

New JLC Mask System at B=3T

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Contents:

- Pair background hits in JLC detector models
 - 2T, 3T($l^*=2\text{m}$), 3T($l^*=4.3\text{m}$)
- 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.	γ, n	VTX, CDC
	(extraction line)		
Beam-strahlung γ :	b.s.	γ, n	VTX
	(γ beam dump)		
Main beam :	b.s.	n	VTX
	(e beam dump)		
Synchrotron Rad. :	b.s.	γ	VTX, CDC
	(extraction line)		

Simulation

Generation of pair background:

CAIN

Ebeam=250GeV

"A" option ("Y" option)

Detector Simulation:

JIM (based on GEANT3)

Ecut for γ : 10 keV

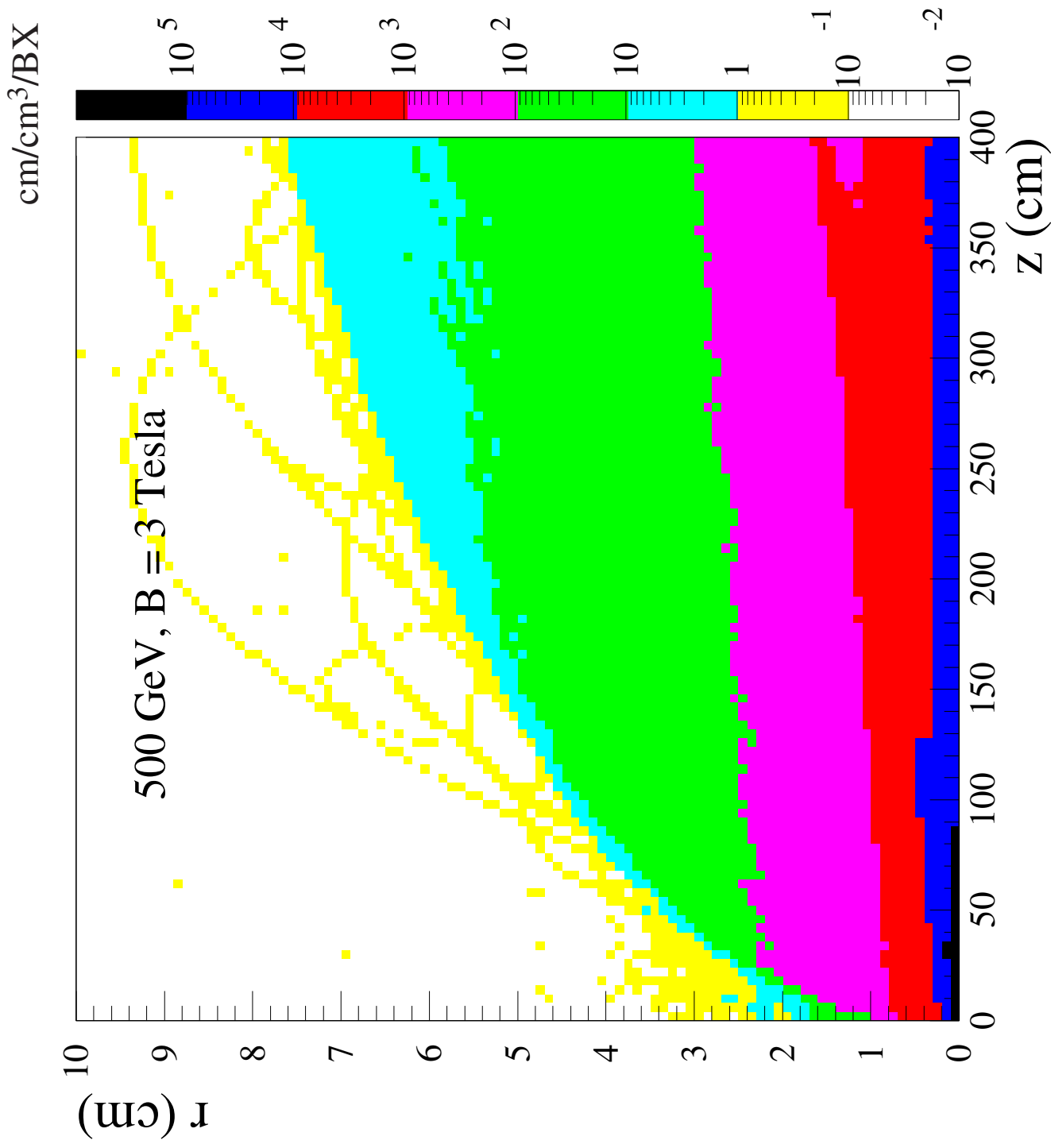
Ecut for n: 1 keV

B field of compensation mag. & QC included

500GeV (CM) Hi-Lum Parameters of JLC

	A	X	Y
Luminosity			
Nominal Lum. ³⁾	0.88	1.57	2.61
	0.63	1.08	1.75
