New JLC Mask System at B=3T

Y. Sugimoto
KEK
@LCWS2000

Contents:

- Pair background hits in JLC detector models

  --- 2T, 3T(l^*=2m), 3T(l^*=4.3m)

- Beam background from disrupt beam

  --- Preliminary design of the beam extraction line

Background Source for Detector Components

Pair Background :	**direct**	**e**	**VTX**
	b.s. (QC1)	**e**	**VTX**
	b.s. (QC1)	**γ, n**	**CDC,CAL,LUM**
Disrupt Beam :	**b.s. (extraction line)**	**γ, n**	**VTX, CDC**
Beam-strahlung γ :	**b.s. (γ beam dump)**	**γ, n**	**VTX**
Main beam :	**b.s. (e beam dump)**	**n**	**VTX**
Synchrotron Rad. :	**b.s. (extraction line)**	**γ**	**VTX, CDC**

Simulation

Generation of pair background:

CAIN
Ebeam=250GeV
"A" option ("Y" option)

Detector Simulation:

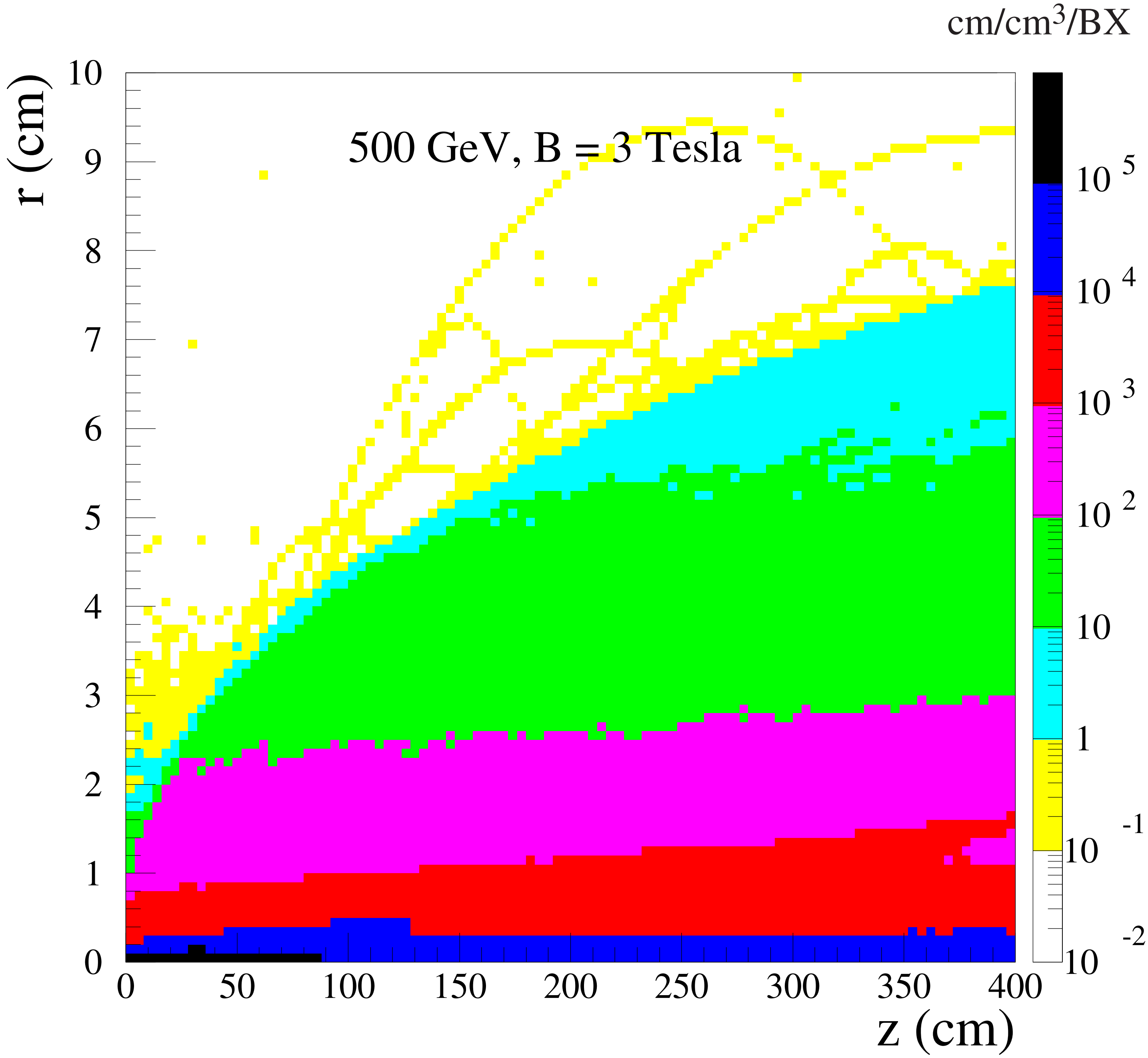
JIM (based on GEANT3)
Ecut for γ: 10 keV
Ecut for n: 1 keV
B field of compensatiom mag. & QC included

K. Yokoya, March 1999

500GeV (CM) Hi-Lum Parameters of JLC

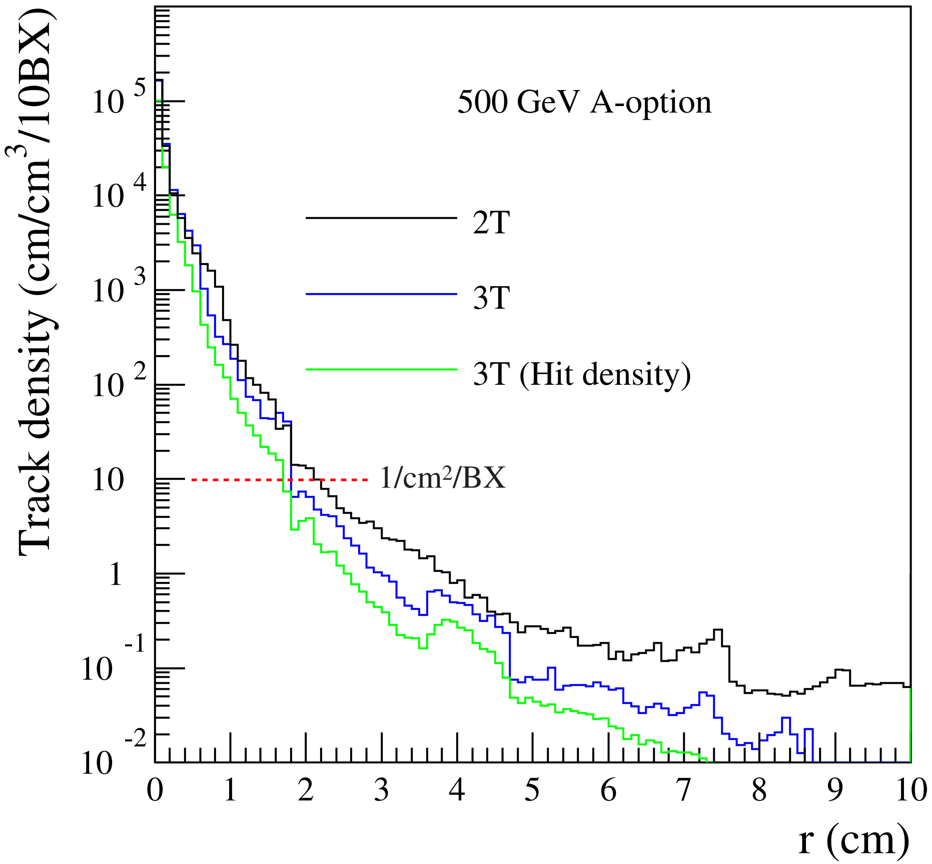
		A	X	Y
Luminosity	$10^{34}/cm^2 s$	0.88	1.57	2.61
Nominal Lum.[3]	$10^{34}/cm^2 s$	0.63	1.08	1.75
Bunch Population	10^{10}	0.75	0.55	0.70
No. of bunches/pulse		95	190	190
Bunch separation	ns	2.8	1.4	1.4
Linac length/beam[7]	km	5.21	5.54	5.97
AC power(2 linacs)	MW	117	126	136
Beam power/beam	MW	4.28	6.28	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

