JLC IP layout/issues

LCWS99, Sitges, Barcelona, Spain, April 30, 1999
T. Tauchi (KEK)

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1. High luminosity (upgrade senario)

2. Beam collimation and muon background

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Possibility of JLC Luminosity Upgrade

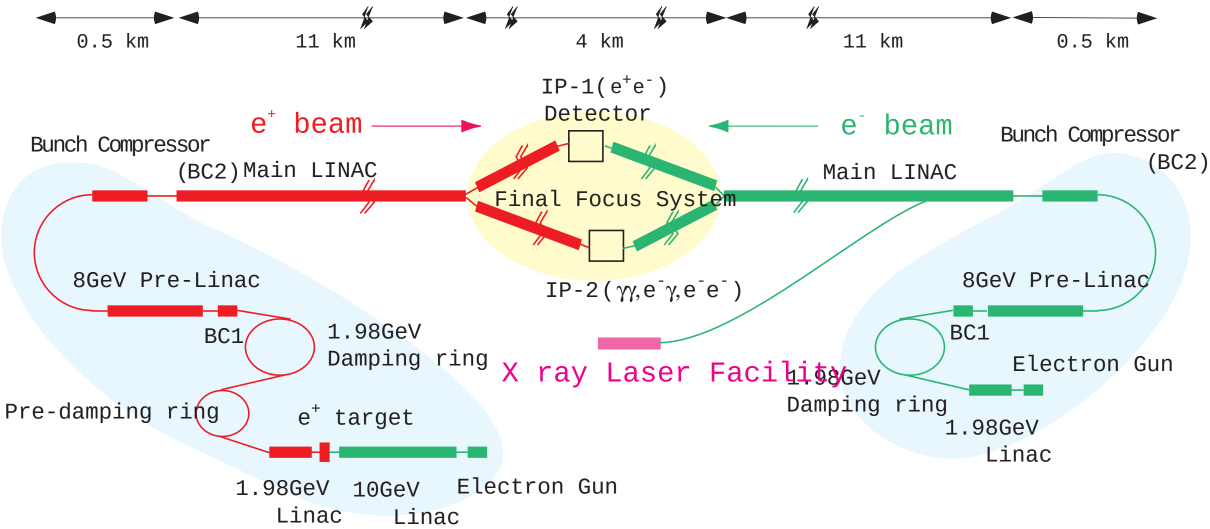
K. Yokoya, KEK, Mar. 17, 1999, ACFA

At E_{CM} = 500GeV,

JLC:L=0.9x10^{34} v.s. TESLA:L=4x10^{34}

JLC is lazy? TESLA is crazy?

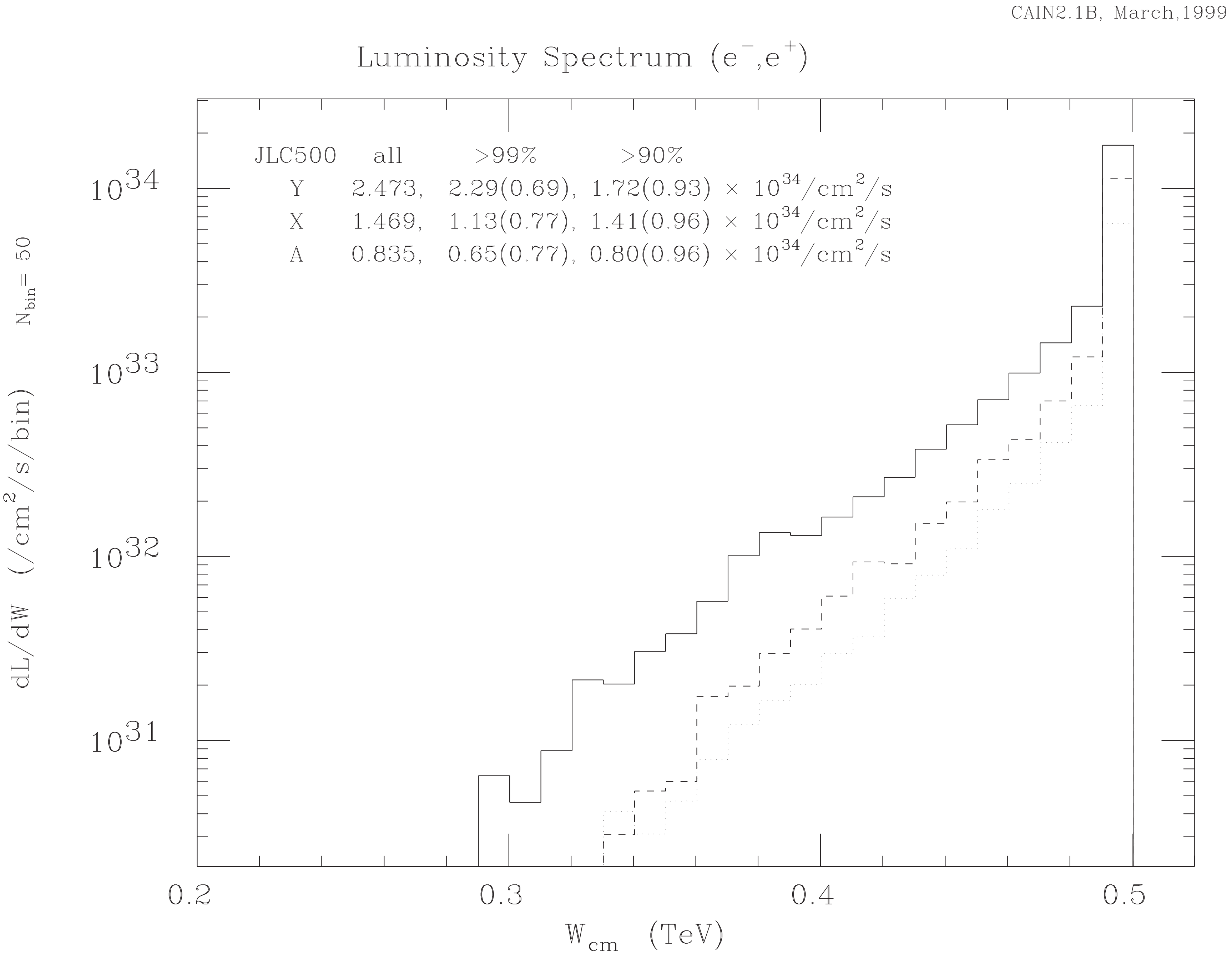
- Think of Luminosity Upgrade of JLC
- E_{CM} 500GeV only



