Beam-beam and Neutron Background in the JLC Detector

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e^+e^- pair background
- -> Vertex detector hit
- -> Luminosity monitor hit

Neutron background
- -> Flux at IP
- -> CDC hit
- -> Neutron from downstream

e+e- pair background

Generation of e^+e^- pair ; CAIN

Input parameters;

- Bunch population	0.75×10^{10}/bunch
- Ebeam	250 GeV (4.3MW/beam)
- Bunch length	90 μm
- Emittance $\gamma\varepsilon_{x/y}$	4 /0.06 $\times 10^{-6}$m
- β_x / β_y	10 /0.1 mm

Luminosity;

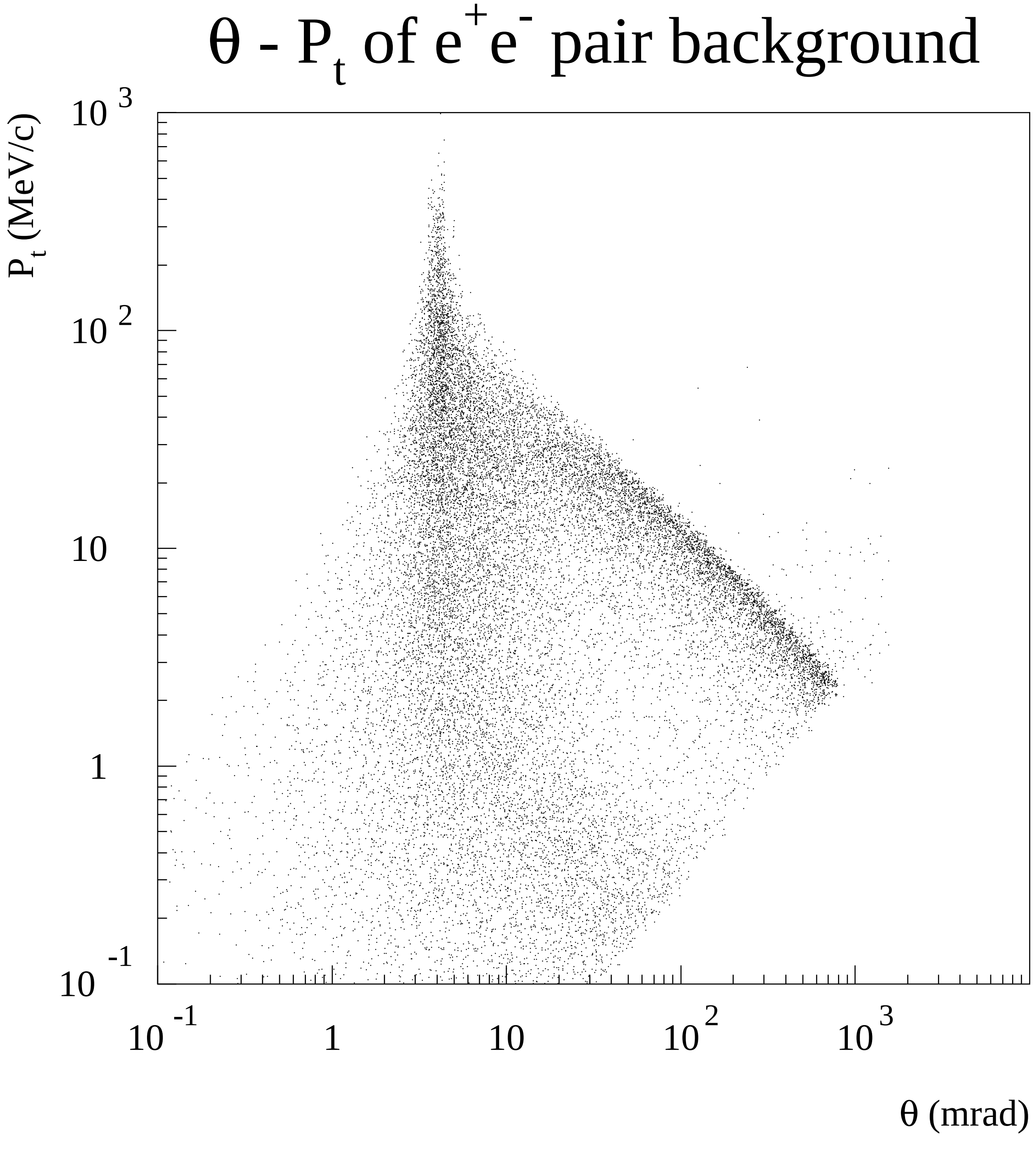
- L	0.64×10^{34} /cm^{2}s
- H_DL	0.88×10^{34} /cm^{2}s