Pair background track density

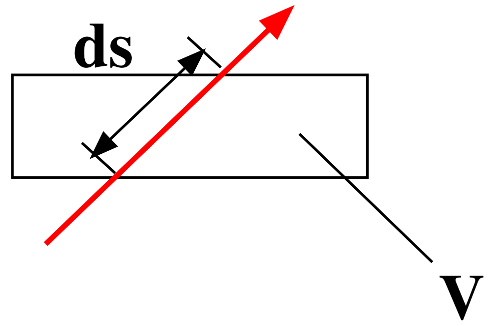


Pair background track density

|cos |<0.9



track density =   ds / V

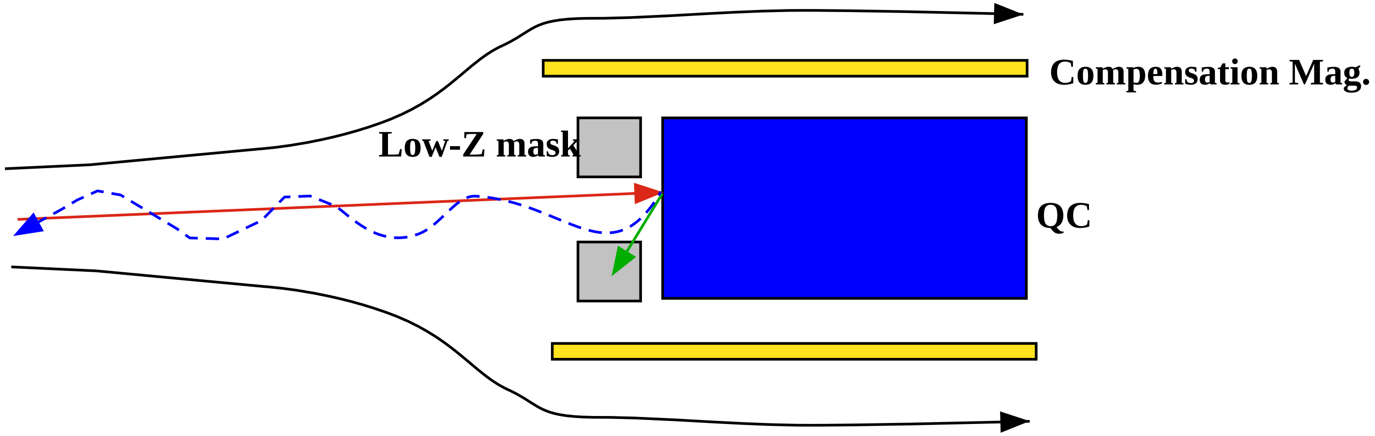


Detector models and Mask system

Detector Model		QC1 surrounded by	Mask System
Old	B=2T l*=2m	CDC	Long tungsten(W) mask inside support tube Low-Z (graphite/CH_2) mask in front of QC1
Now	B=3T l*=2m	CAL	Long W Mask inside Support Tube (Short W mask is enough) Low-Z mask
Future	B=3T l*=4.3m	Endcap Iron	Forward calorimeters (No W mask) Low-Z mask

Effect of Low-Z Mask

- **Low-Z (graphite/polyethylene) mask at B~0 is very effective to absorb backscattered low energy e^+/e^-**