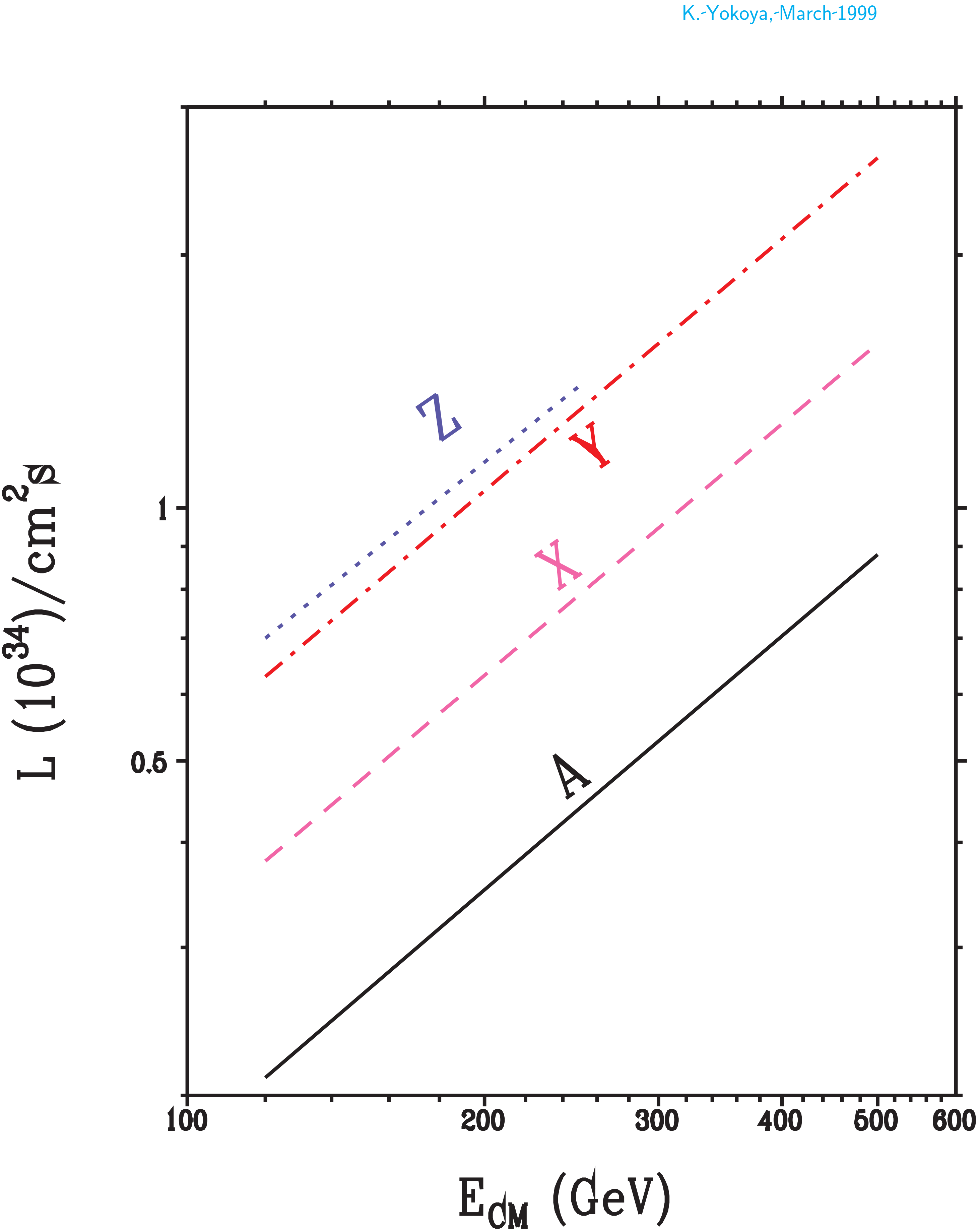
K. Yokoya, March 1999

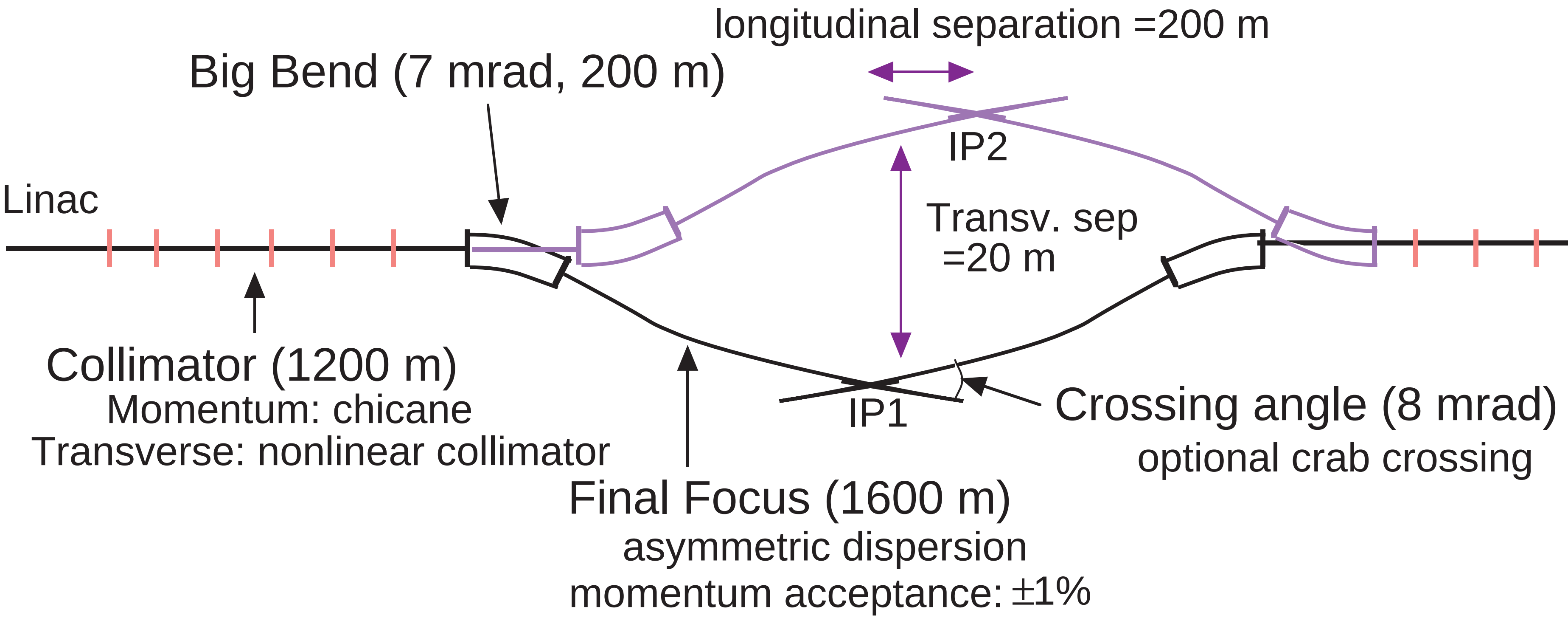
500GeV (CM) Hi-Lum Parameters of JLC

		A	X	Y
Luminosity	$10^{34}/cm^2 s$	0.88	1.57	2.61
Nominal Lum.[3)]	$10^{34}/cm^2 s$	0.63	1.08	1.75
Bunch Population	10^{10}	0.75	0.55	0.70
No. of bunches/pulse		95	190	190
Bunch separation	ns	2.8	1.4	1.4
Linac length/beam[7)]	km	5.21	5.54	5.97
AC power(2 linacs)	MW	117	126	136
Beam power/beam	MW	4.28	6.28	7.99
Loaded gradient[4)]	MV/m	57.6	54.2	50.2
Bunch length σ_z	μm	90	80	80
$\gamma\varepsilon_x$ (DR exit)	10^{6} m	3	3	3
$\gamma\varepsilon_y$ (DR exit)	10^{6} m	0.03	0.02	0.02
$\gamma\varepsilon_x$ (IP)	10^{6} m	4	4	4
$\gamma\varepsilon_y$ (IP)	10^{6} m	0.06	0.04	0.04
Cavity align. tol.[6)]	μm	15	18	14
β^*_x	mm	10	6	6
β^*_y	mm	0.1	0.1	0.1
IP beam size σ^*_x	nm	286	222	222
σ^*_y	nm	3.15	2.86	2.86
Diagonal angle σ^*_x/σ_z	mrad	3.18	2.77	2.77
Disruption param D_x		0.094	0.102	0.130
D_y		7.64	7.89	10.04
Pinch enh. H_D[5)]		1.38	1.45	1.49
Υ_{ave}		0.136	0.146	0.188
δ_{BS}	%	4.42	4.39	6.67
n_γ		1.07	1.01	1.28

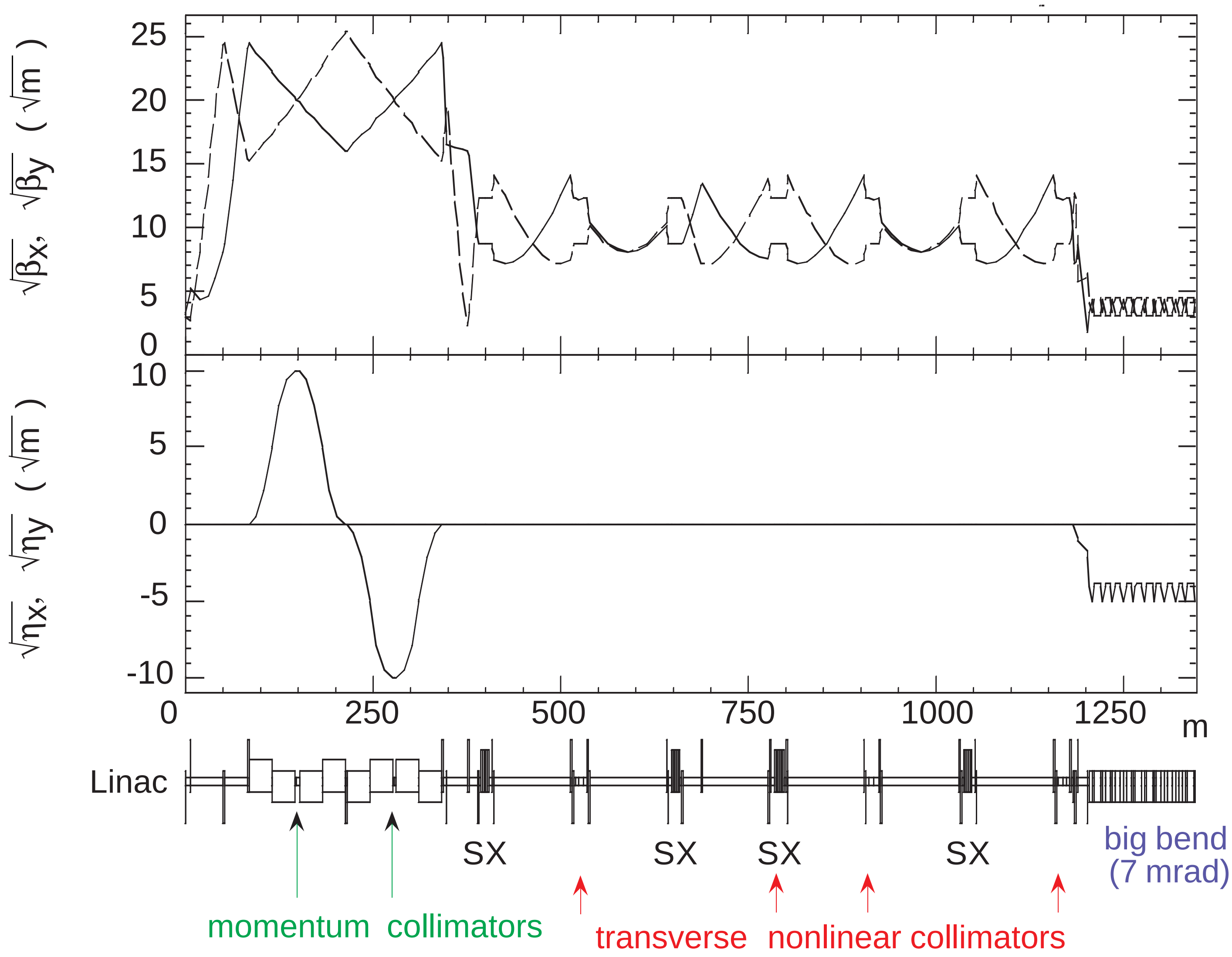


CAIN2.1B, March,1999
Luminosity Spectrum (e−,e+)
JLC500 all >99% >90%
Y 2.473, 2.29(0.69), 1.72(0.93) × 10^34/cm^2/s
X 1.469, 1.13(0.77), 1.41(0.96) × 10^34/cm^2/s
A 0.835, 0.65(0.77), 0.80(0.96) × 10^34/cm^2/s
N_bin= 50
dL/dW (/cm^2/s/bin)
10^34
10^33
10^32
10^31
0.2
0.3
0.4
0.5
W_cm (TeV)