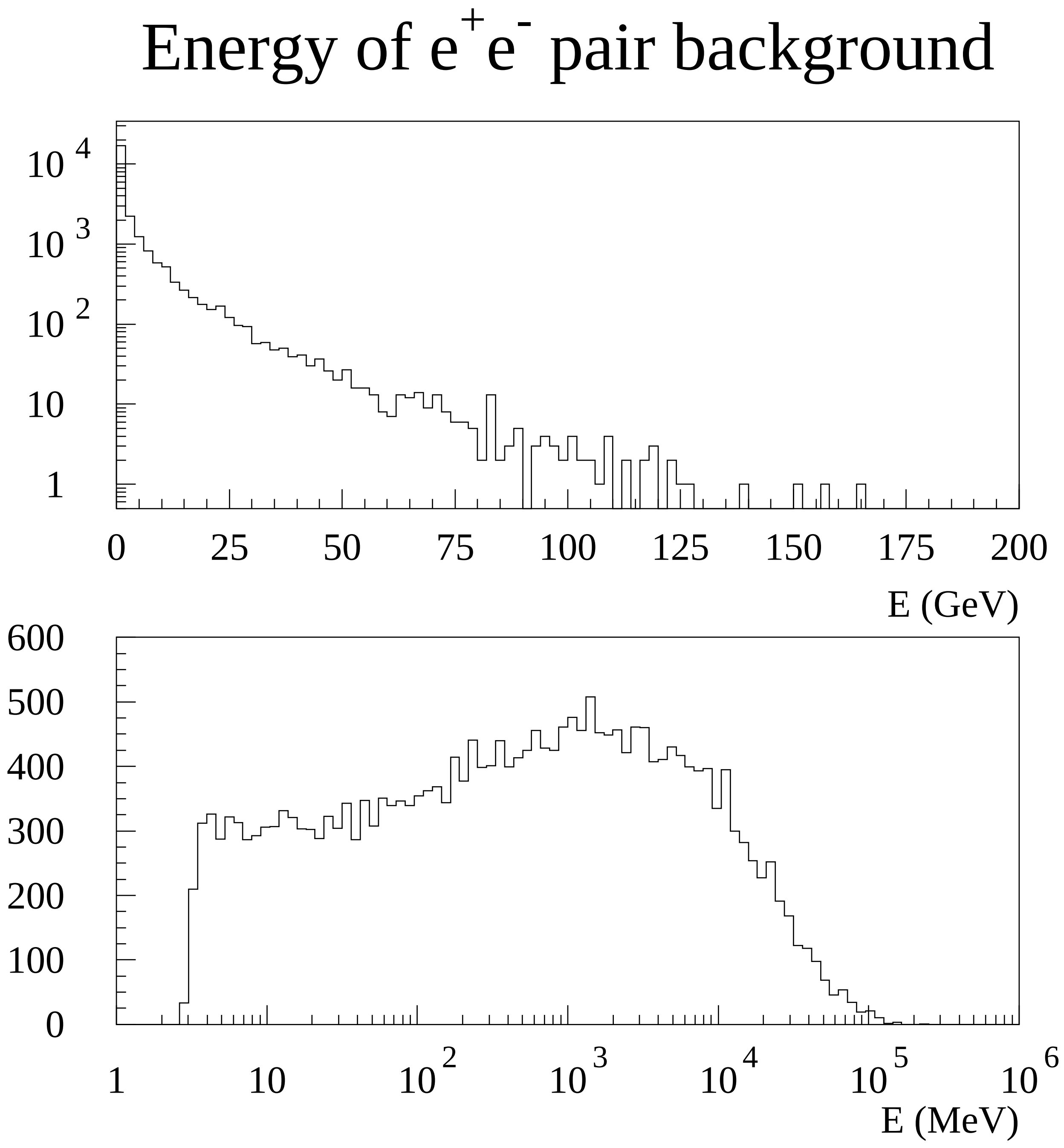
Pair background;

- # of e^+e^-	25 k / BX
- $\langle E_e \rangle$	4 GeV
- Total energy	100 TeV / BX

Beamstrahlung γ;

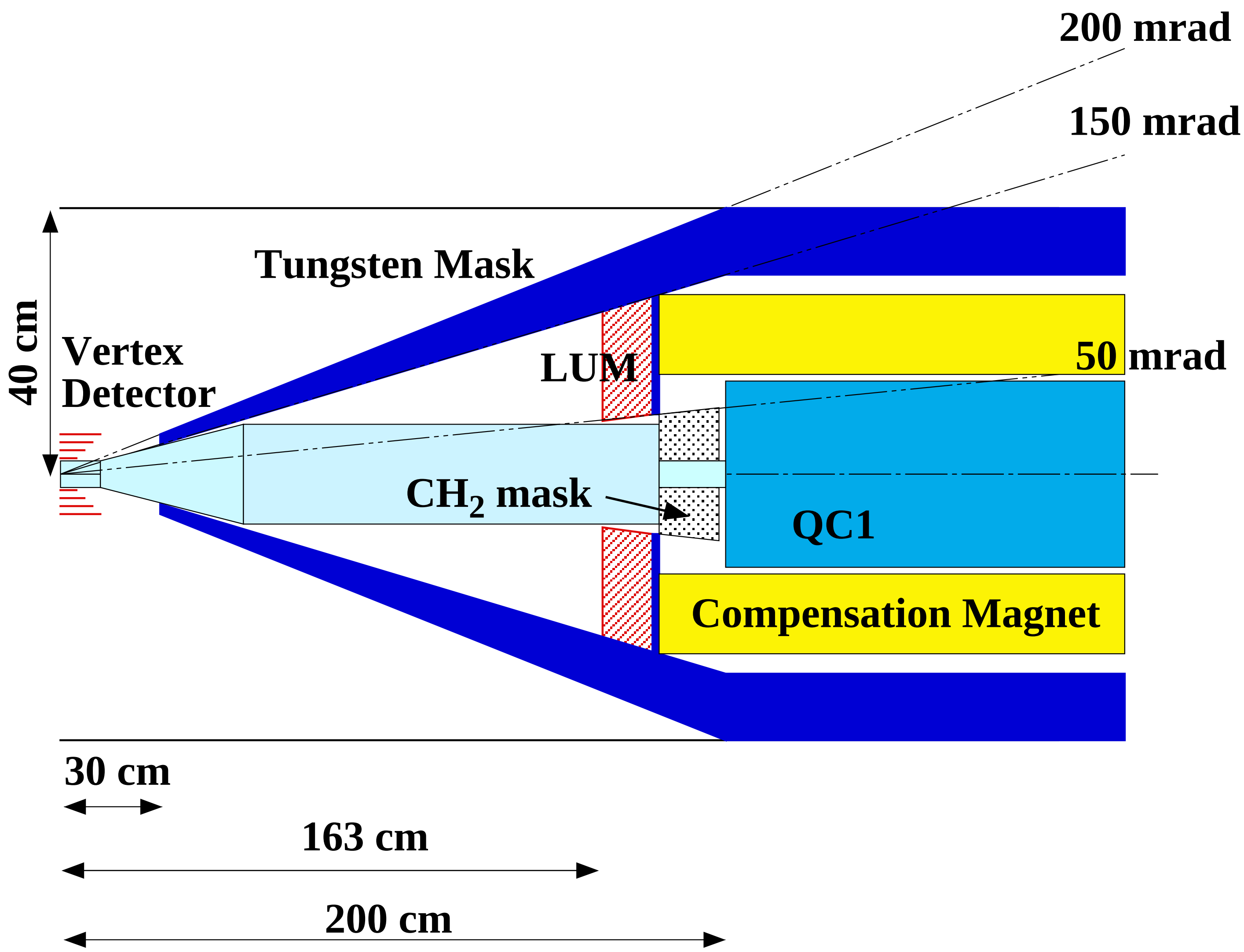
- # of γ	1.5×10^{10} / BX
- $\langle E_\gamma \rangle$	10 GeV
- Total energy	340 kW
- δ_{BS}	4.0 %