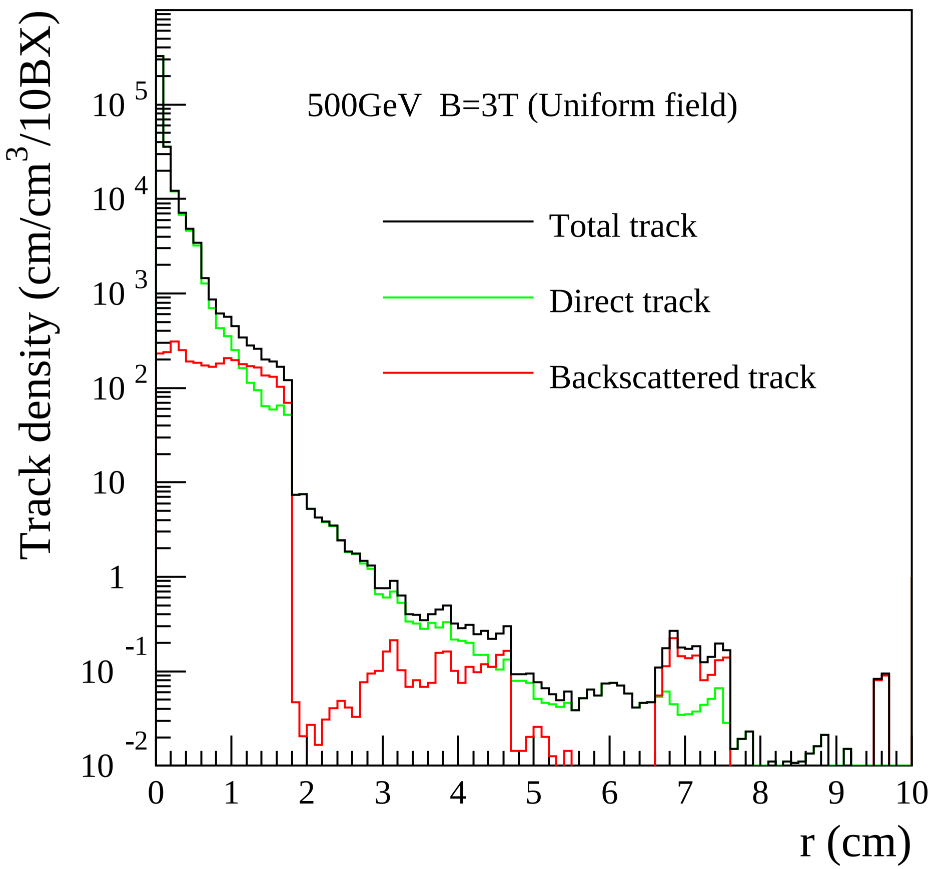


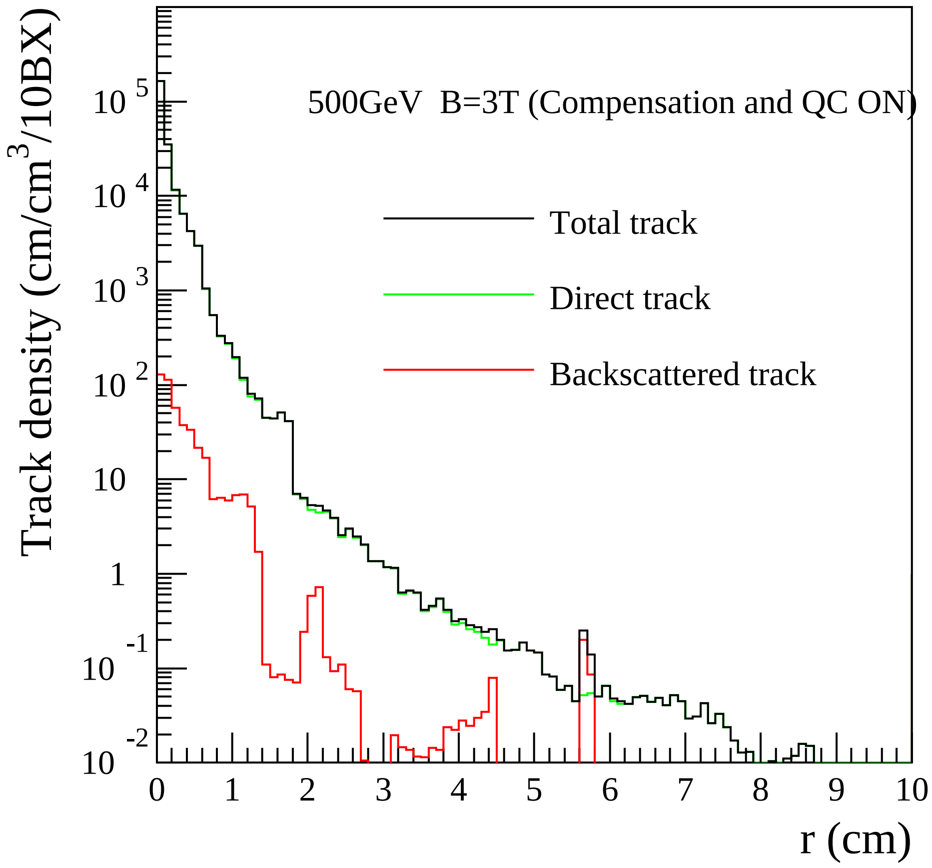
- **Low-Z mask works as a neutron shield**

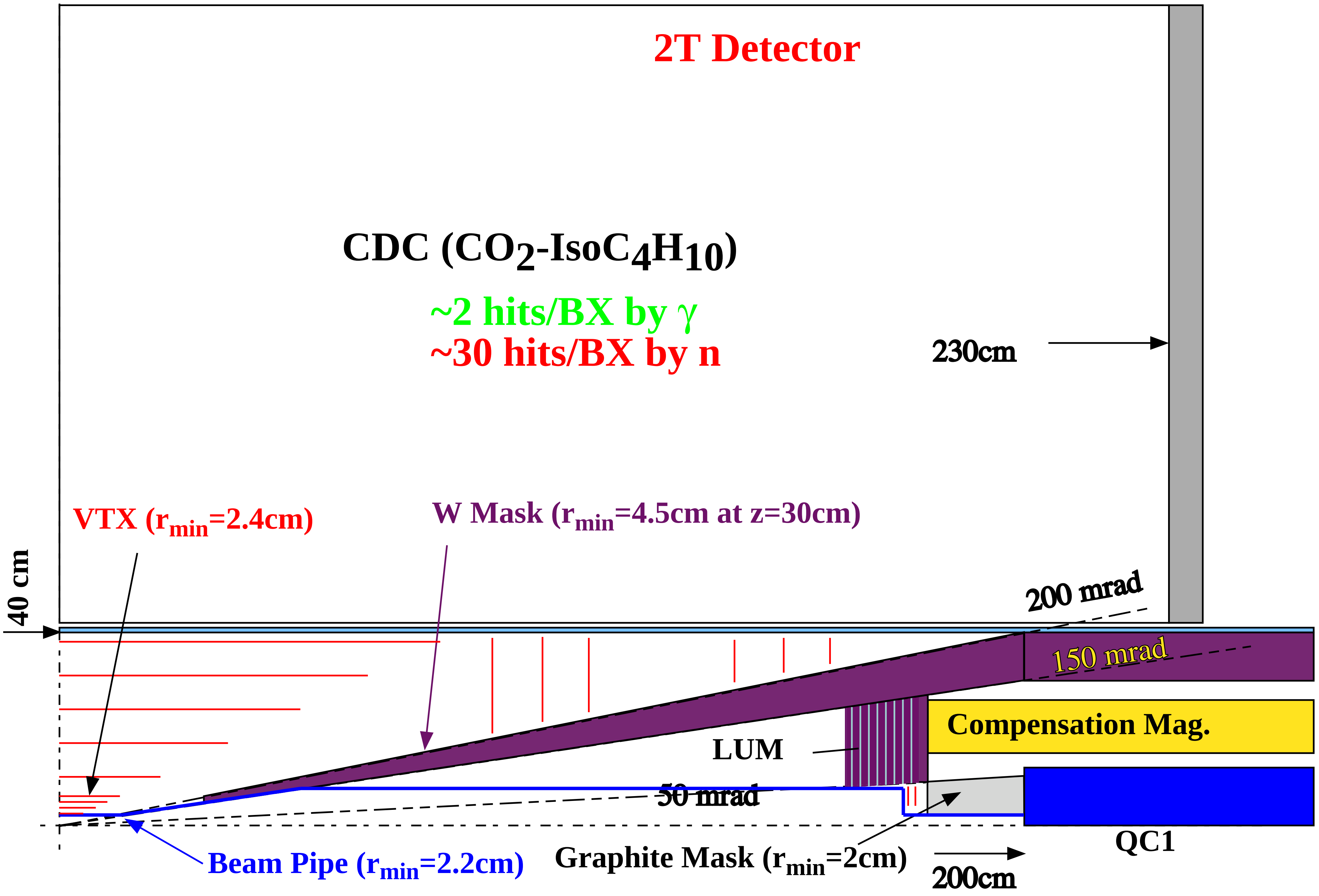