K.-Yokoya,-March-1999
L $(10^{34})/cm^2s$
1
0.5
Z
Y
X
A
100
200
300
400
500
600
E_{CM} (GeV)



Schematic layout of the beam delivery system at JLC

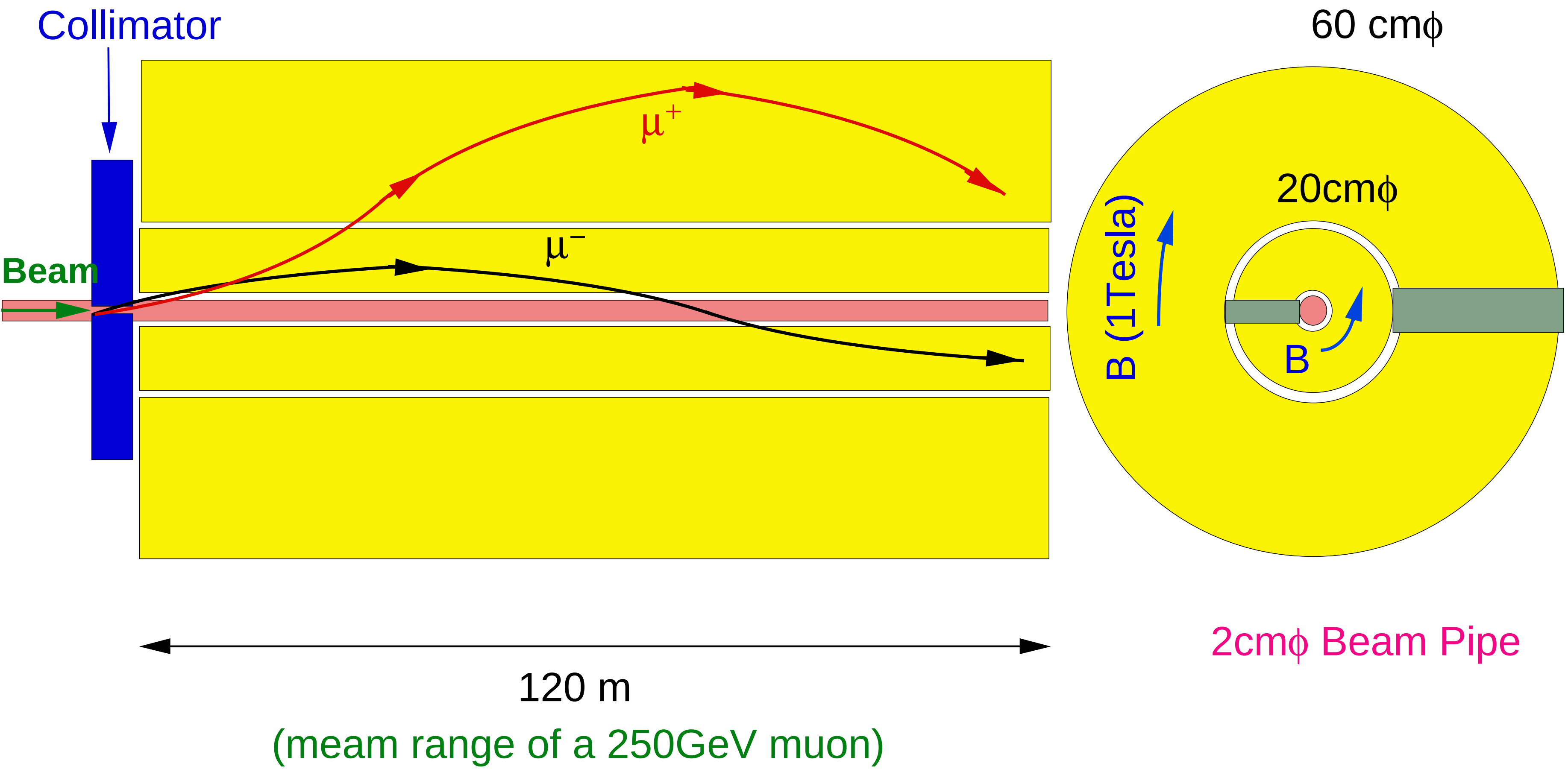


Location of bending magets and collimators

element	s from IP (m)	function
bend1	90	-3.28 mrad
bend2	1600	7 mrad
COLLI1.8	1840.3	x', y' second colli.
COLLI1.7	1966.7	x', y' first colli.
COLLI1.6	2093.1	x, y second colli.
COLLI1.5	2219.5	x, y' first colli.
COLLI1.4	2357.4	momentum second colli.
COLLI1.3	2483.9	momentum first colli.
COLLI1.2	2725.4	(in the linac)
COLLI1	2855.6	(in the linac)