Bunch Population	0.75	0.55	0.70
No. of bunches/pulse	95	190	190
Bunch separation	2.8	1.4	1.4
Linac length/beam ⁷⁾	5.21	5.54	5.97
AC power(2 linacs)	117	126	136
Beam power/beam	4.28	6.28	7.99
Loaded gradient ⁴⁾	57.6	54.2	50.2
Bunch length σ_z	90	80	80
$\gamma\mathcal{E}_x$ (DR exit)	3	3	3
$\gamma\mathcal{E}_y$ (DR exit)	0.03	0.02	0.02
$\gamma\mathcal{E}_x$ (IP)	4	4	4
$\gamma\mathcal{E}_y$ (IP)	0.06	0.04	0.04
Cavity align. tol. ⁶⁾	15	18	14
β_x^*	10	6	6
β_y^*	0.1	0.1	0.1
IP beam size σ_x^*	286	222	222
σ_y^*	3.15	2.86	2.86
Diagonal angle σ_x^*/σ_z	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
γ_{ave}	0.136	0.146	0.188
δ_{BS}	4.42	4.39	6.67
n_γ	1.07	1.01	1.28

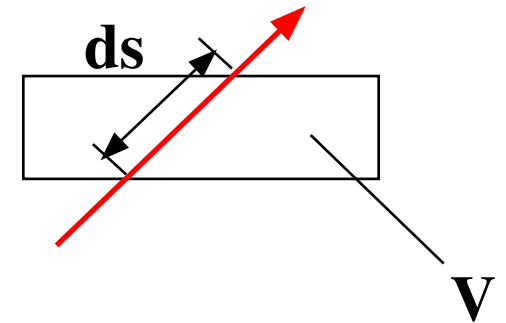
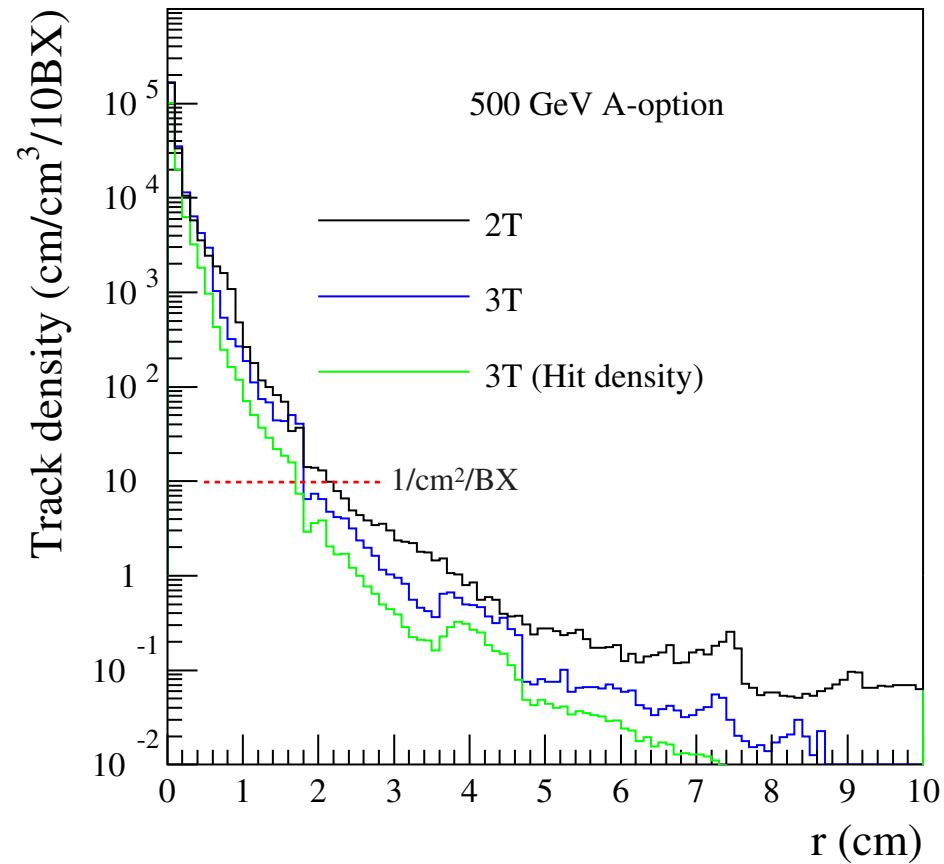
Pair background track density