~1/10 attenuatin with 20cm CH_2
Boron-loaded CH_2 is available

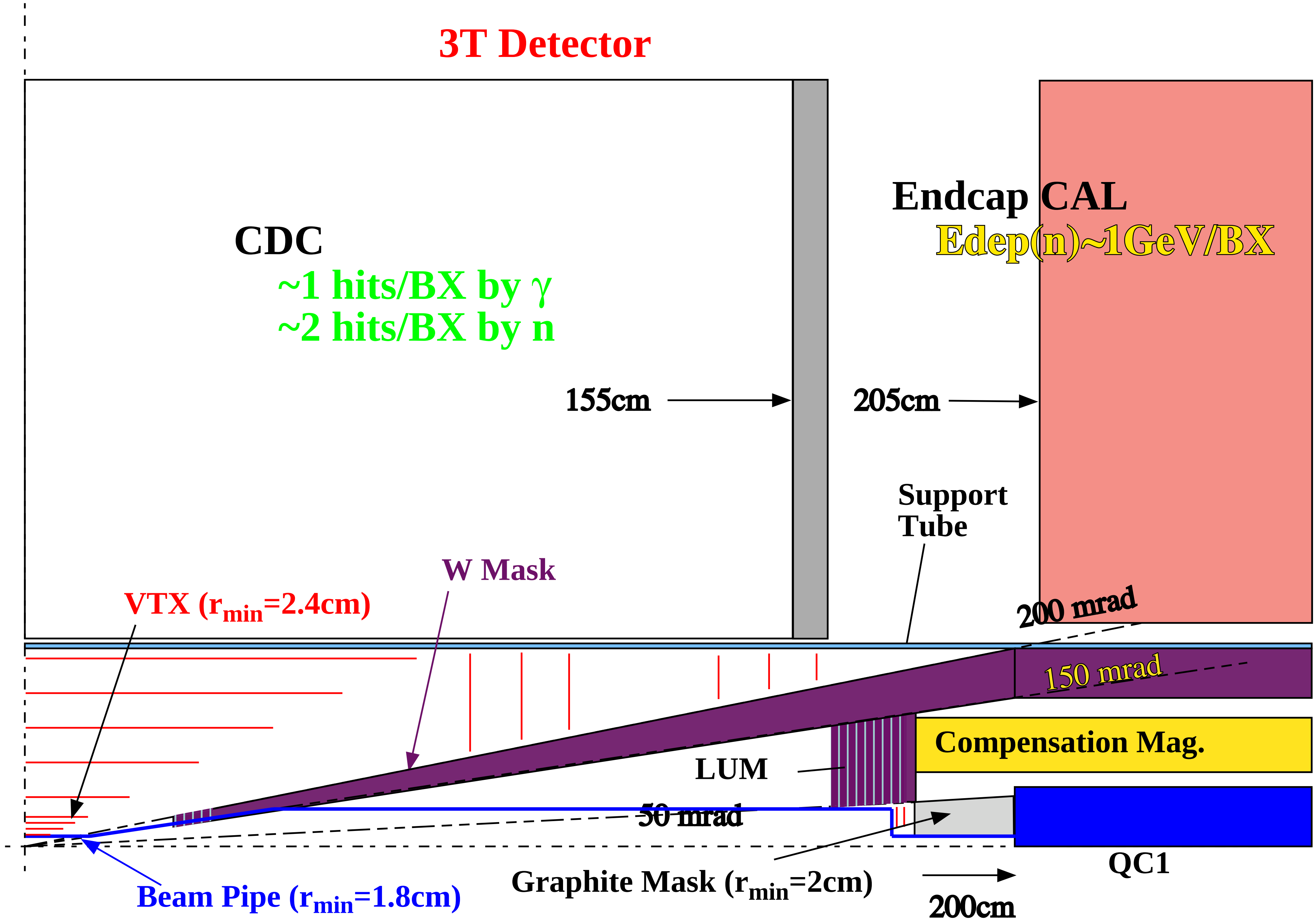
Effect of the magnetic field on the track density