Muon Attenuator

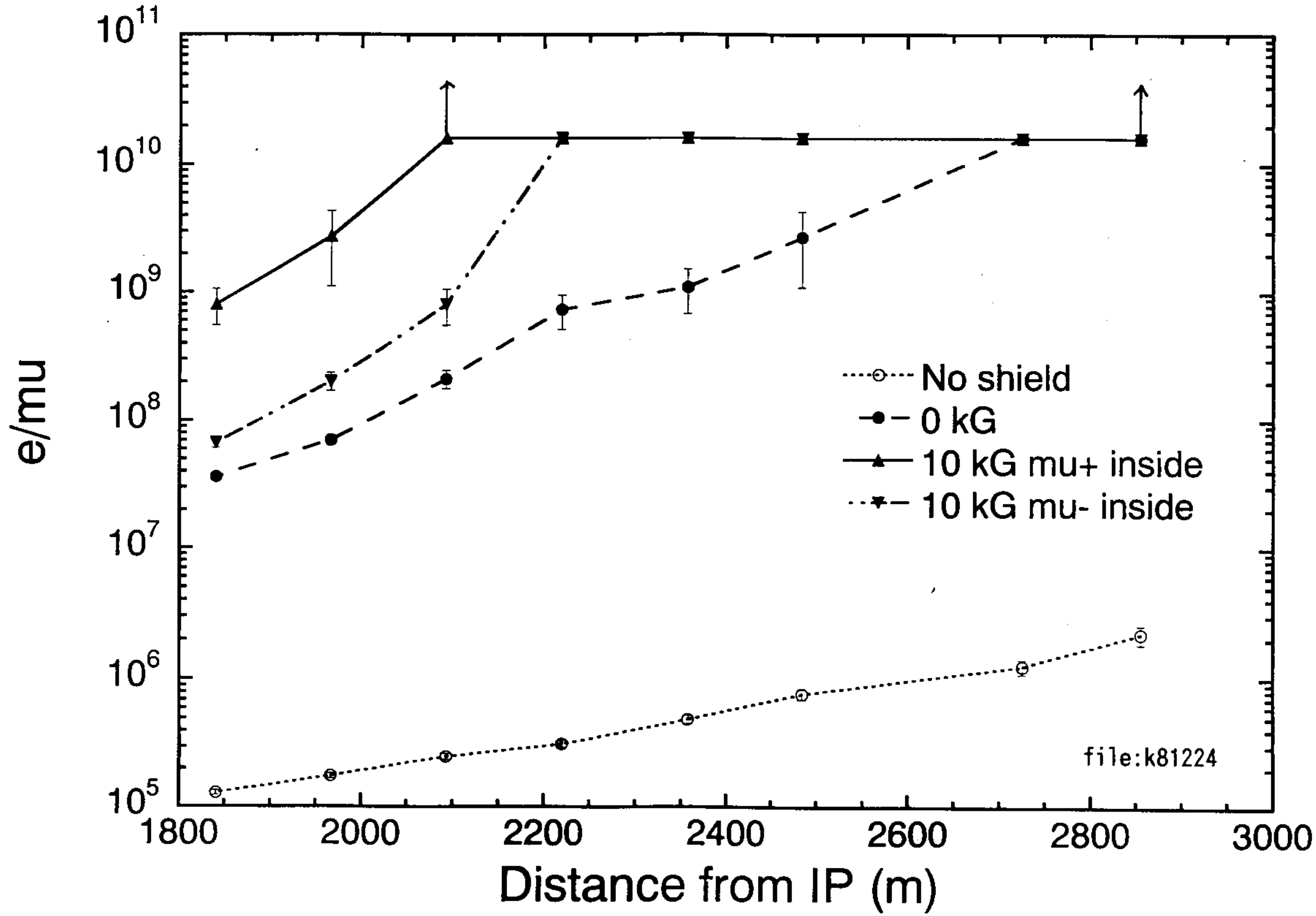
E.A.Kushnirenko, LC92



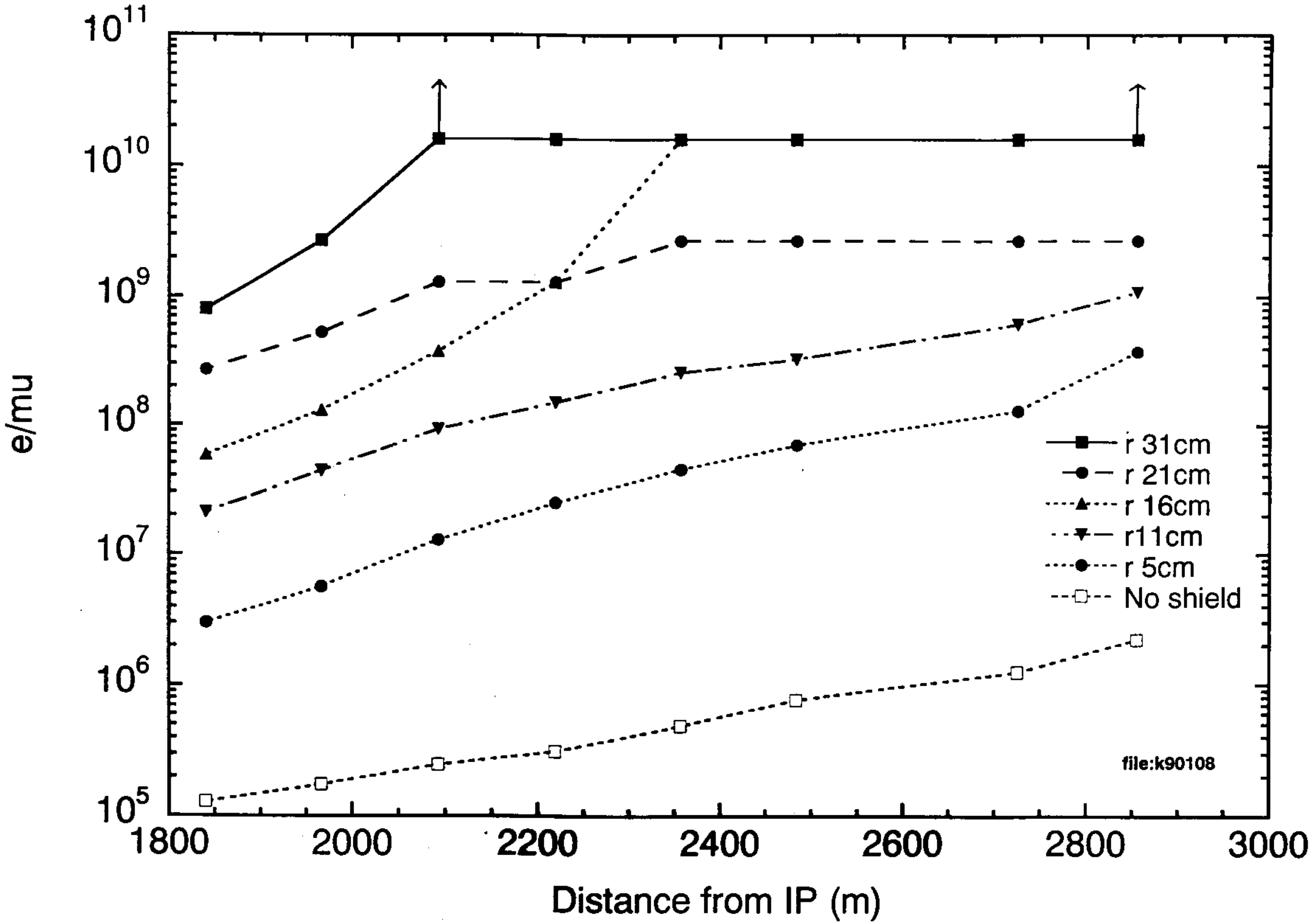
1 Best case: muon attenuator at 1510-2856 m

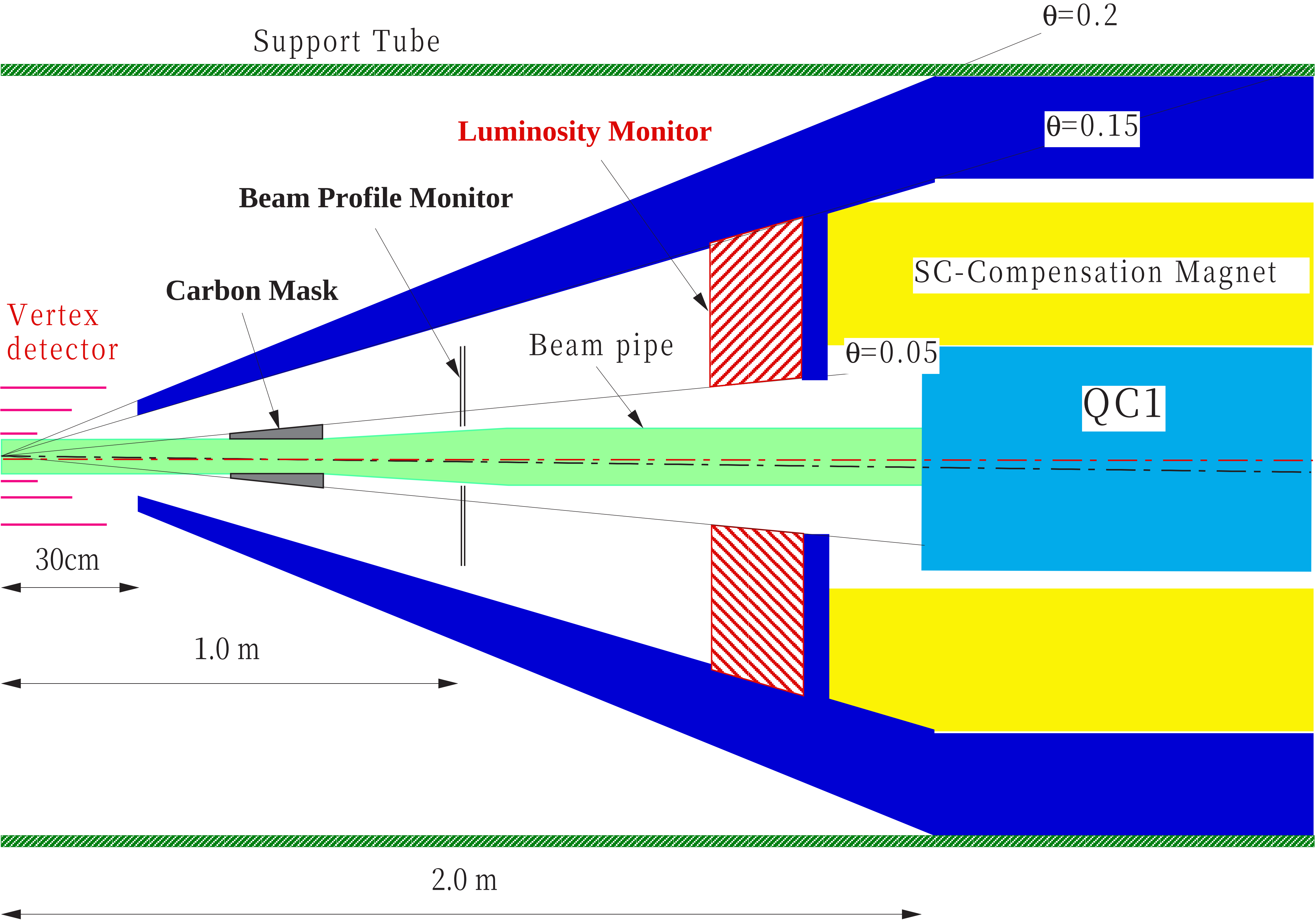
2 Muon attenuator at 1510-2856 m, into the tunnel