Pair background track density

$$|\cos \theta| < 0.9$$

$$\text{track density} = ds / V$$

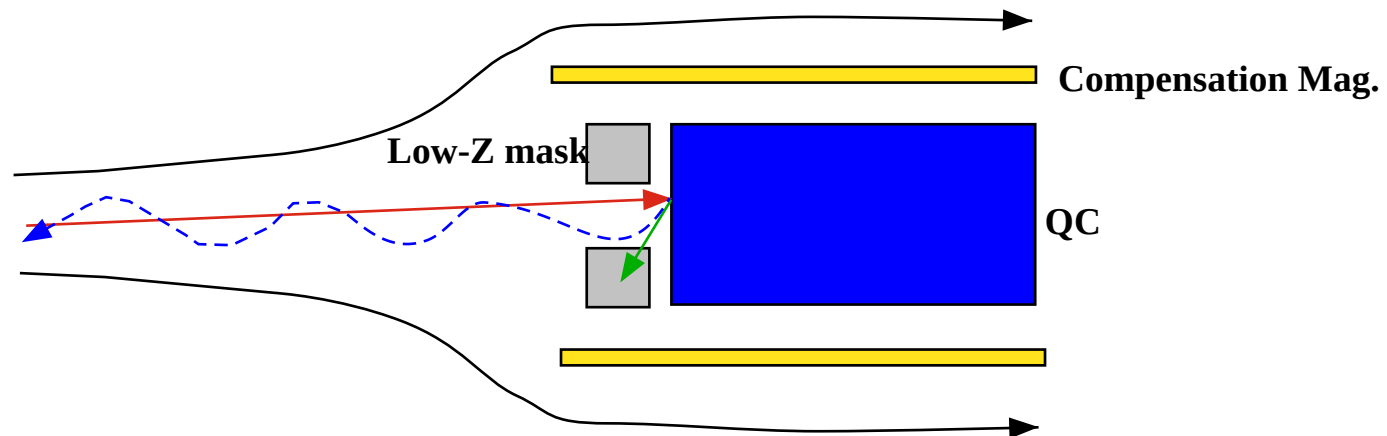


Detector models and Mask system

Detector Model		QC1 surrounded by	Mask System
Old	B=2T l*=2m	CDC	Long tungsten(W) mask inside support tube Low-Z (graphite/CH₂) 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 $B \sim 0$ is very effective to absorb backscattered low energy e^+/e^-



