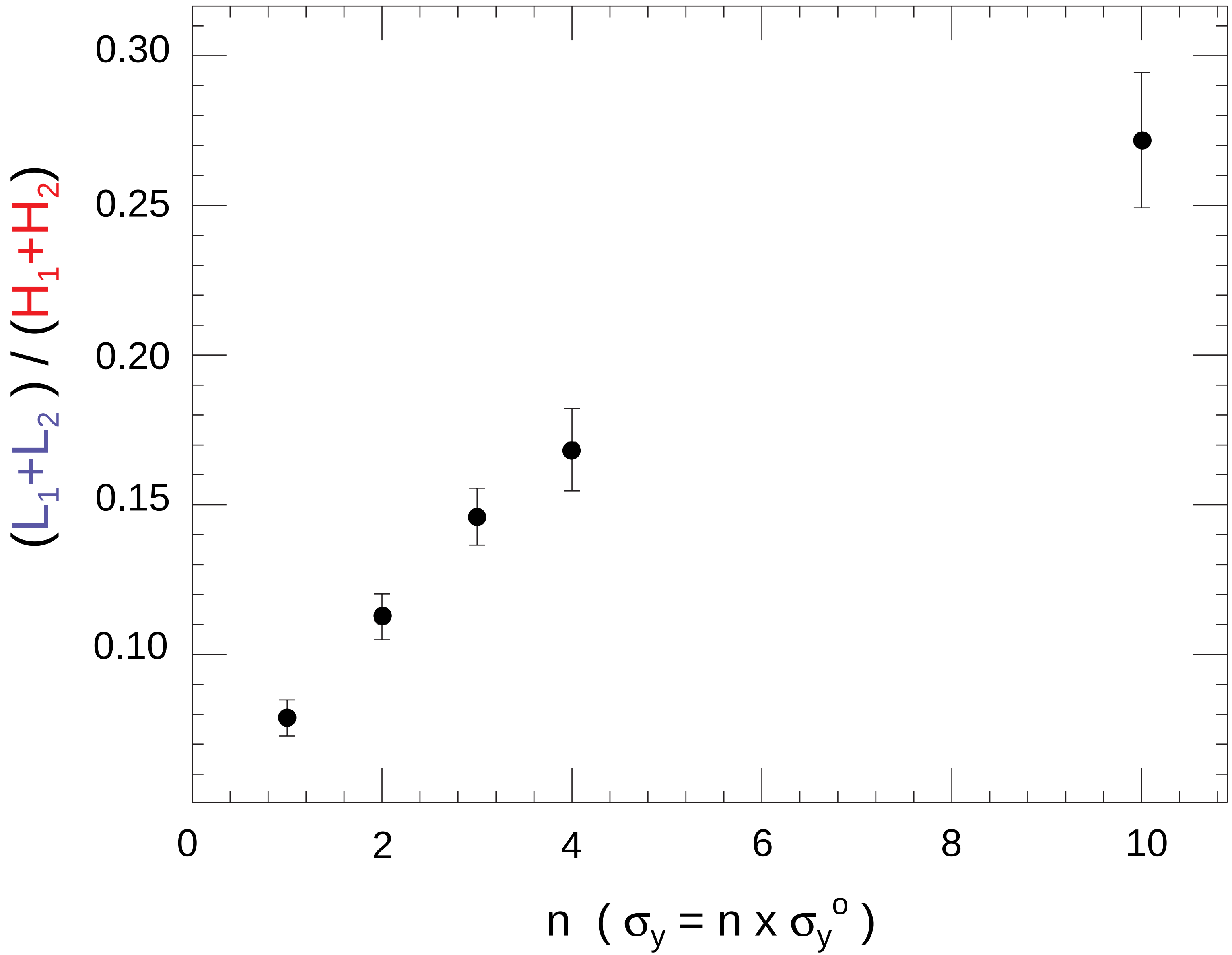


Pairs at the Monitor, 100bunches, B=2 Tesla: Energy vs R and their projections o
ID=138,N=105928
BM:Energy(GeV) vs R(cm)
ID=139,N=6667
BLOW BM:Energy(GeV) vs R(cm)
ID=140,N=82269
PROX BM:Energy(GeV) vs R(cm)
ID=141,N=6667
PROX BLOW BM:Energy(GeV) vs R(cm)


Study for S/N ratio in the pair monitor
ID=104,N=50411
BM+Z1:Hits:Phi(radian):R(cm)
ID=114,N=1798
Secondary:BM+Z1:Hits:Phi(radian):R(cm)
ID=124,N=38573
Edep70KEV:BM+Z1:HITS:PHI(RADIAN):R(CM)
ID=23,N=7746
Secondary:BM:Energy deposit(KeV):Number of Hits


top:Signals of 70KEV WITH BACKGROUNDS BOTTOM:S/N IN 6 r 7 cm
ID=140,N=2542
PROX BLOW Edep70KEV:BM+Z1:HITS:PHI(RADIAN):R(CM)
ID=141,N=2570
OPER PROX BLOW Edep70KEV:BM+Z1:HITS:PHI(RADIAN):R(CM)

Pair Monitor



Pixel Beam Profile Monitor for Linear Collider

A. Miyamoto, Y. Sugimoto, T. Tauchi, K. Yokoya
High Energy Accelerator Research Organization (KEK)

G. Alimonti, T. Browder, C. Kenney, S. Olsen, S. Parker,
M. Rosen, K. Travelsi, G. Varner, H. Yamamoto
The University of Hawaii