[redacted] Y. Namito

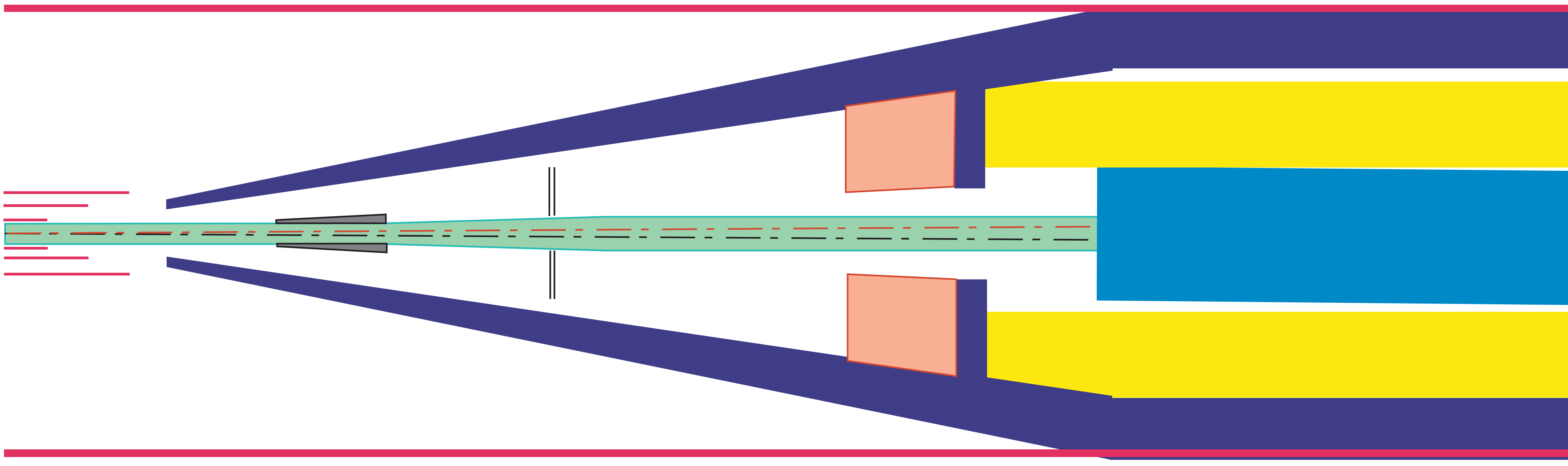


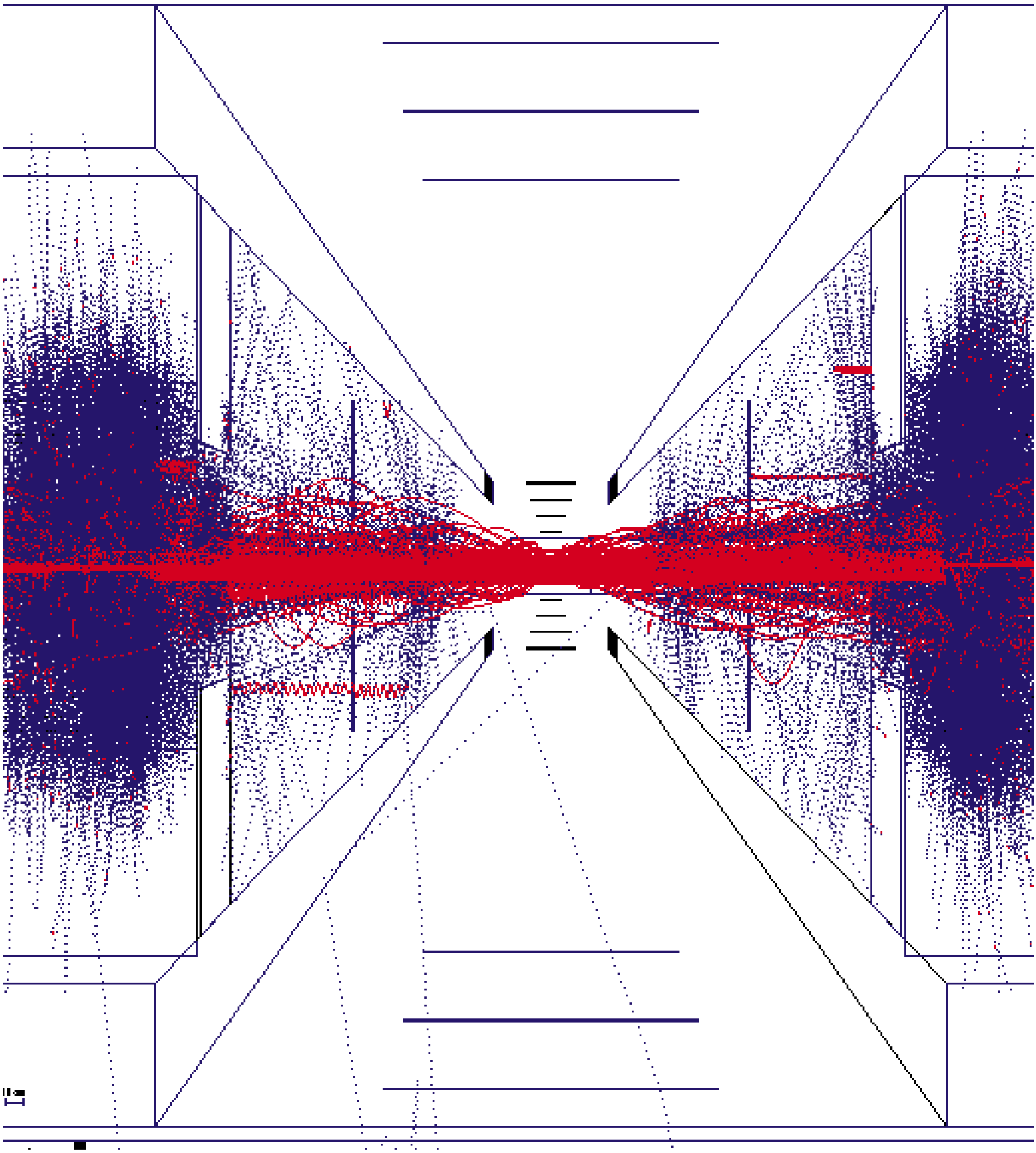
5 Case study: muon attenuator at 1510-2856 m, various radius





θ=0.2
Support Tube
θ=0.15
Luminosity Monitor
Beam Profile Monitor
SC-Compensation Magnet
Carbon Mask
Vertex
detector
Beam pipe
θ=0.05
QC1
30cm
1.0 m
2.0 m