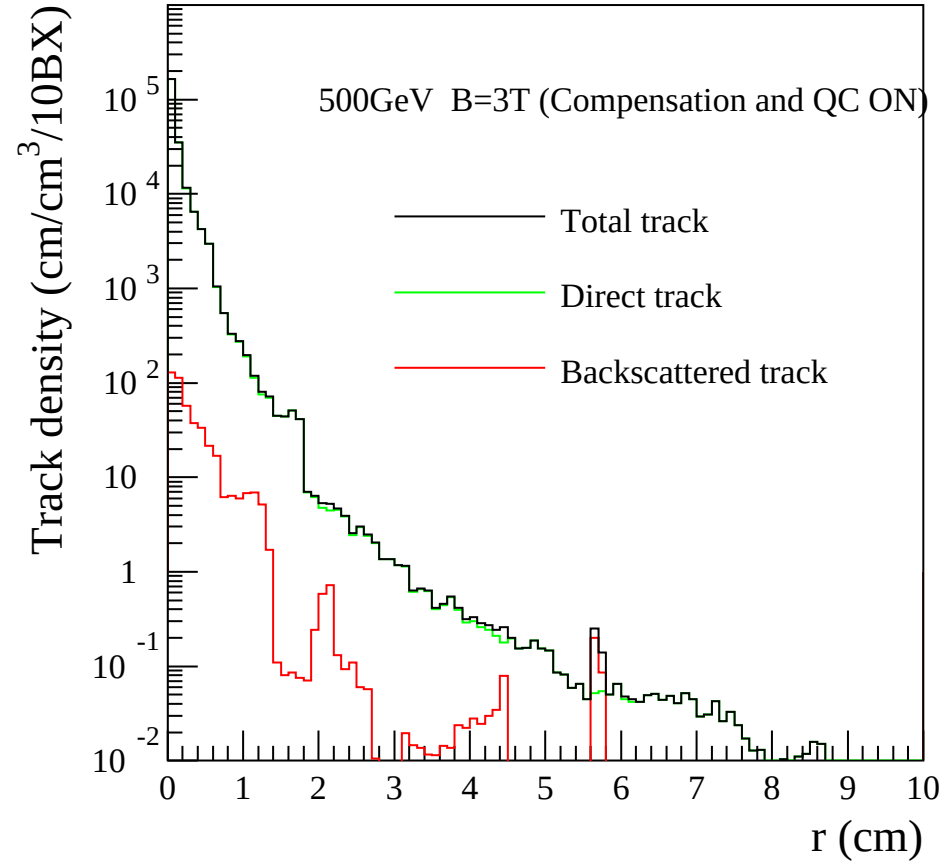
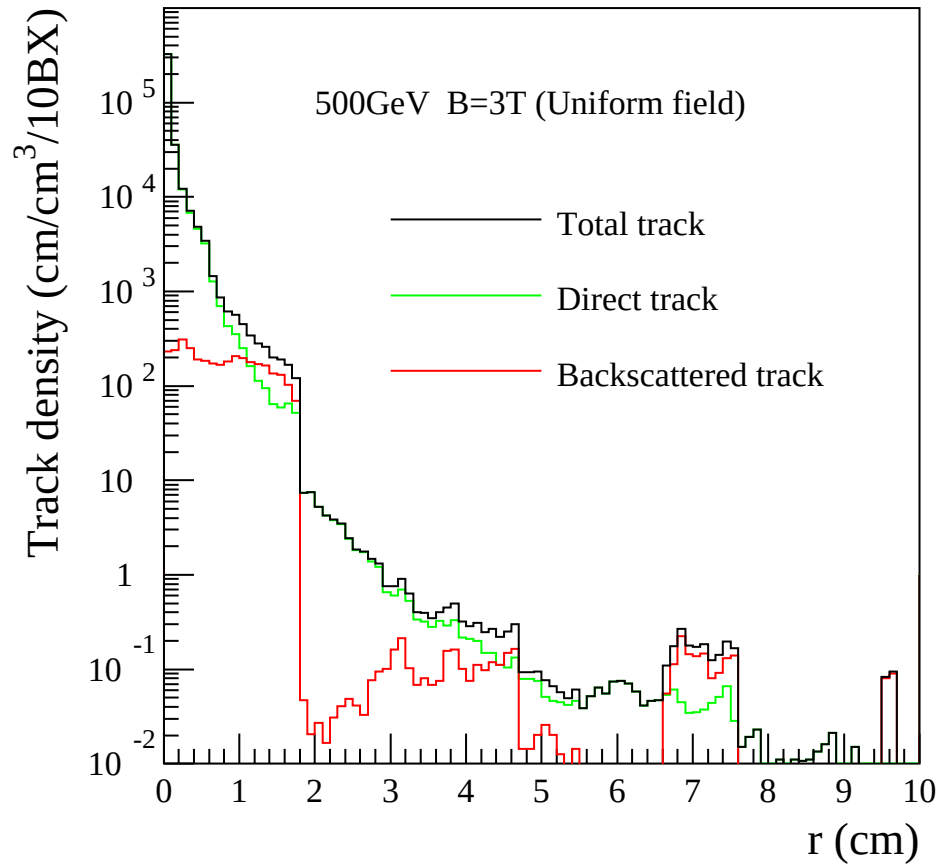
- Low-Z mask works as a neutron shield