θ - P_t of e+e- pair background
P_t (MeV/c)
10^3
10^2
10
1
10^-1
10^-1
1
10
10^2
10^3
θ (mrad)


Energy of e^+e^- pair background
10^4
10^3
10^2
10
1
0
25
50
75
100
125
150
175
200
E (GeV)
600
500
400
300
200
100
0
1
10
10^2
10^3
10^4
10^5
10^6
E (MeV)

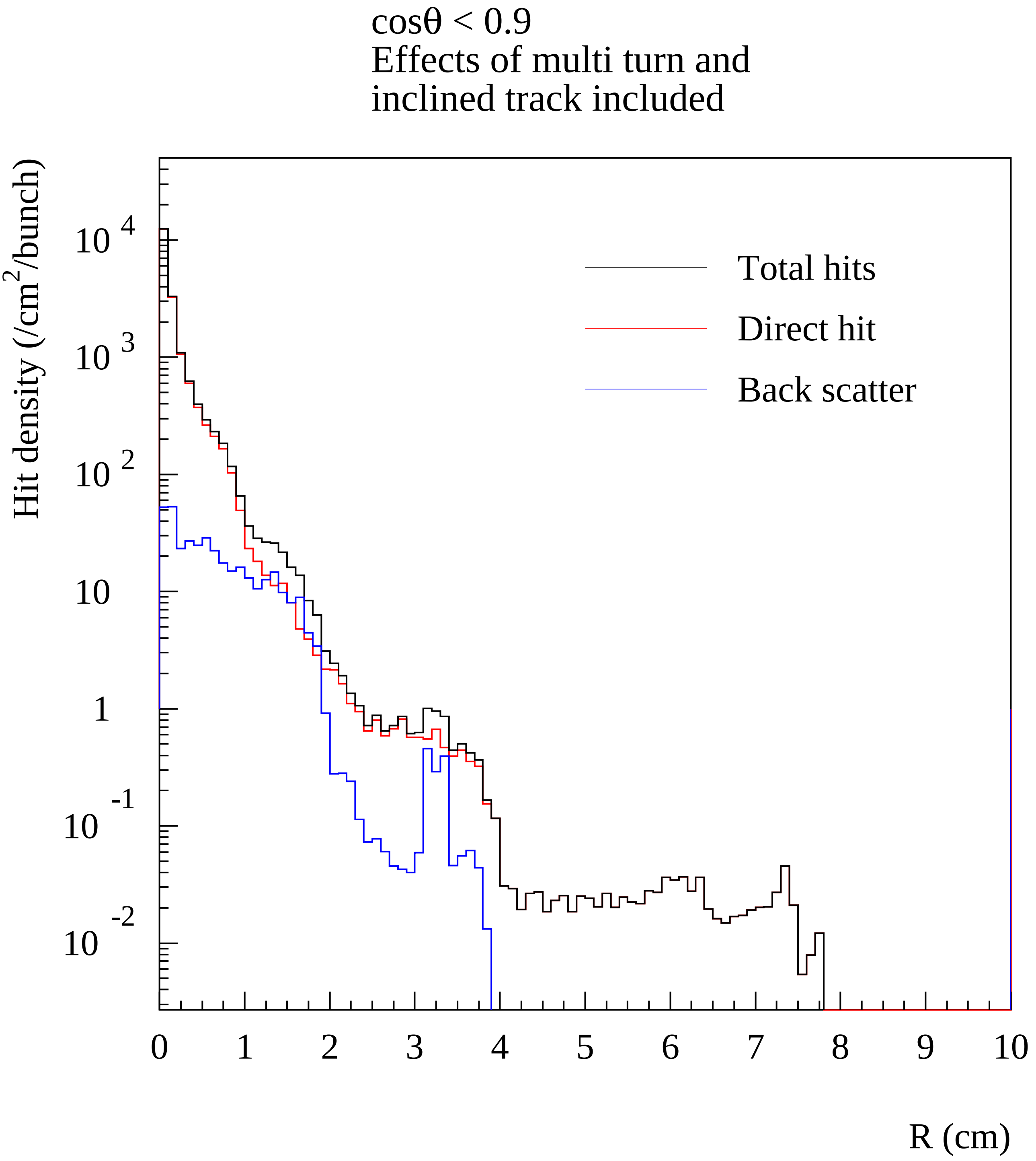
Detector simulation

- Uniform B field of 2T
- Beam pipe r = 2.0 (Be) / 7.5 (Al) cm
- Polyethylene (CH_2) mask, r_{in} = 2 cm
- Vertex detector;
  r = 2.4, 3.6, 4.8, 6.0 cm
  $\cos\theta < 0.9$
- Luminosity Monitor;
  z = 163 cm
  r = 8 cm (50 mrad)