| cosθ |<0.9
Rin of the graphite mask = 2.0cm

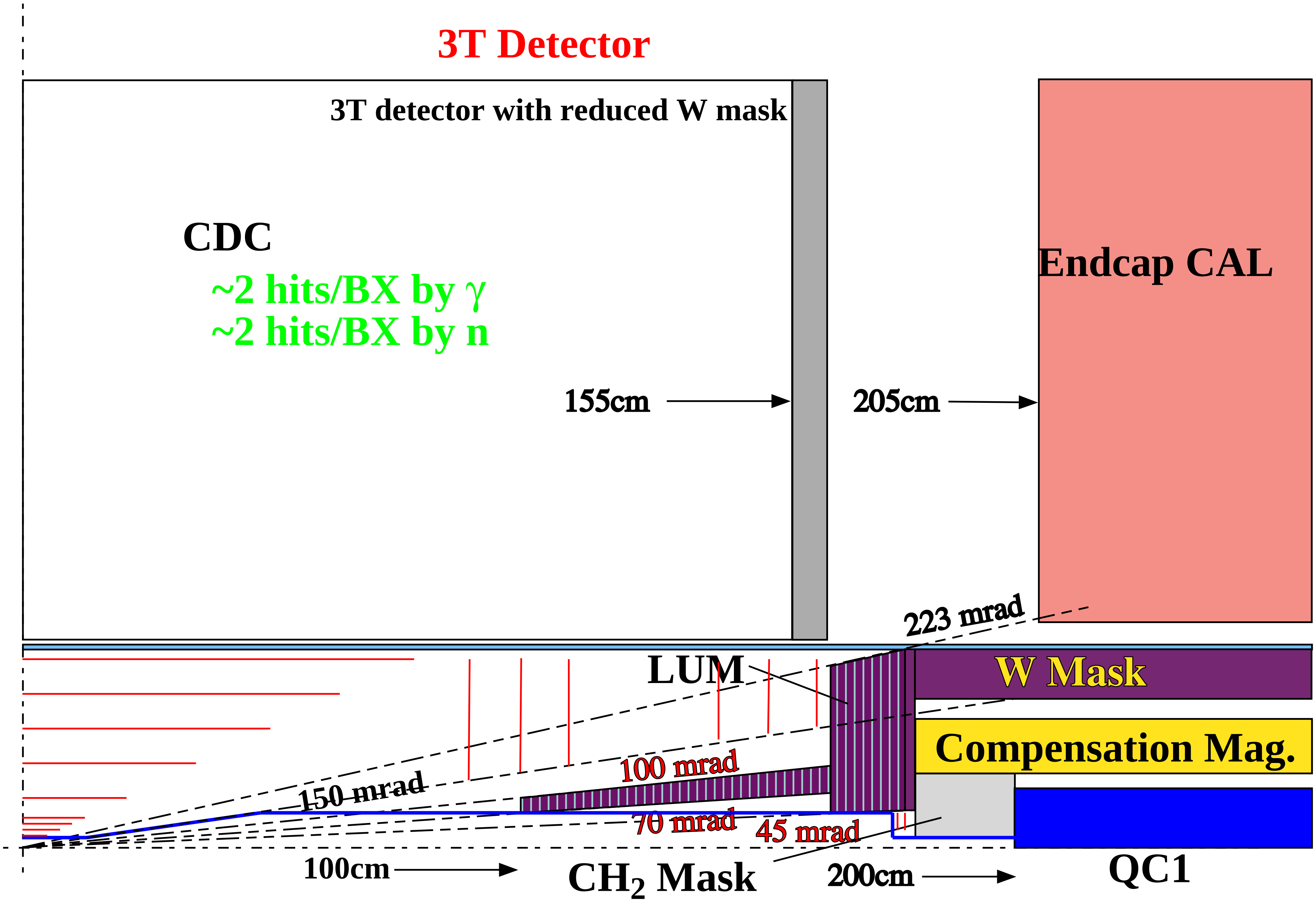




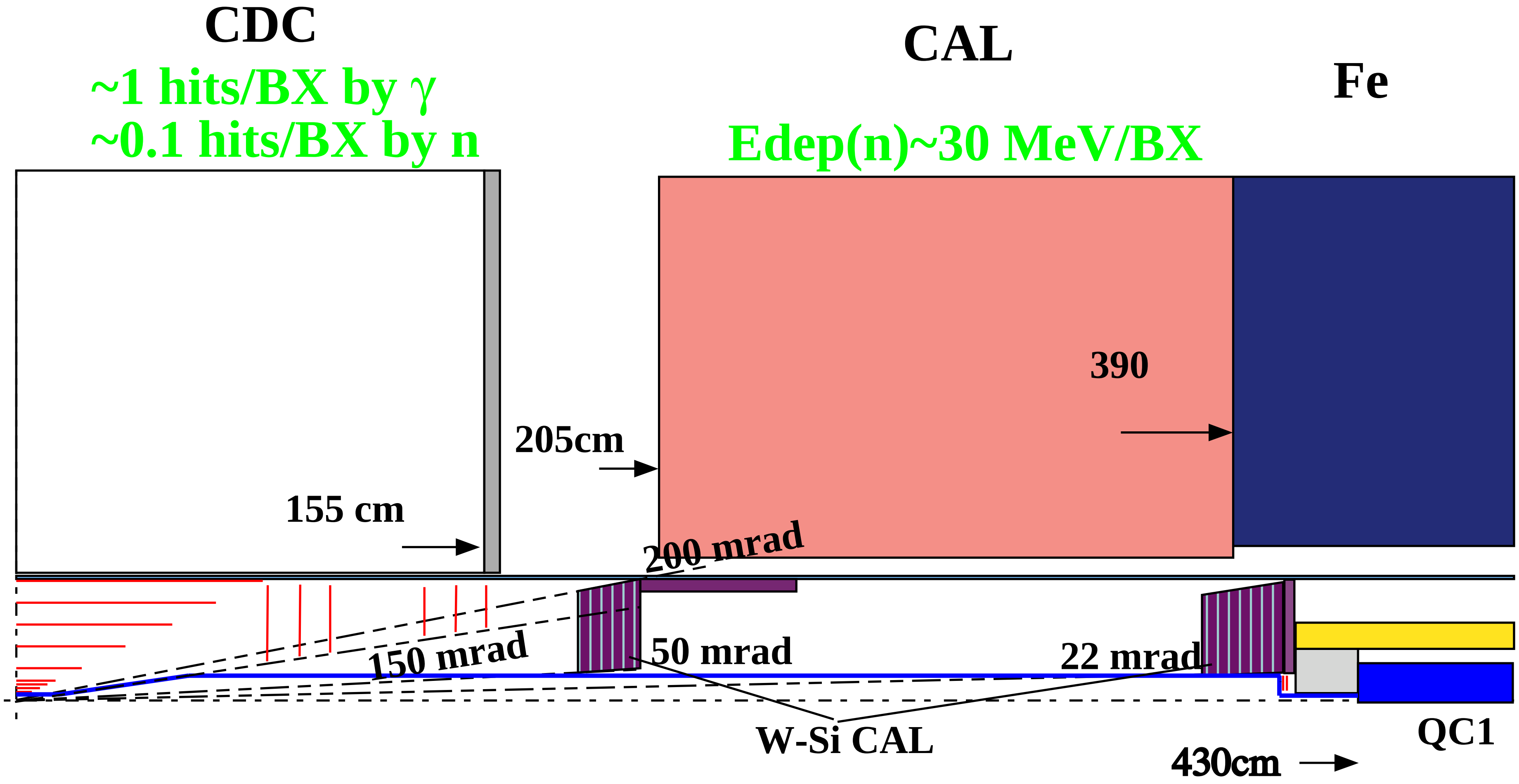

2T Detector
CDC (CO_2-IsoC_4H_{10})
~2 hits/BX by γ
~30 hits/BX by n
230cm
VTX (r_{min}=2.4cm)
W Mask (r_{min}=4.5cm at z=30cm)
40 cm
200 mrad
150 mrad
Compensation Mag.
LUM
50 mrad
Beam Pipe (r_{min}=2.2cm)
Graphite Mask (r_{min}=2cm)
200cm
QC1



3T Detector
CDC
~1 hits/BX by γ
~2 hits/BX by n
Endcap CAL
Edep(n)~1GeV/BX
155cm
205cm
Support
Tube
W Mask
VTX (rmin=2.4cm)
200 mrad
150 mrad
Compensation Mag.
LUM
50 mrad
Graphite Mask (rmin=2cm)
QC1
Beam Pipe (rmin=1.8cm)
200cm


3T Detector
3T detector with reduced W mask
CDC
~2 hits/BX by γ
~2 hits/BX by n
155cm
205cm
Endcap CAL
223 mrad
LUM
W Mask
Compensation Mag.
100 mrad
150 mrad
70 mrad
45 mrad
100cm
CH_2 Mask
200cm
QC1

3T *l**=4.3m Detector



Impact of the new optics (*l**=4.3m) on the detector

-Huge W-mask NOT needed

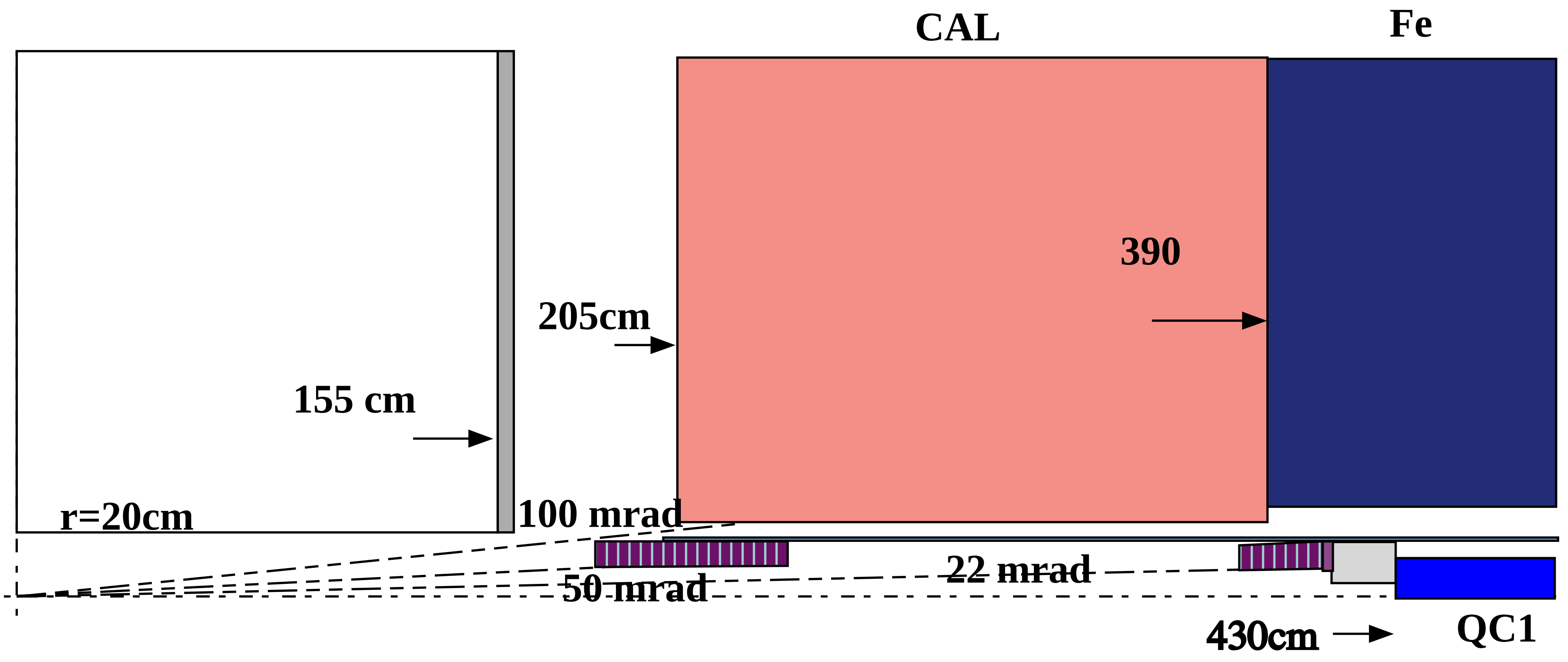
-Background hit much smaller (CDC, CAL)

-No need for Support tube (?)