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

Effect of the magnetic field on the track density

$$|\cos\theta| < 0.9$$

Rin of the graphite mask = 2.0cm



2T Detector

CDC (CO₂-IsoC₄H₁₀)

~2 hits/BX by γ

~30 hits/BX by n

230cm

VTX ($r_{\min}=2.4\text{cm}$)

W Mask ($r_{\min}=4.5\text{cm}$ at $z=30\text{cm}$)

40 cm

200 mrad

150 mrad

LUM

Compensation Mag.

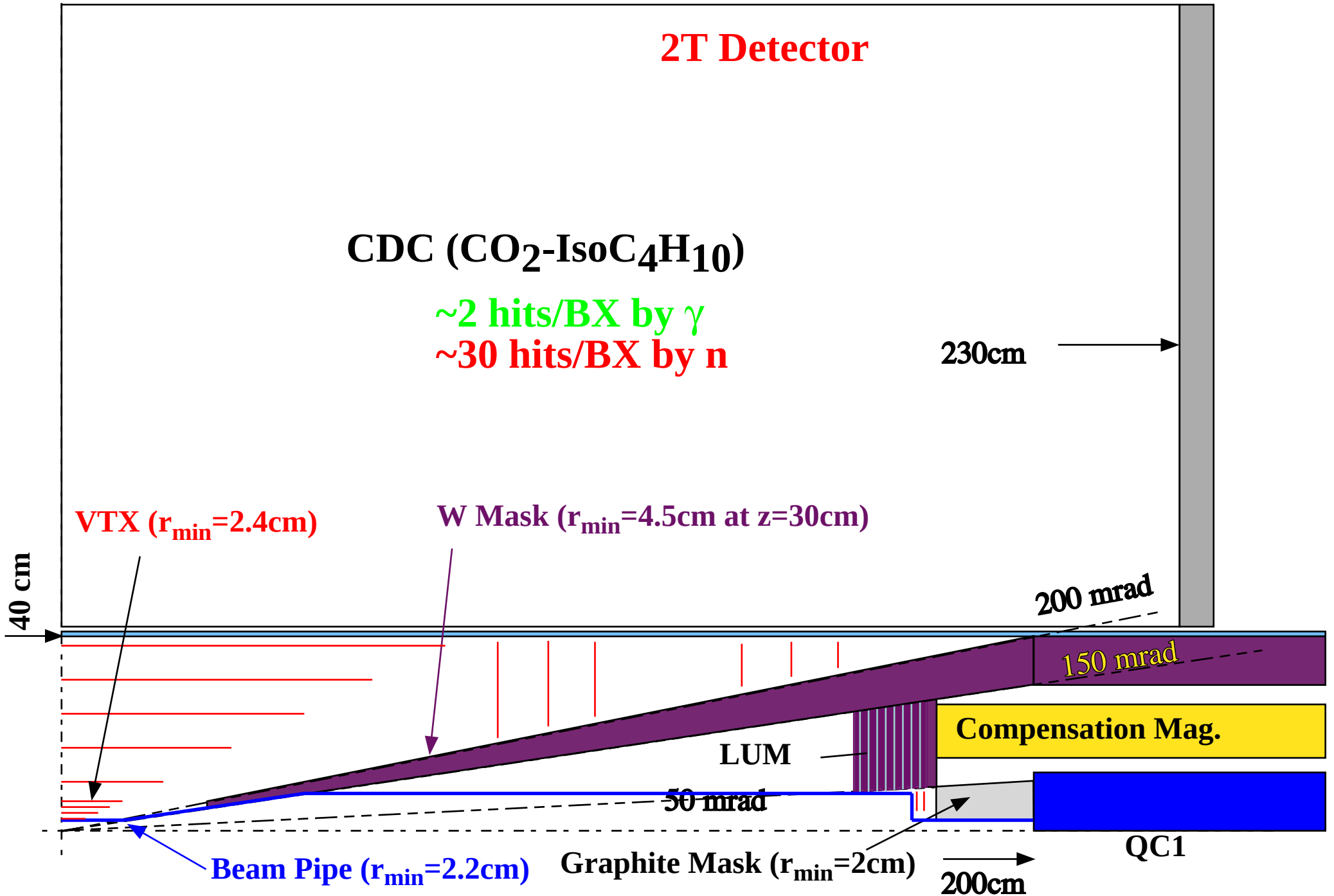
50 mrad

Beam Pipe ($r_{\min}=2.2\text{cm}$)