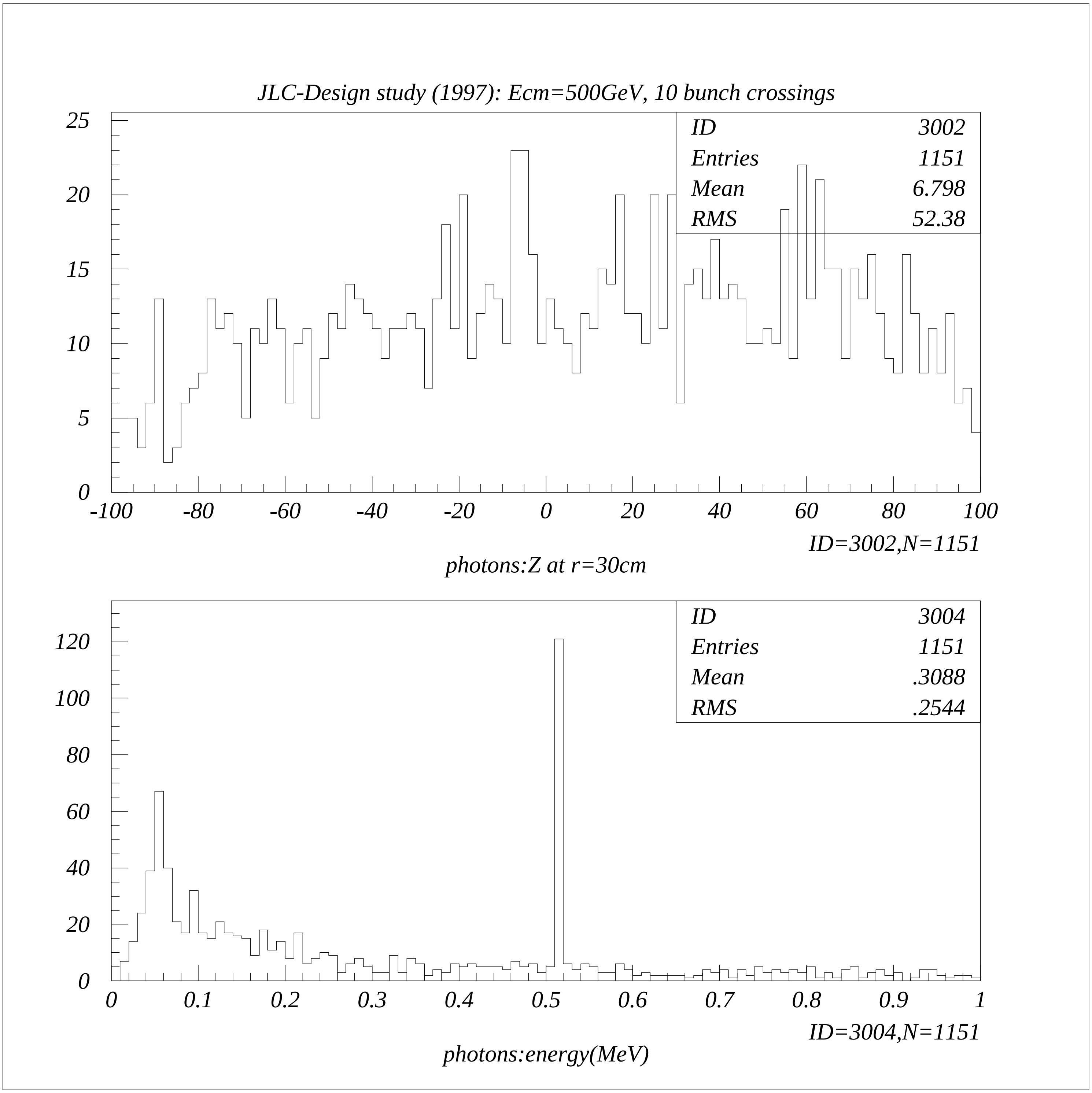


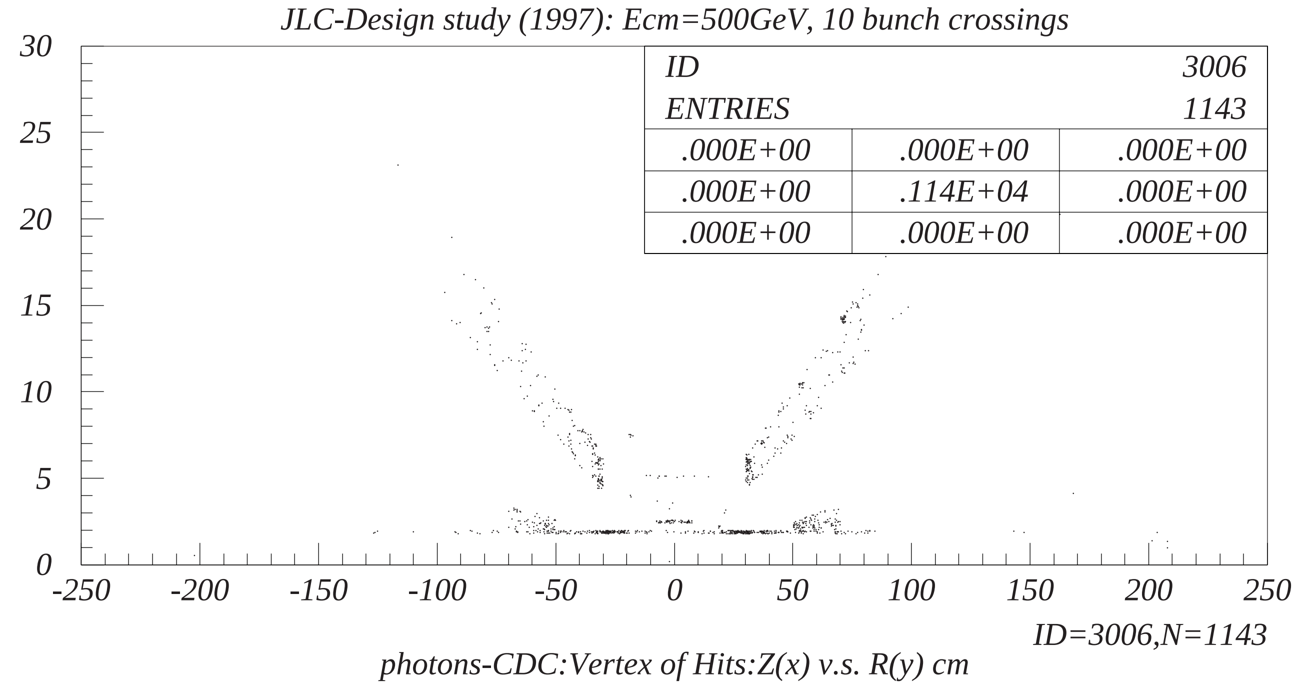


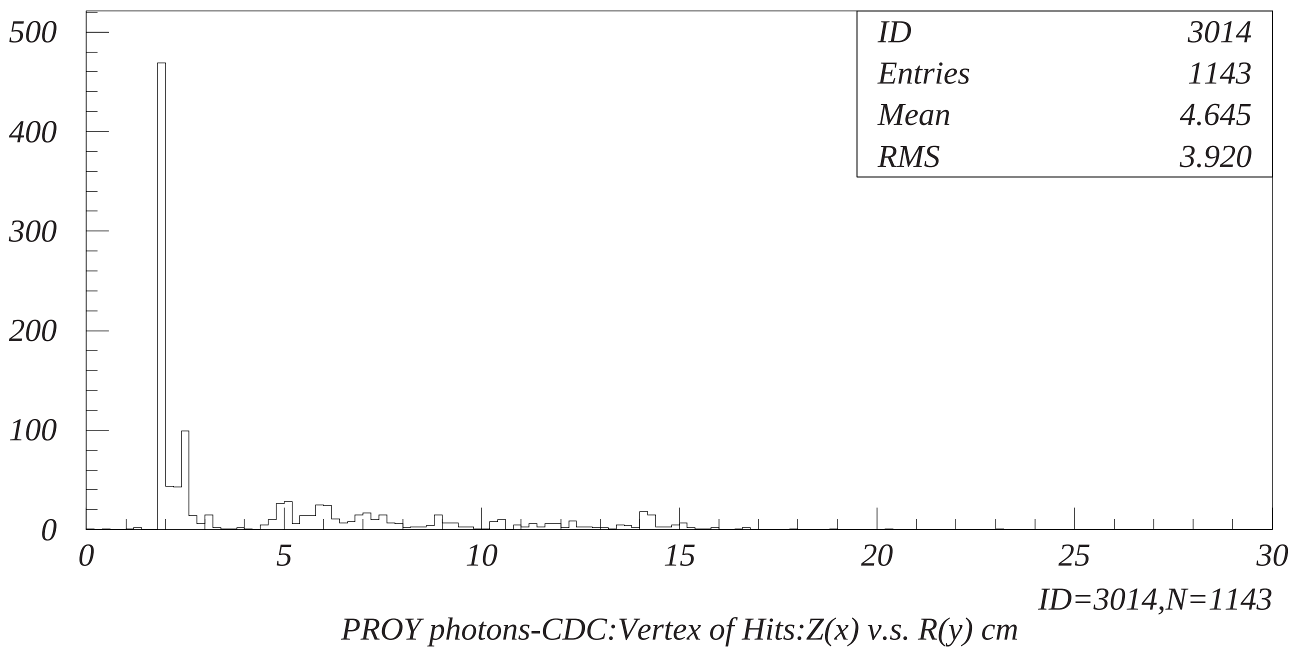
JIM based on GEANT3

$E_e > 200$ keV

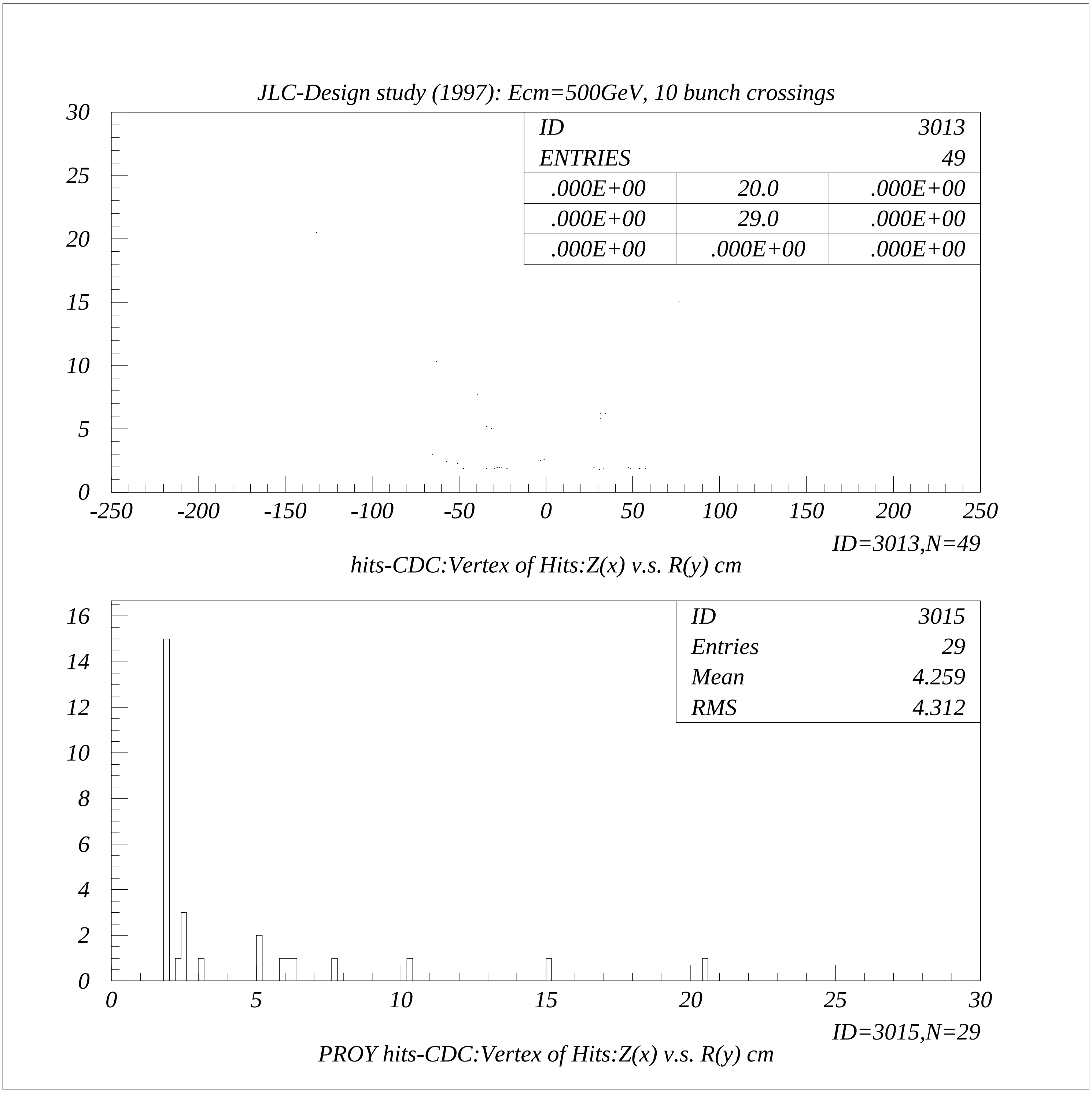
$E_\gamma > 10$ keV


JLC-Design study (1997): Ecm=500GeV, 10 bunch crossings
ID 3002
Entries 1151
Mean 6.798
RMS 52.38
ID=3002,N=1151
photons:Z at r=30cm
ID 3004
Entries 1151
Mean .3088
RMS .2544
ID=3004,N=1151
photons:energy(MeV)