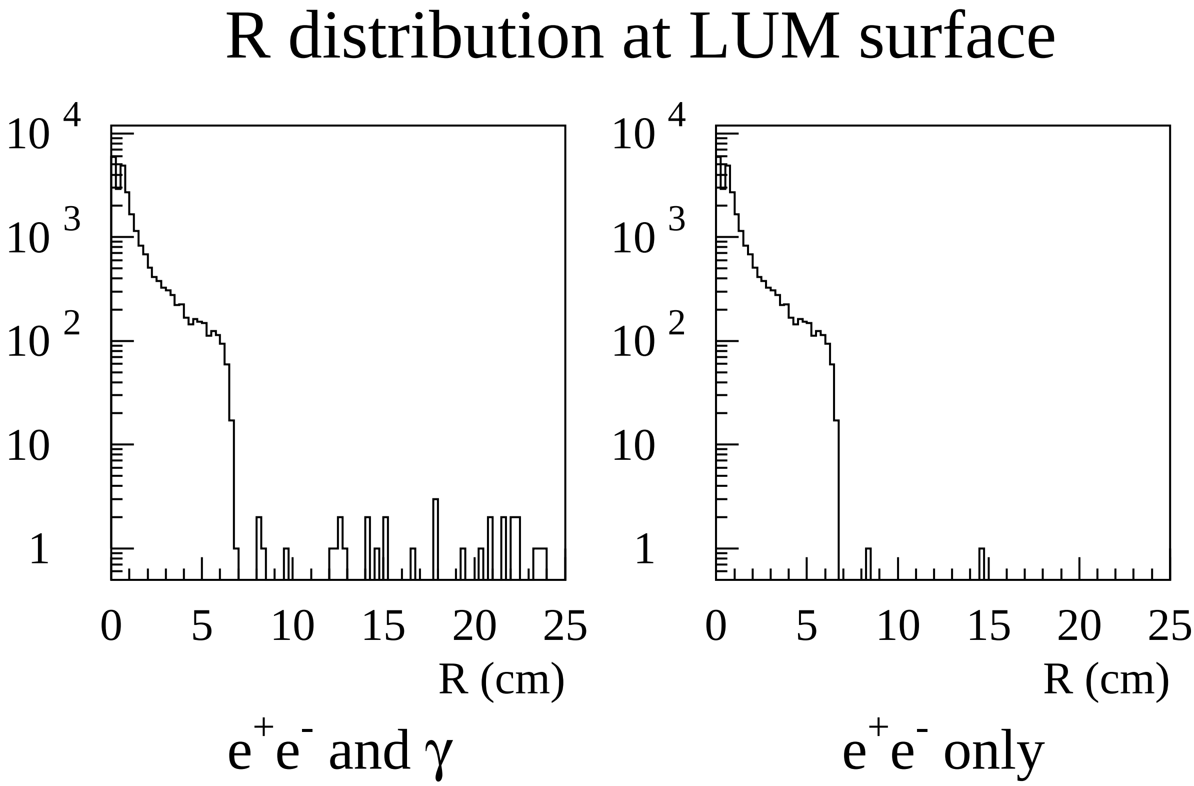


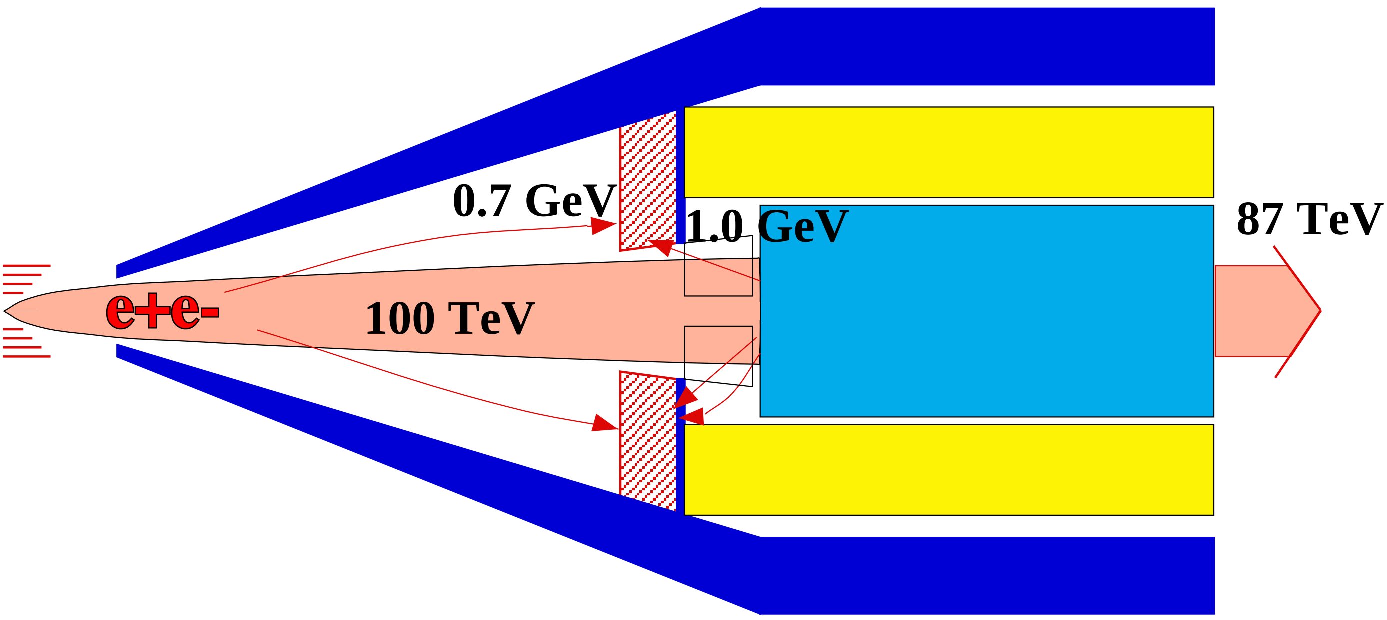
Vertex detector hit by e^+e^-

At r_{min} = 24 mm ;
~ 1 hit / mm^2/train
= $1.5*10^{11}/cm^2y$