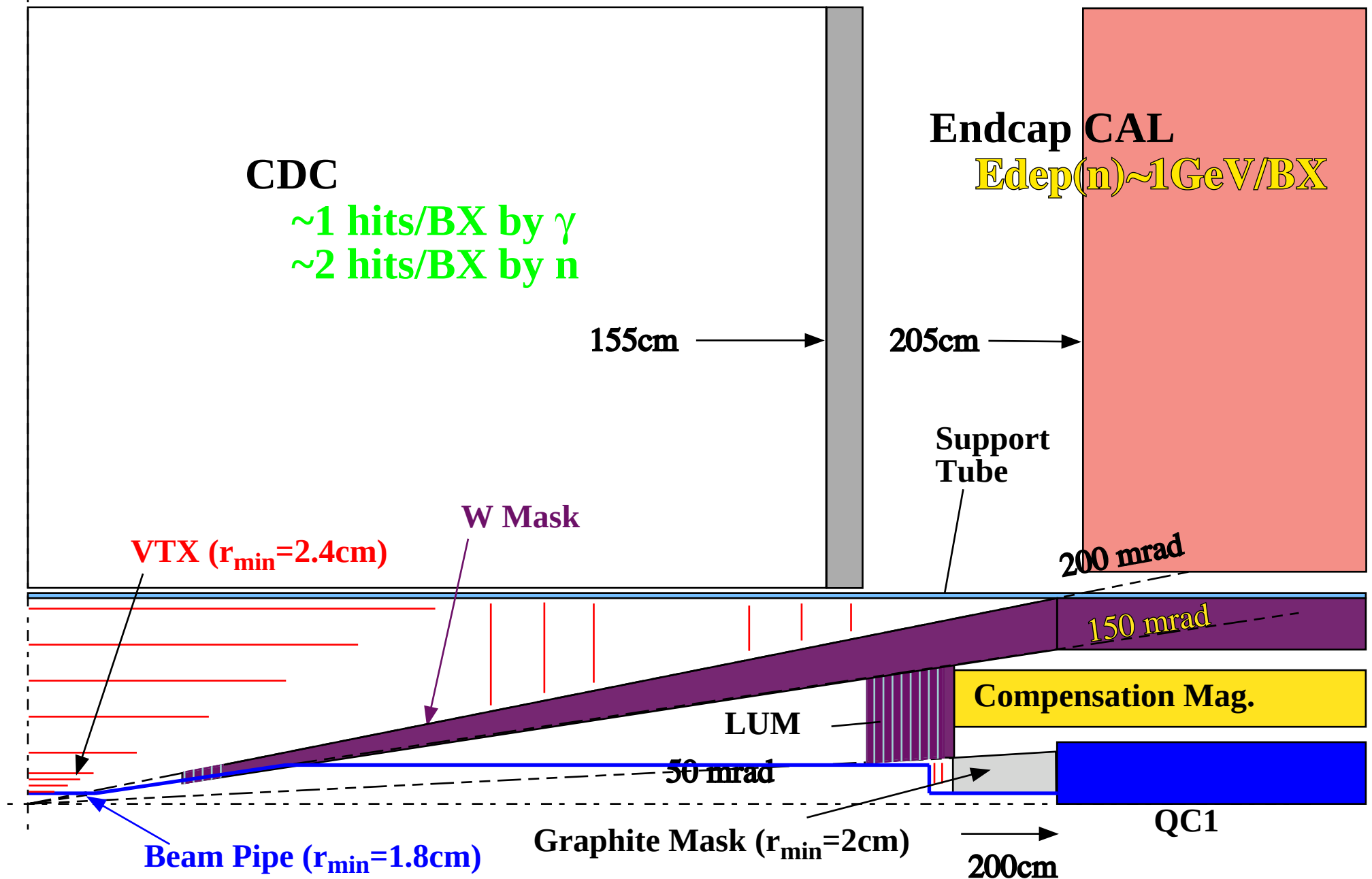
Graphite Mask ($r_{\min}=2\text{cm}$)

200cm

QC1



3T Detector



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.