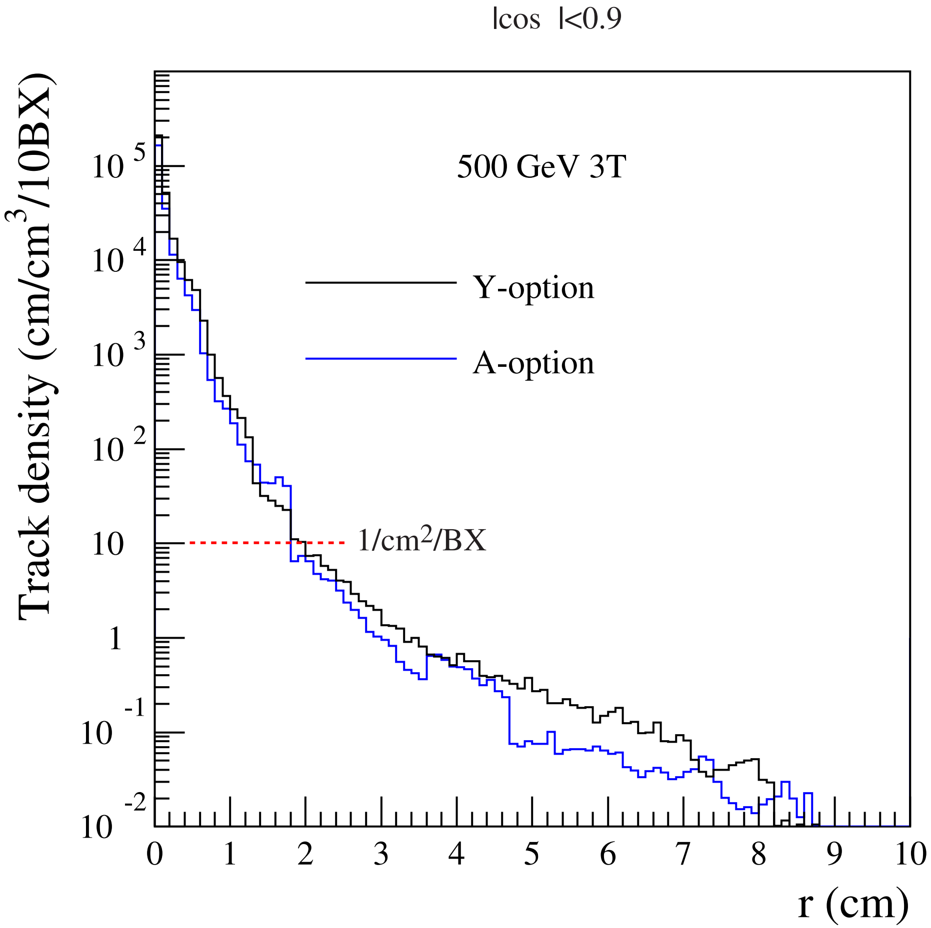
-No need for Compensation magnet (?)

if the B field @4.3m is weak enough

-Smaller R_{min} of CDC and CAL possible



Beam background with "Y" option

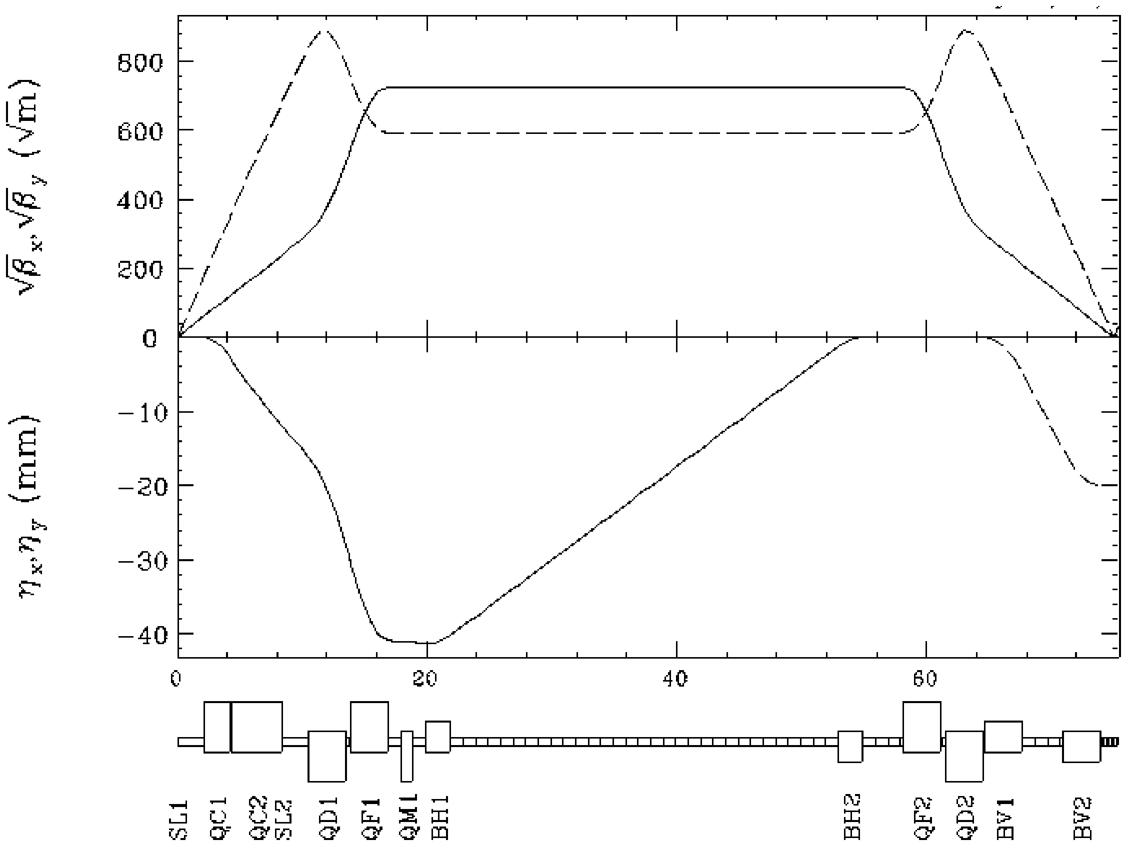


~ x2 more background than "A" option

Energy deposit in QC
"A" 17 TeV/BX
"Y" 30 TeV/BX

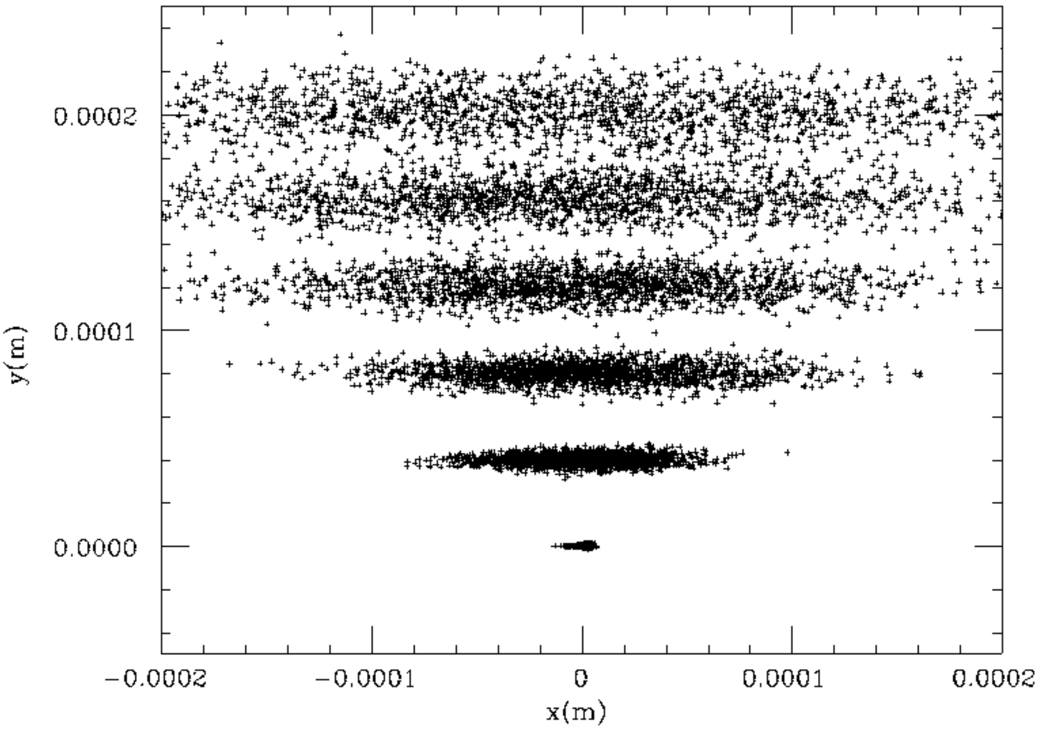
Beam extraction line with energy measurement