Luminosity monitor hit by e+e-



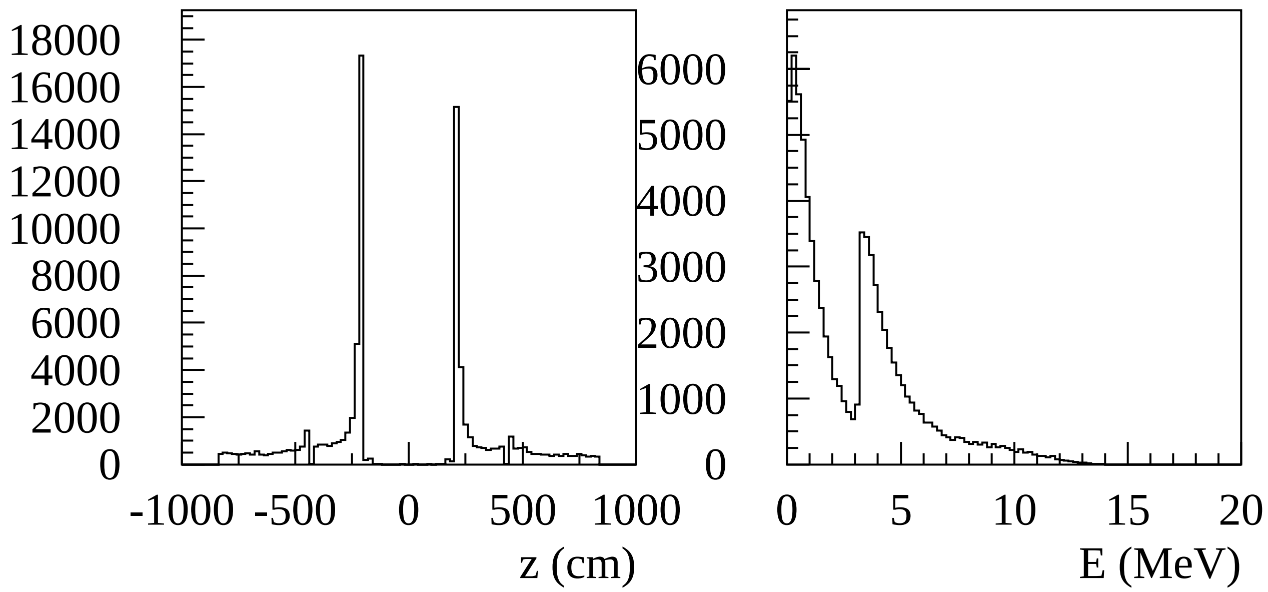


1.7 GeV / BX = 80 GeV / train / side

Neutron background

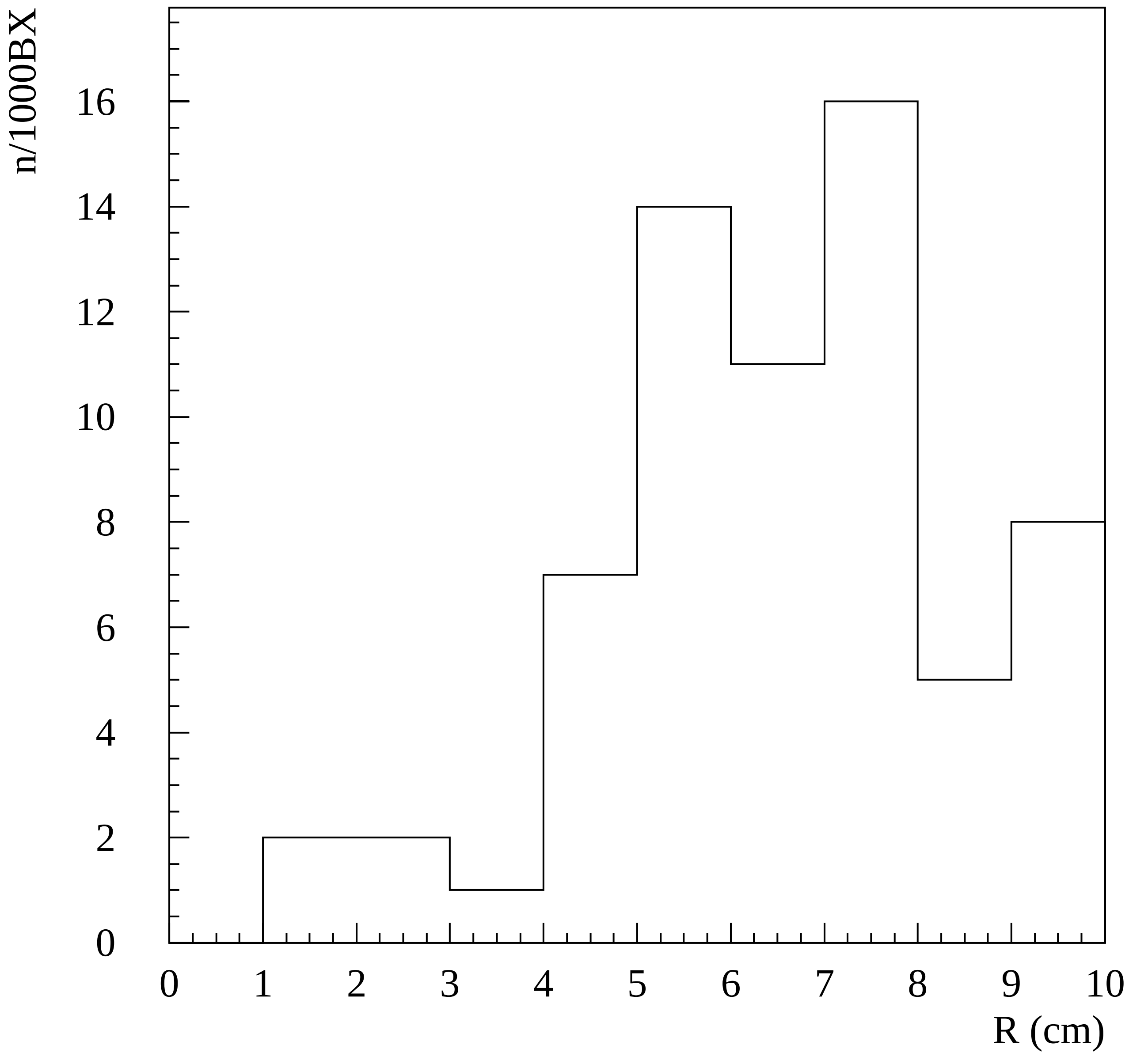
Neutron generation;