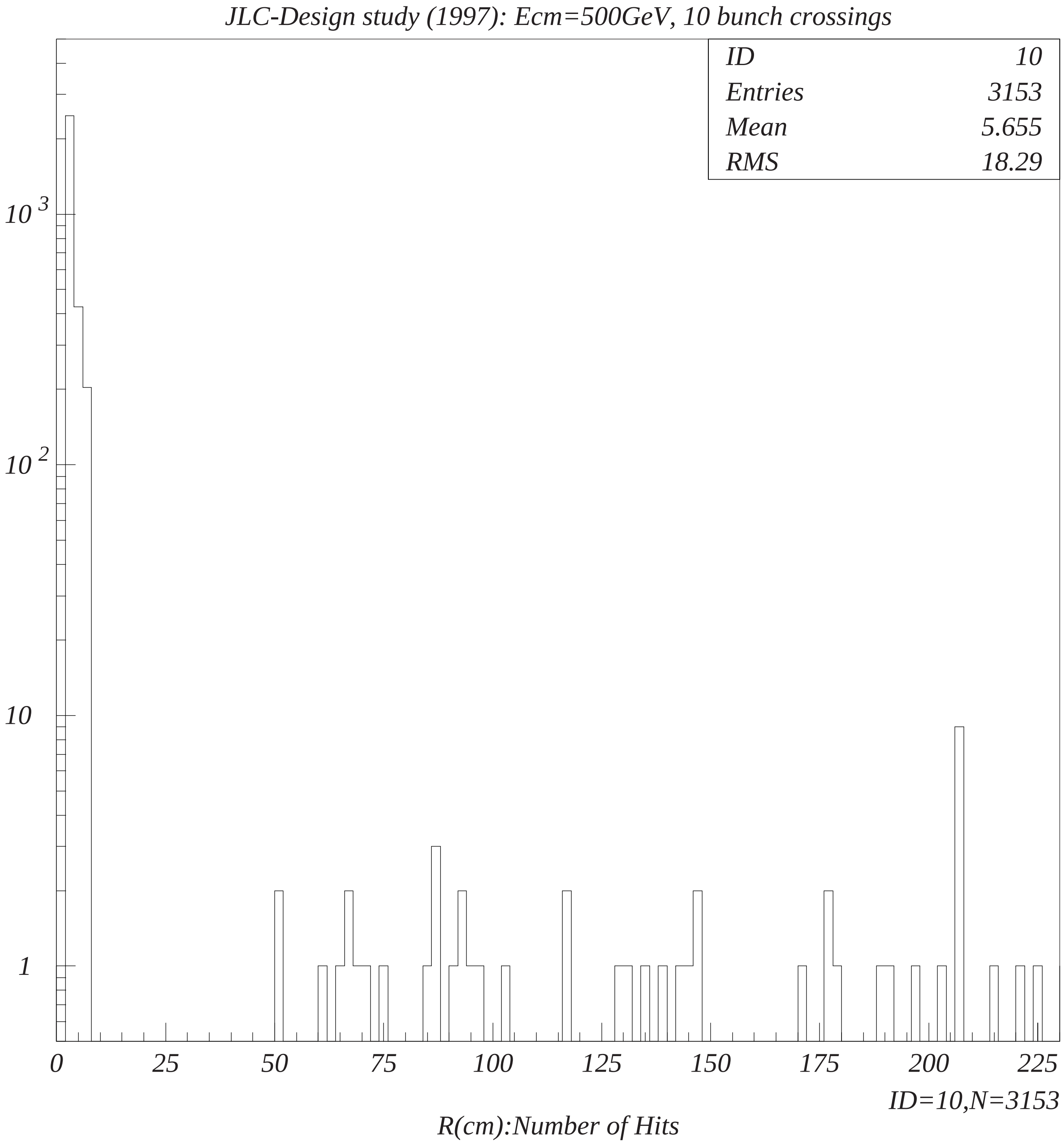




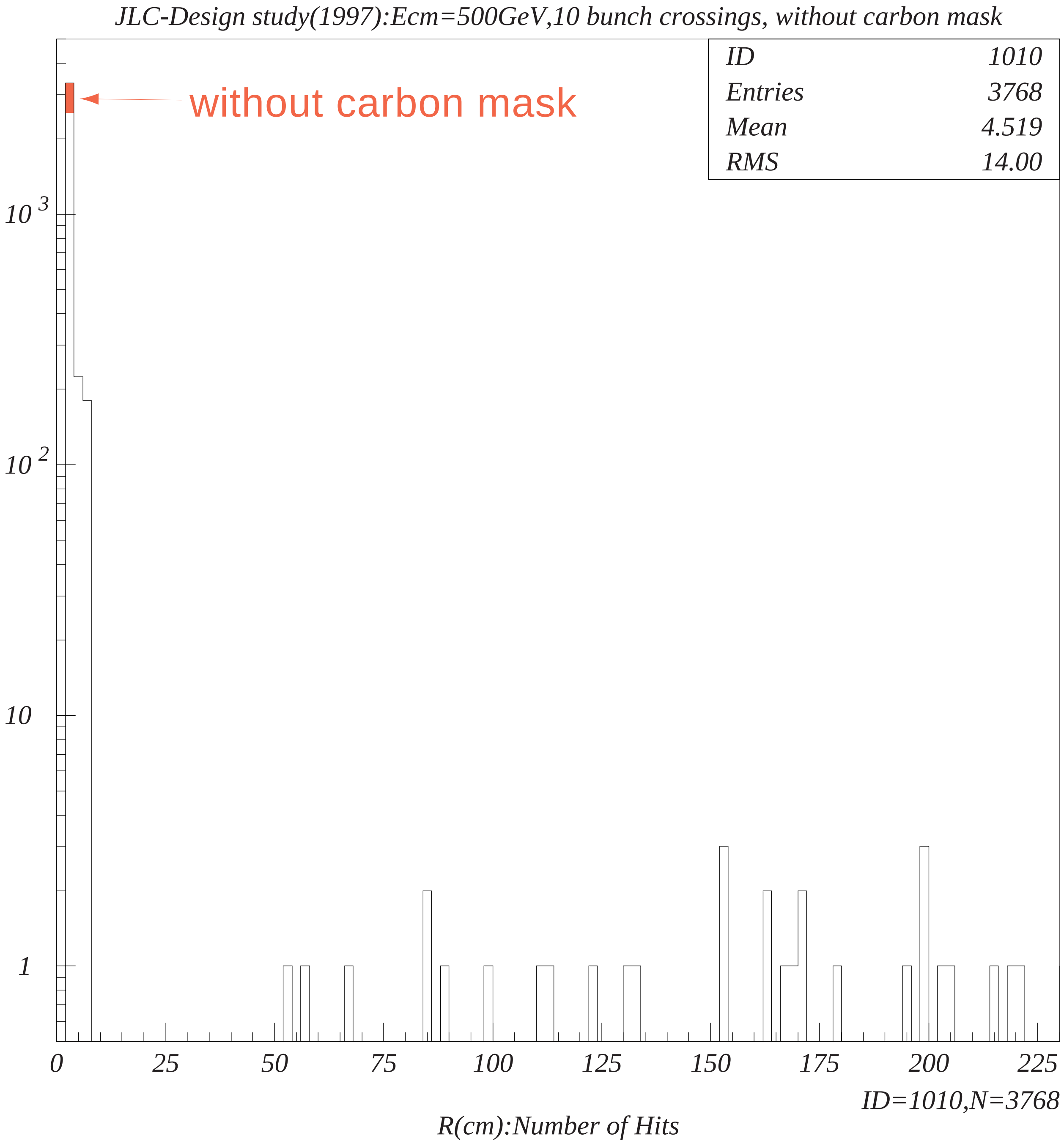
note: only ±20cm of beam pipe at IP is beryllium, while the other part is aluminium in this simulation.



JLC-Design study (1997): Ecm=500GeV, 10 bunch crossings
ID 3013
ENTRIES 49
.000E+00 20.0 .000E+00
.000E+00 29.0 .000E+00
.000E+00 .000E+00 .000E+00
ID=3013,N=49
hits-CDC:Vertex of Hits:Z(x) v.s. R(y) cm
ID 3015
Entries 29
Mean 4.259
RMS 4.312
ID=3015,N=29
PROY hits-CDC:Vertex of Hits:Z(x) v.s. R(y) cm