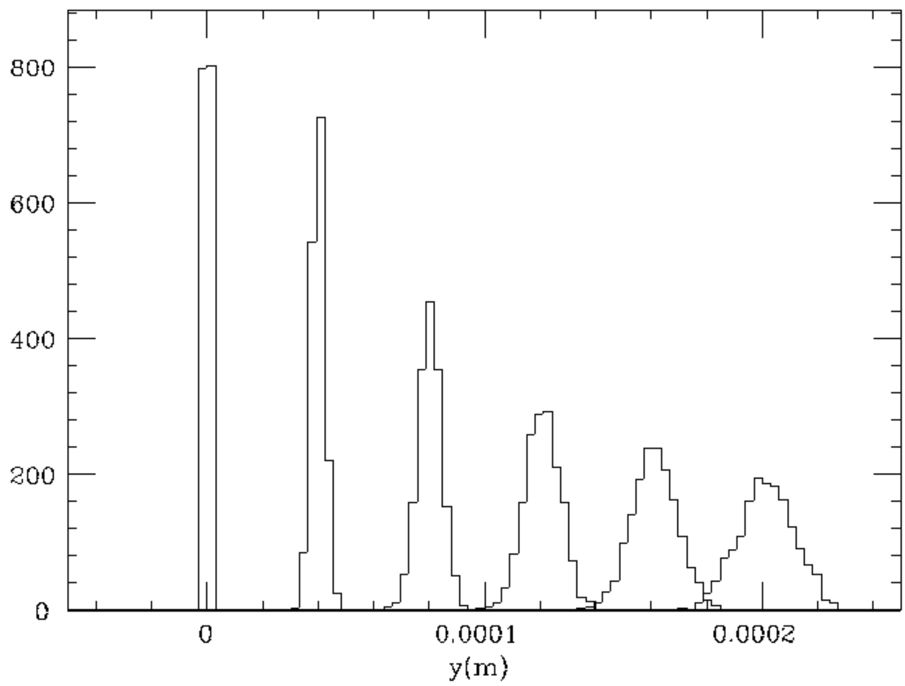
by K. Kubo



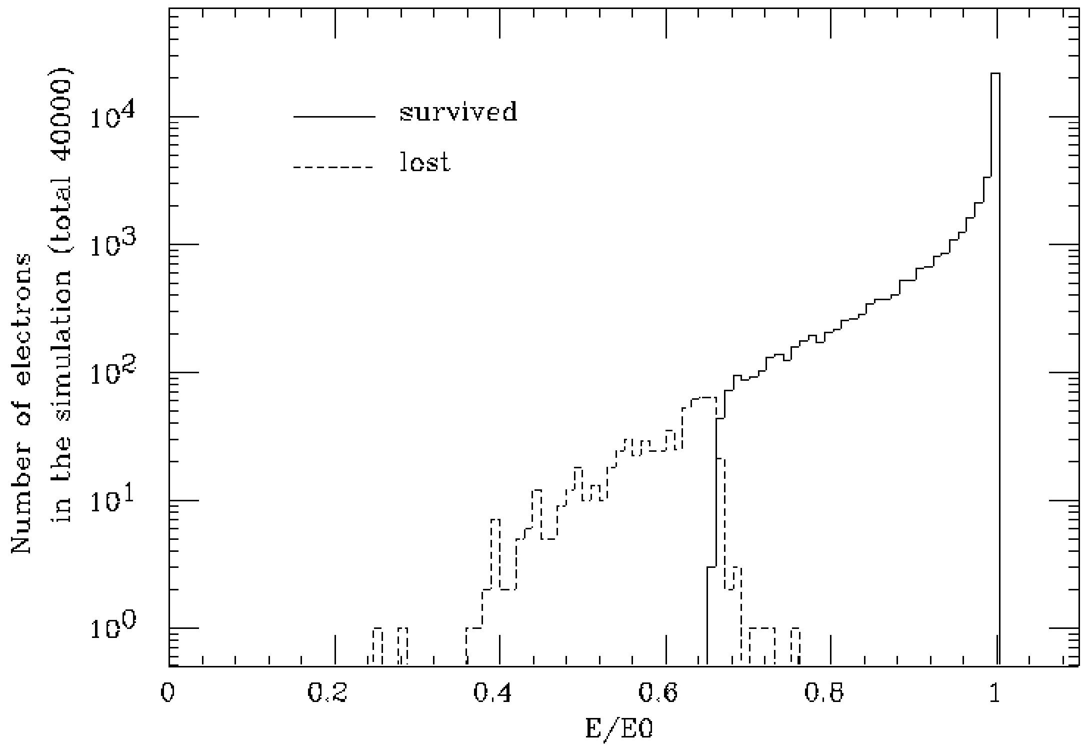
Distribution at the 2nd focal point for monochromatic beams