1 Introduction

At linear colliders, it is expected that a large number of e^-e^+ pairs are created by the QED process $\gamma\gamma \to e^+e^-$ where γ may be off-shell or near-on-shell[1]. Depending on the number of off-shell photons involved, they are classified as Landau-Lifshitz (both off-shell), Bethe-Heitler (one of them is off-shell), and Breit-Wheeler (both near-on-shell). These pairs are predominantly created along the beamline, and acquires p_t kick by the electromagnetic field of the on-coming bunch. As long as the pair is relativistic and the direction is the same as the co-moving bunch, the net force due to the co-moving bunch $\pm e(\vec{E} + \vec{\beta} \times \vec{B})$ cancels out ($\vec{\beta}$ is the velocity of the pair particle in unit of c). One then only needs to consider the effect of the on-coming beam (Figure 1).

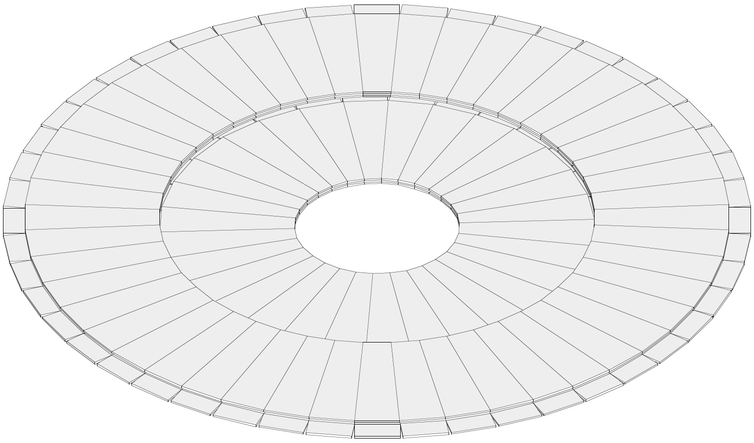
Typical parameters of the bunch is $\sigma_x/\sigma_y/\sigma_z = 260\text{nm}/3\text{nm}/80\mu\text{m}$, and the number of particles per bunch N is $\sim 10^{10}$. If we assume a rectangular beam of $2\sigma_x \times 2\sigma_y \times 2\sigma_z$ with uniform charge density and $\sigma_y \ll \sigma_x$, this creates

$$E(\text{dyne/esu}) = B(\text{gauss}) = \frac{\pi e N}{2\sigma_x\sigma_z} \sim 3.6 \times 10^7 \qquad (1)$$

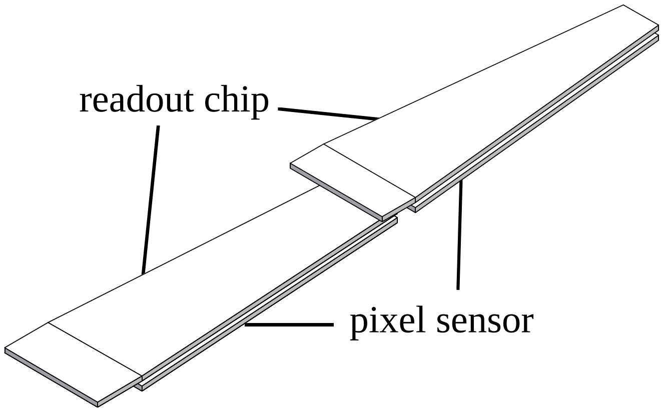
just above or below the on-coming bunch in the laboratory frame. For the typical value of $p = 300$ MeV/c, the curvature due to both E and B fields is about 170μm which can be compared to the bunch length of 80μm. If the charge of the particle and the on-coming bunch are opposite sign, the created particle would undergo a number of oscillations around the beam plane and the net p_t acquired will be small. On the other hand, if the particle and the

Pixel Beam Profile Monitor

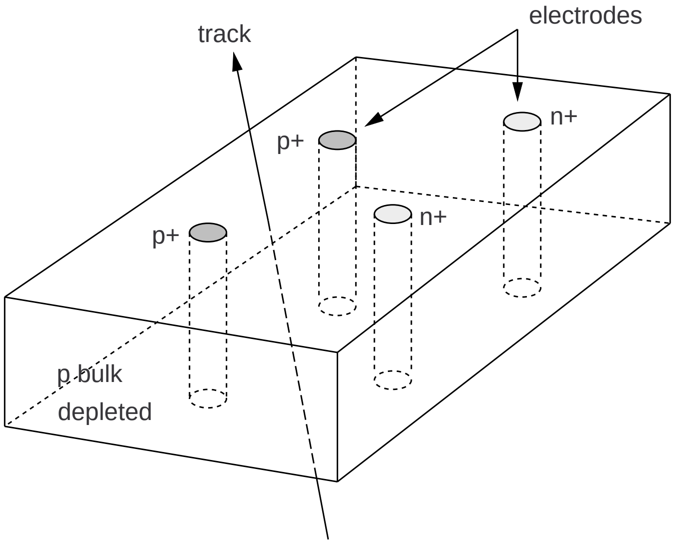
H. Yamamoto et al., University of Hawaii



The sensor arrangement; the top side faces the IP.



One 'segment' ; the bottom side faces the IP.



Schematic diagram of the 3D pixel concept

3D Pixel

1. Fast charge collection
   < 1 nsec :bunch separation
2. Radiation hard
   >>50kRad/year,10^7n/cm^2/year
3. Flexible geometry
4. Active edge