- e^+e^- pair -> EM shower in QC
  -> Photonuclear reaction
- Neutron generation code;
  written by T.Maruyama
  implemented into GEANT3
- Production cross section was artificially multiplied by 100 in the simulation
- FLUKA(E>20 MeV) or MICAP(E<20 MeV) used for neutron transportation in G3 (neutral hadron cut off energy = 1 keV)



Neutron production point   Neutron kinetic energy

Neutron flux at IP



R distribution at z=0

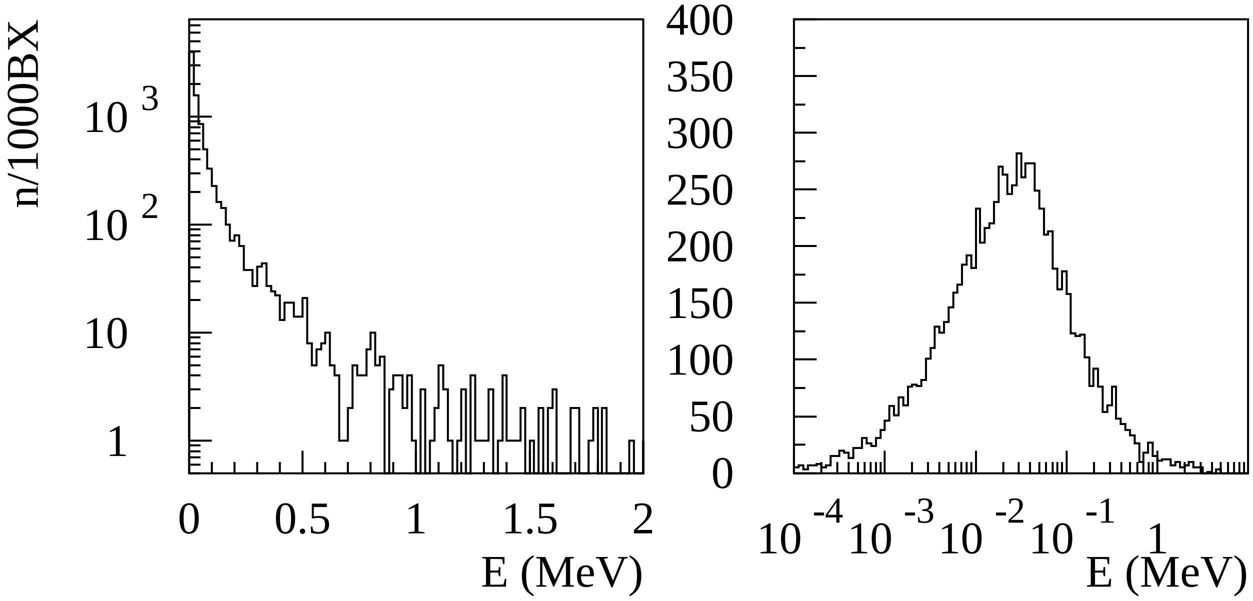
$$66 \,/\, 2\pi r(=10\text{ cm})^2 / \,(10*100)\text{BX}$$