-dE/E = 0, 0.2, 0.4, 0.6, 0.8, 1.0%



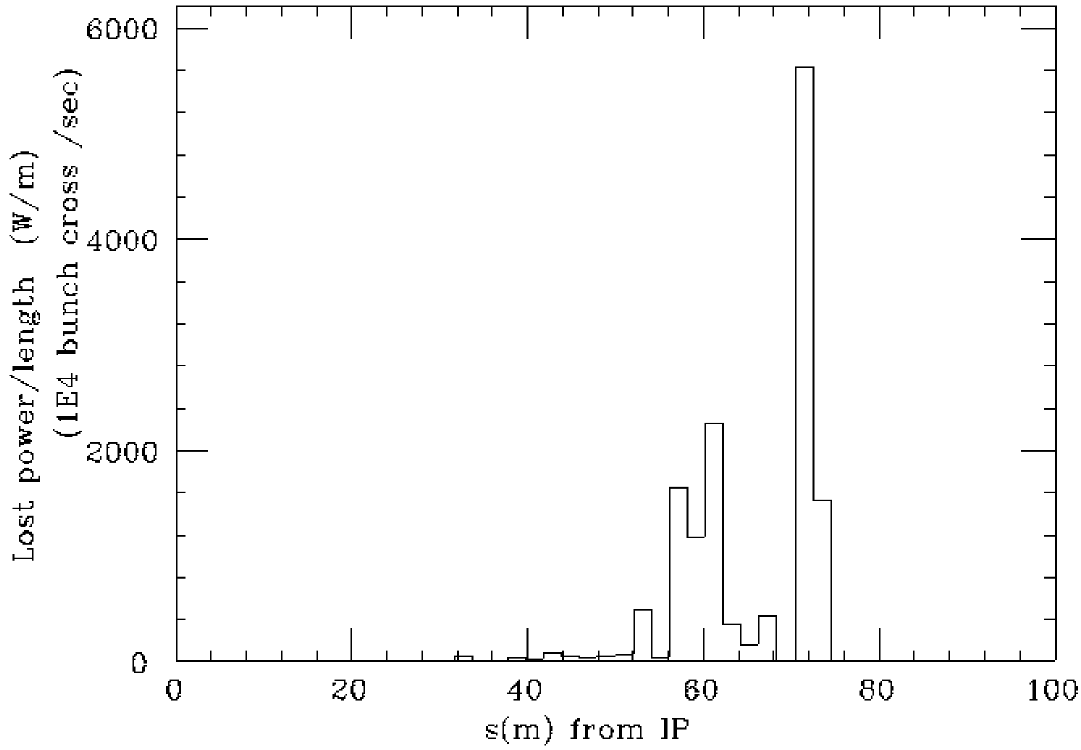


E/E0 distribution

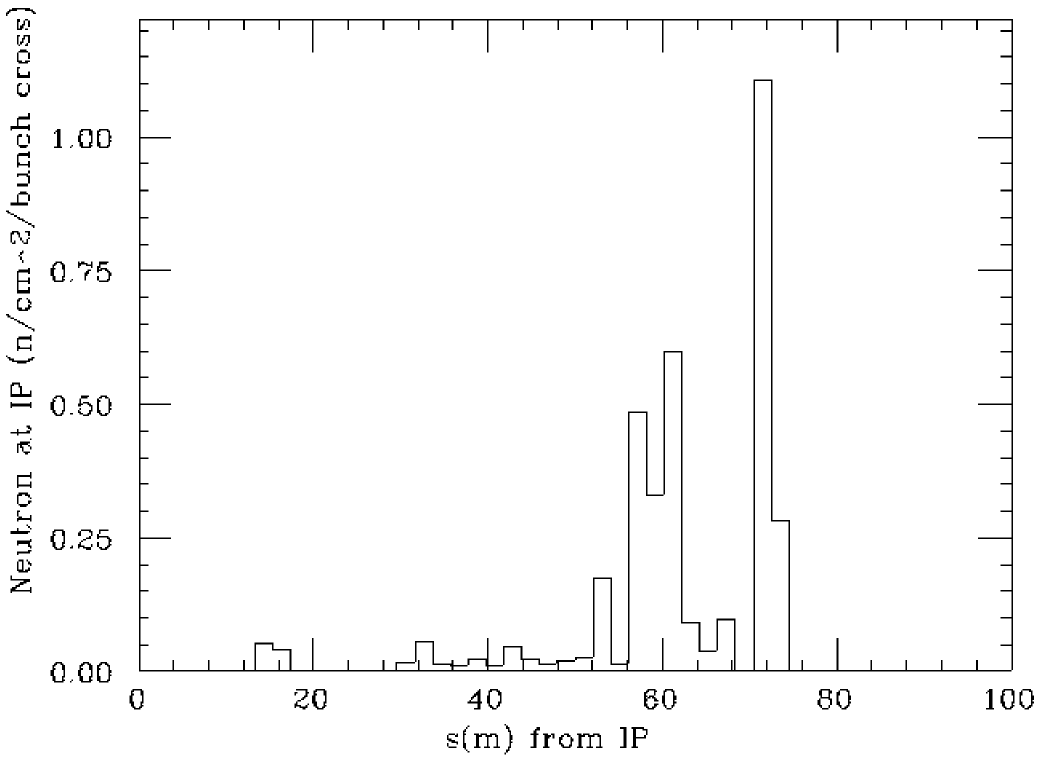


Beam loss along the extraction line

Power (W/m)

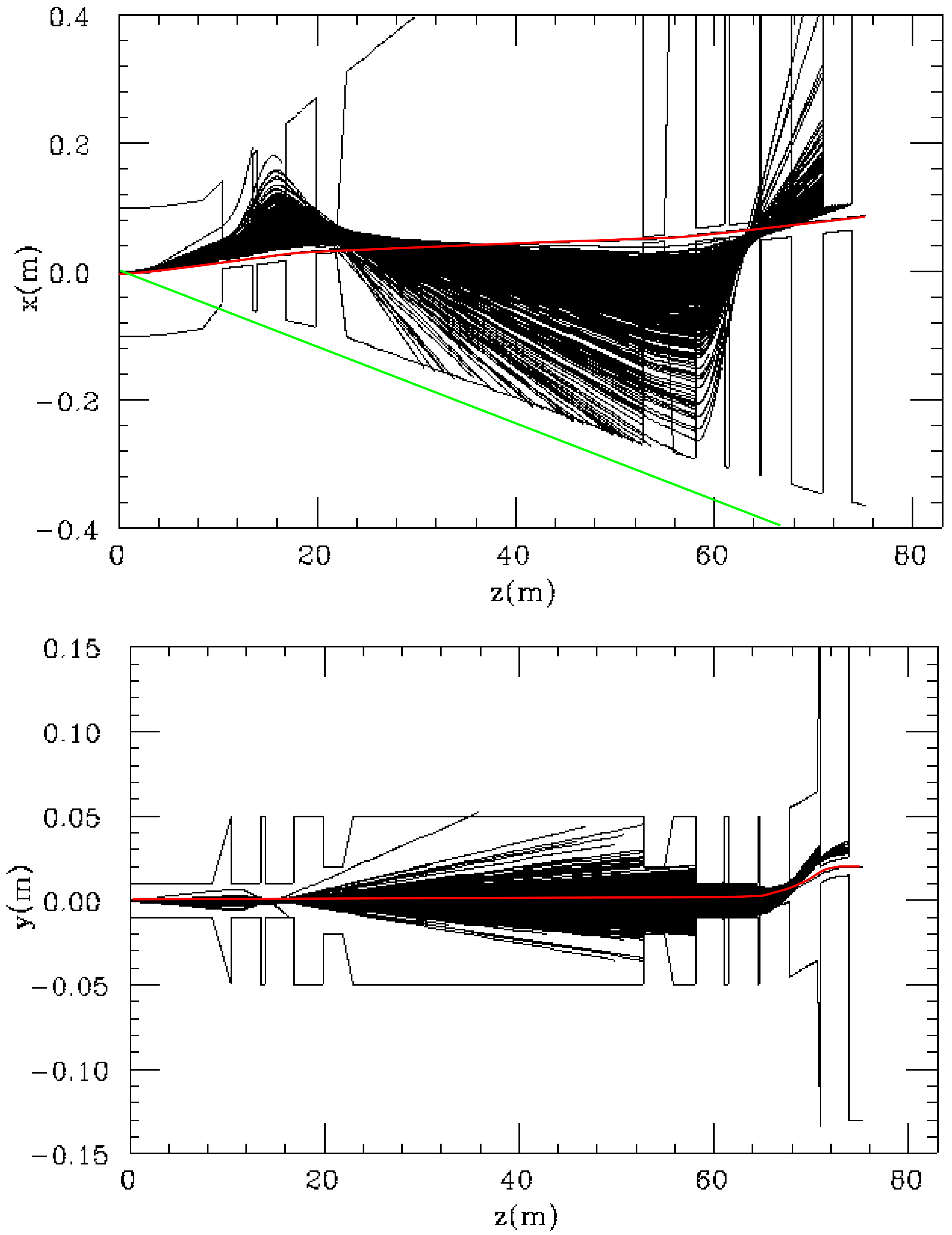


Neutron at IP (/cm^2/bunch crossing)



0.1 n/ GeV is assumed (self shielding effect NOT included)
Total = 4×10^{11}/cm^2/y at IP -> 1/100 attenuation is enough

Trajectories of the lost electrons



Summary

- **VTX hit density in 3T detector is ~1/2 of that in 2T detector. Low-Z mask at B~0 is important to suppress backscatterd e+-.**

- **CDC hits by neutron in 3T detector are much reduced because of reduction of CDC length and change of ECAL position.**

- **With the new optics (l*=4.3 m), background hits in CDC and ECAL becomes still less. The huge W-mask, the support tube, and the compensation magnet may not be necessary.**

Detector Model	CDC hits / BX (γ)	CDC hits / BX (n)	CAL Edep (GeV / BX) (γ)	CAL Edep (GeV / BX) (n)
2T	2	30	~0	0.6
3T (l*=2 m)	1	2	~0	0.9
3T (l*=4.3 m)	1	0.1	0.01	0.03

- **With higher (x3) luminosity option, background hits becomes ~x2**

- **Design of beam extraction line with energy measurement capability has been started. Neutron background produced by disrupt beam along the extraction line is $4 \times 10^{11}/cm^2/y$ at IP without any shielding.**