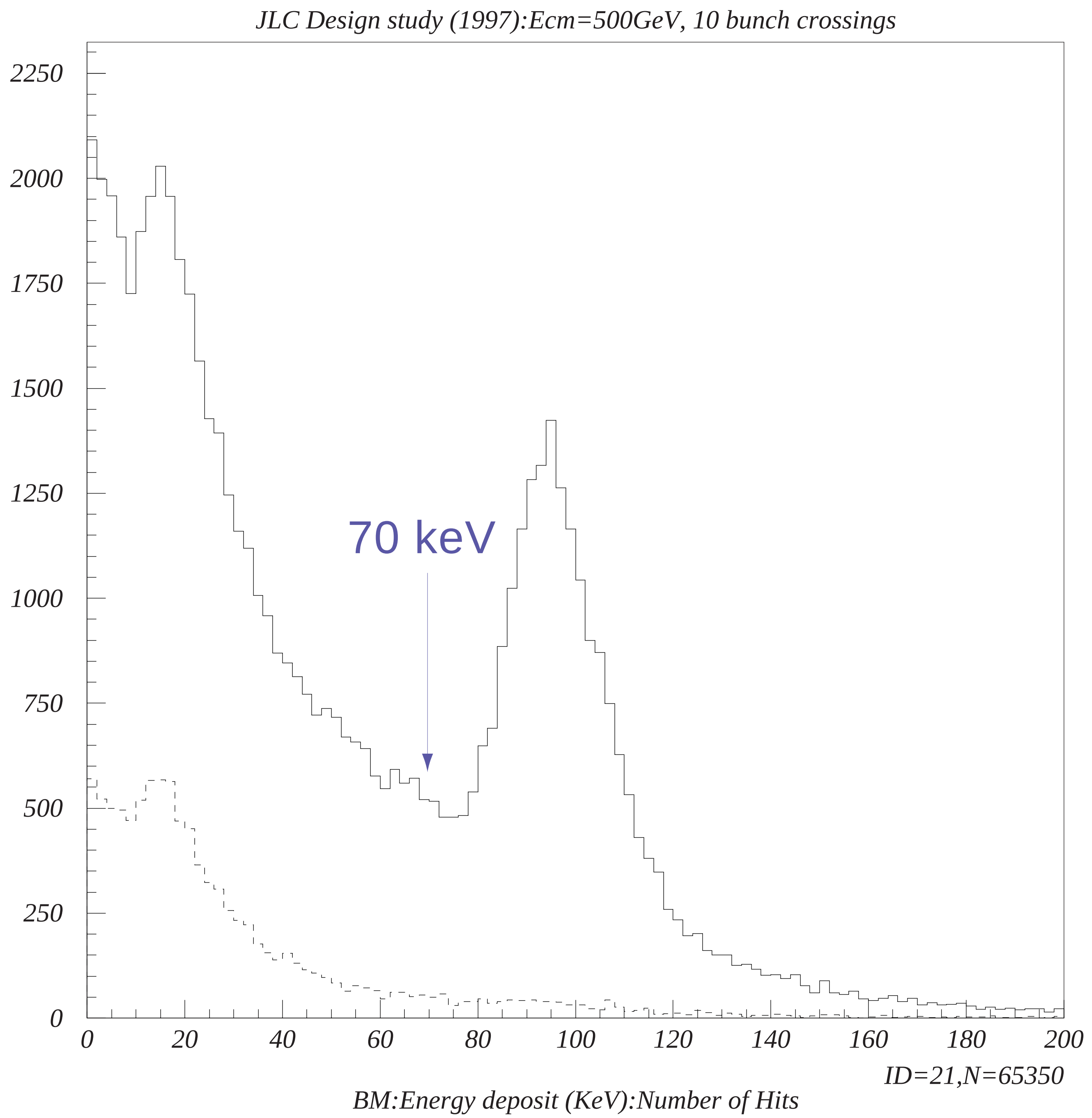
49 hits in CDC (CO_2/isobutane=90/10)
corresponding to ~500 hits/train

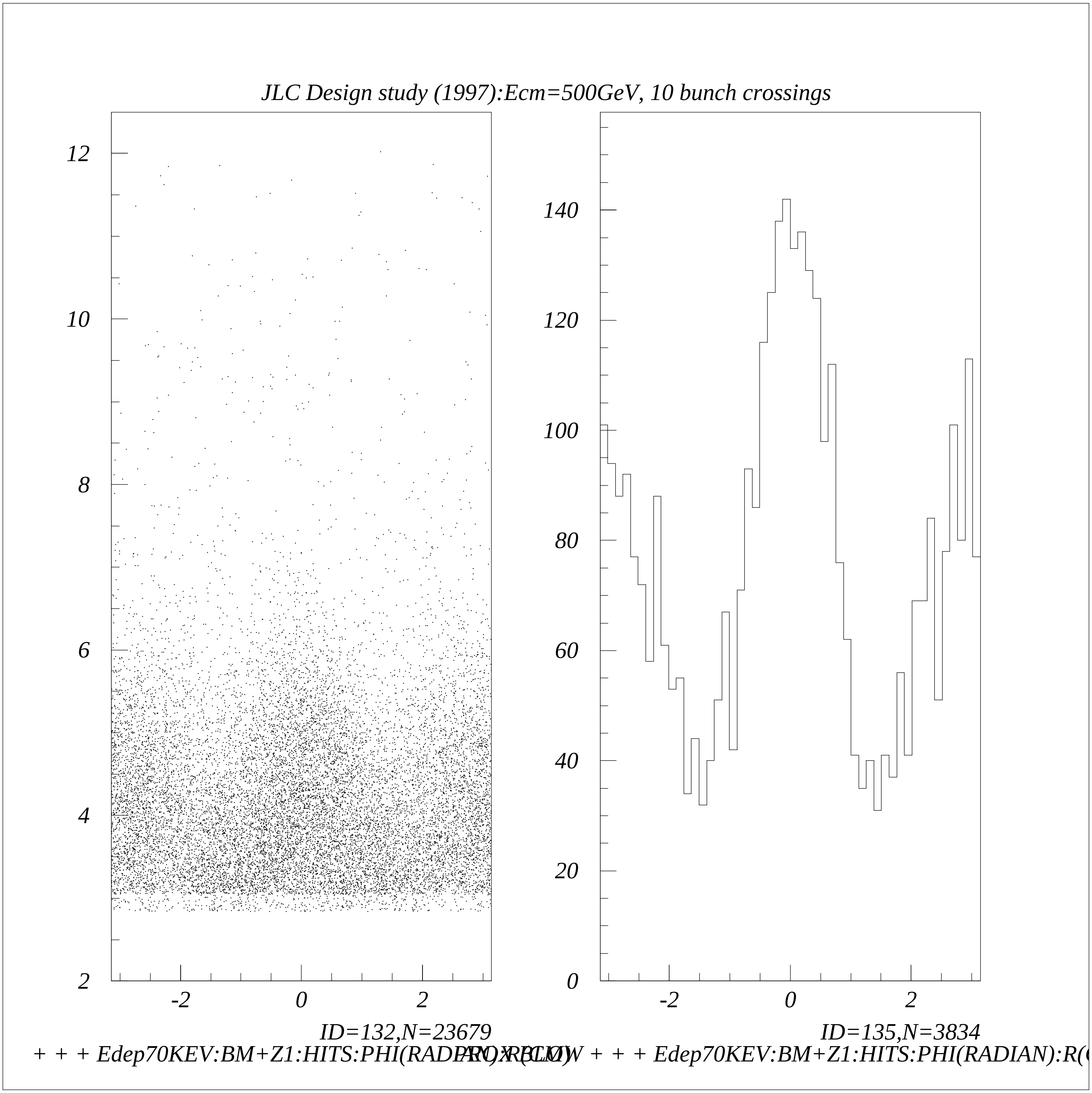


JLC-Design study(1997):Ecm=500GeV,10 bunch crossings, without carbon mask
ID 1010
Entries 3768
Mean 4.519
RMS 14.00
without carbon mask
10 3
10 2
10
1
0
25
50
75
100
125
150
175
200
225
ID=1010,N=3768
R(cm):Number of Hits

Pair Monitor at ±1 m

a pixel device (50x50 μm^2,300μm^t silicon)




JLC Design study (1997):Ecm=500GeV, 10 bunch crossings
ID=132,N=23679
ID=135,N=3834
+ + + Edep70KEV:BM+Z1:HITS:PHI(RADIAN):R(CM)
+ + + Edep70KEV:BM+Z1:HITS:PHI(RADIAN):R(

IR issues: to be studied

1. Mask design

CAIN for pair generation instead of ABEL
good agreement between CAIN and ABEL
neutron background estimation
magnetic field of QC1 and compensation SC must be included.
optimization :

R_{VTX}↓, dead cone↓, B↑, l* of QC1↑......

2. Veto system

Active mask and luminosity monitor
minimum veto angle = 50 mrad -> smaller ?
choice of detector :

e.g. Si/W sandwich for active mask,
? for luminosity monitor in huge X rays
BGO, Cherenkov counter ....

4. Pair monitor

1st feasibility study by JIM and analytic estimations
more detailed study(background) is necessary .
choice of detector :
Active pixel sensor (APS) with a fast gate and readout for bunch separation; position and deposit energy measurements

5. Support tube

How to install/support the support tube and how to access inside-detectors ?

stability of two QC1's : < a few nm at freq. > 1Hz

(1st estimtion by S. Kanda; using ANSYS)

or alternative method such as

independent support of two QC1s, optical anchor....

6. Muon tracking with optical elements

from collimation section to IP

Namito's estimation with muon attenuators :

MUCARLO

More realistic estimation with optics is necessary:

SAD

7. Extraction line (to beam dump)

beam separation and transportation of disrupted beams with good efficiency : CAIN, SAD, JIM

measurements of beam energy,

energy spread(in Δ(E/Eo)< ±1%?),

and polarization.

neutron background from the beam dump.

No serious design so far for JLC.

8. Fast feedback system

bunch by bunch feedback for beam stabilization
very important for high integrated luminosity
instrumentation:
Beam position monitor (BPM) , pair monitor with fast electronics
note: bunch separation = 1.4 nsec for high lum.

9. Superconducting final focus magnet

w/o compensation magnet -> compact support tube
larger inner radius for finite horizontal xing angle
or smaller xing angle but limited by beam effect
or larger xing angle (exit beam outside it)...

10. Stronger detector solenoid field, B

to reduce backgrounds for shorter radius of the innermost layer, e.g. 2.5 -> 1 cm, of vertex detector.
2 -> 3 Tesla or higher B requires optimization of detectors
beam blow-up ? : SAD