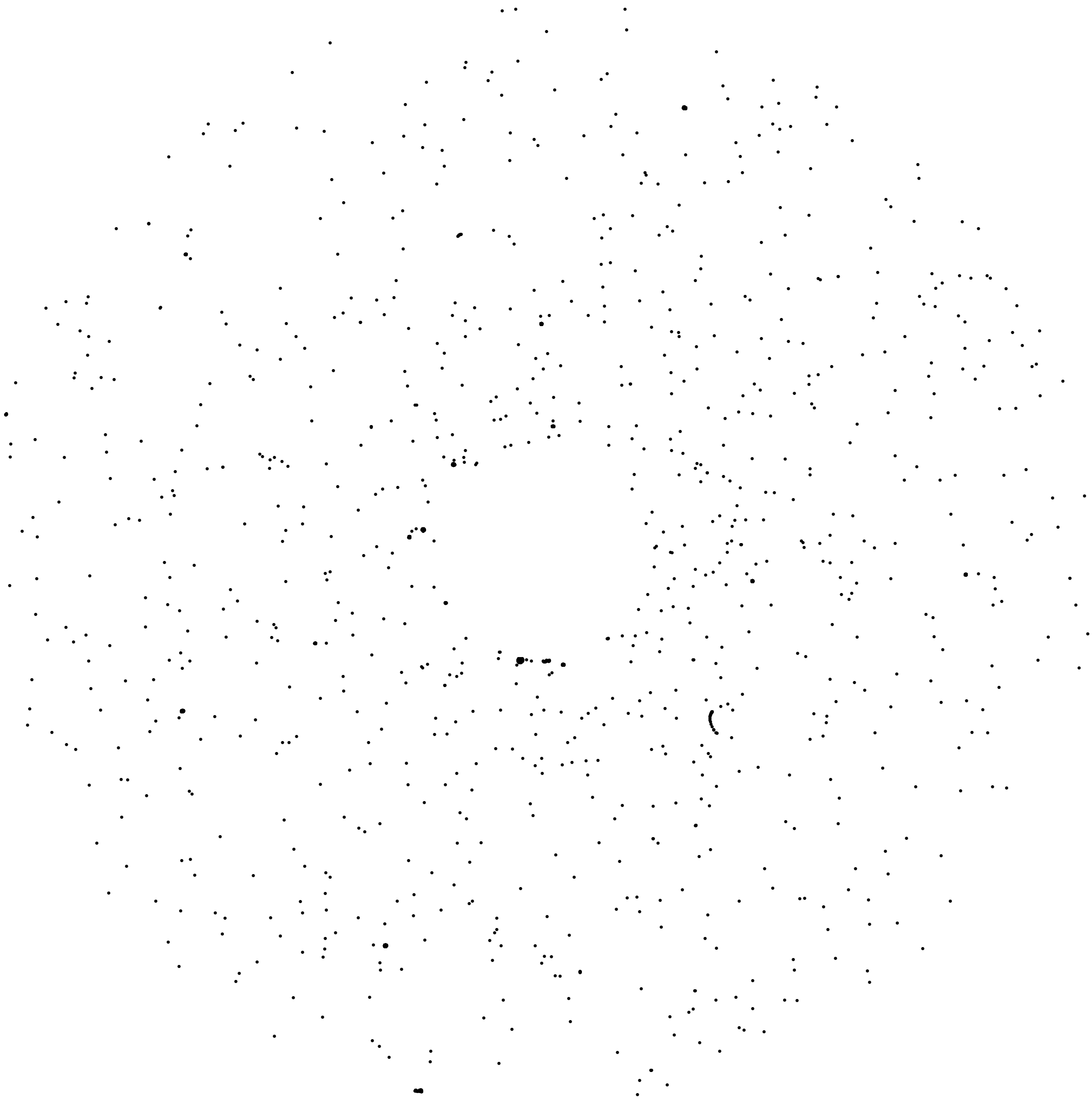
$$= 1.5*10^7 \text{ /cm}^2\text{y}$$

CDC hit by neutron

CDC gas mixture ;
CO_2-Isobuthane(C_4H_{10}) 90:10

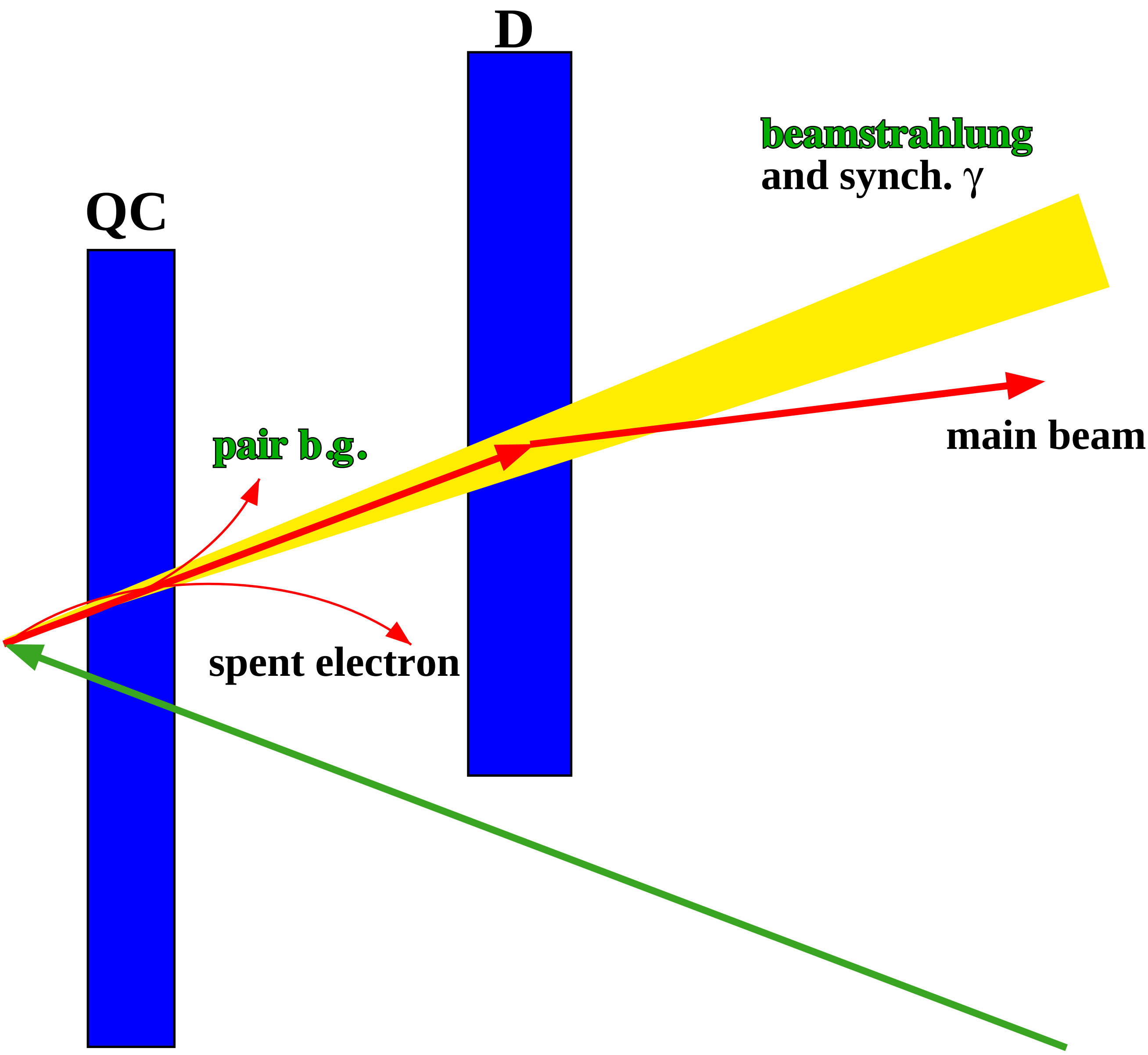
-> ~800 CDC hits / train





Neutron from downstream

- Design of beam extraction line of JLC does not exist yet
- My personal guess is given below



Very rough estimates

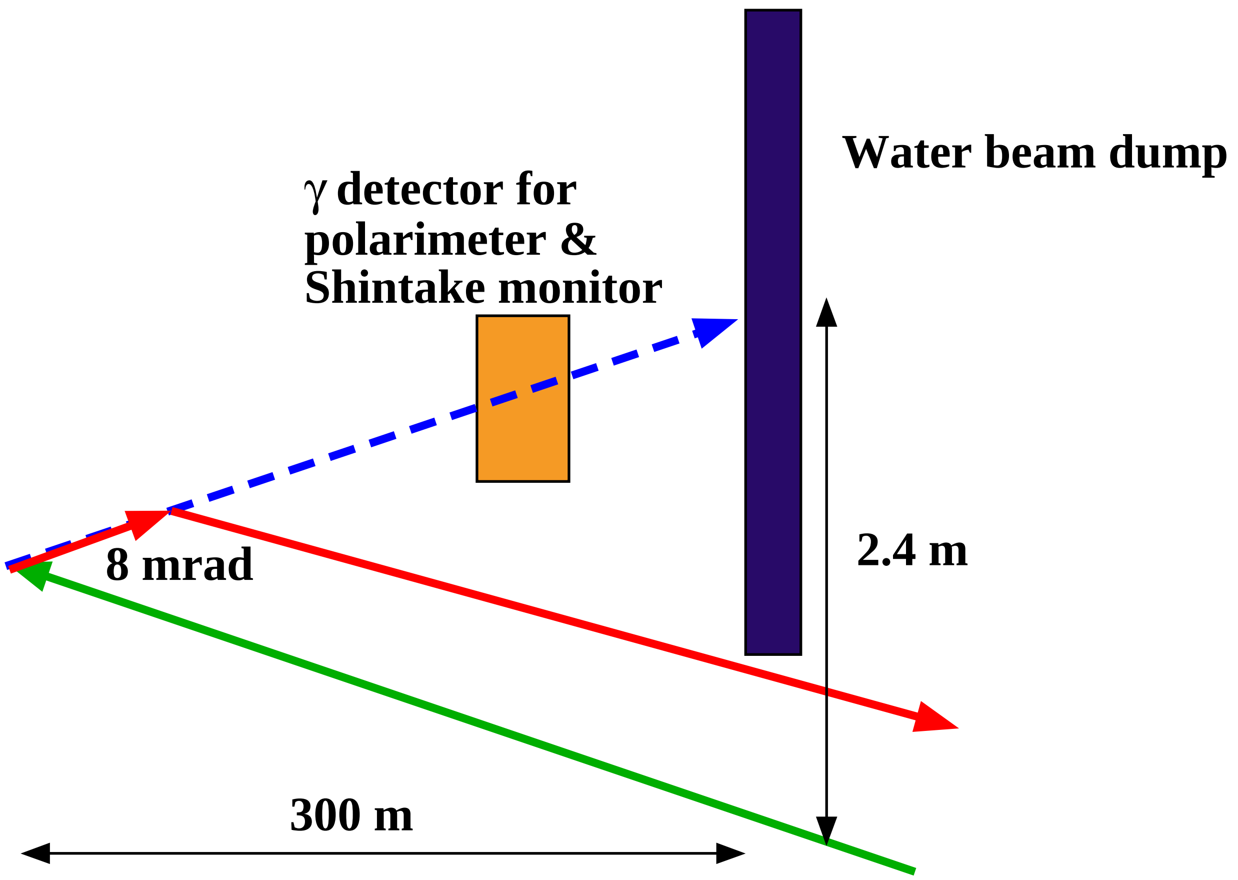
Neutron from pair background :

Upper limit = $1.5*10^7$ * 100TeV/(100-87)TeV
~ $1 * 10^8$ /cm^{2}y

Neutron from beamstrahlung :

Angular divergence < 500 μrad
-> Assume 340 kW is dumped in
γ–beam dump (φ = 3 m, L = 10 m,
made of water) at 300 m from IP

Neutron generation = $6*10^{22}$ / y
Neutron leakage = $6*10^{18}$ / y
× Acceptance ($1/(4\pi r^2/2)$, r=30000cm)
= $1*10^9$ /cm^{2}y



Summary

Background hits in detectors (/ train):

	pair	neutron
-Vertex det. (r=24mm)	1/ mm^2	-
-CDC	-	800
-Luminosity Mon.	80 GeV/side	-

Radiation dose (/ cm^2y):

- e^+e^-	$1.5*10^{11}$ (24 mm, 2T)
- neutron from;	
e^+e^-	$1.5*10^7$ (< $1*10^8$)
beamstrahlung	$1*10^9$

Things to be studied:

- Non-uniform magnetic field in the detector
- Shielding agains neutrons from beam dump
- Effect of beam halo
- Design of the beam extraction line