150 mrad

100 mrad

70 mrad

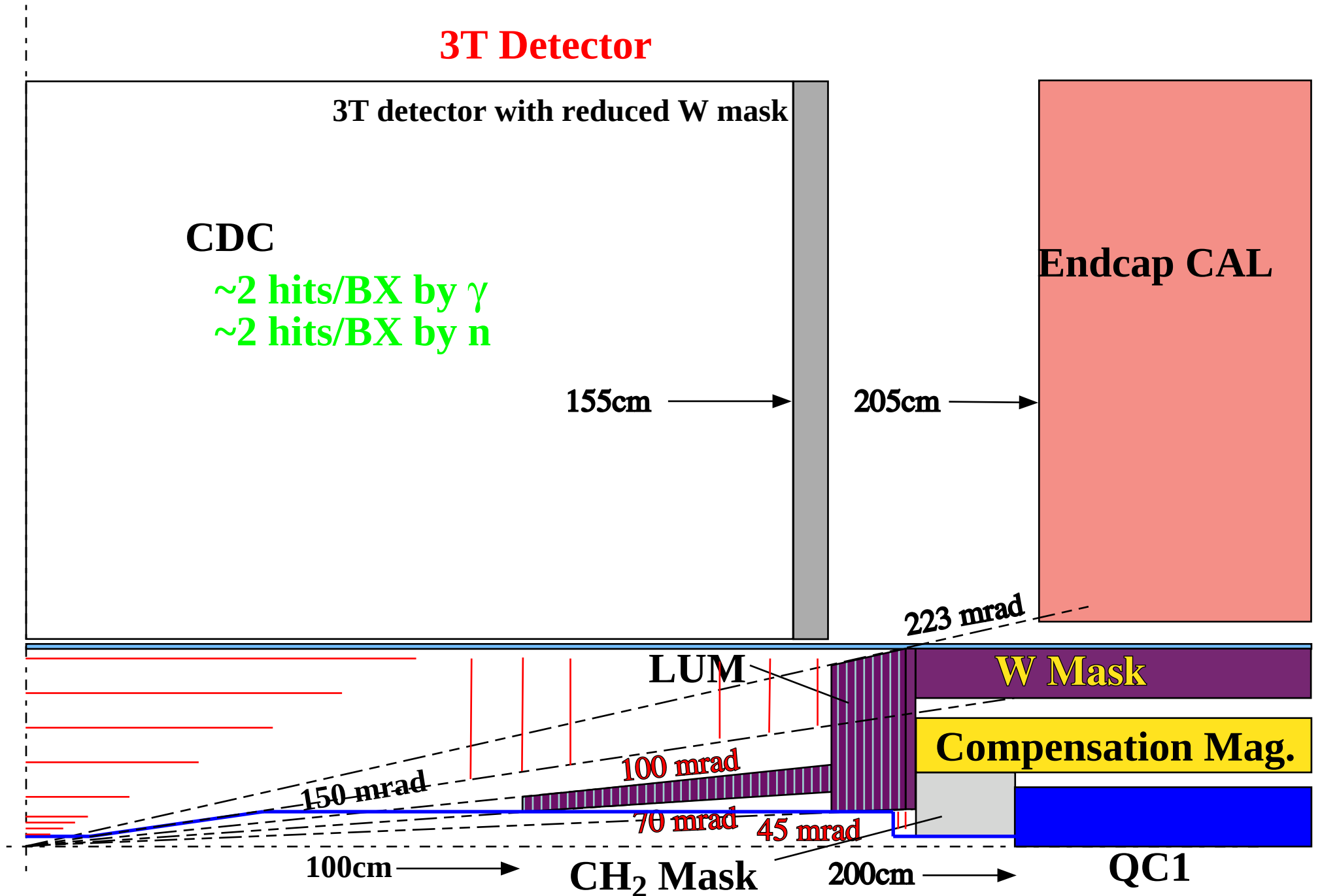
45 mrad

100cm

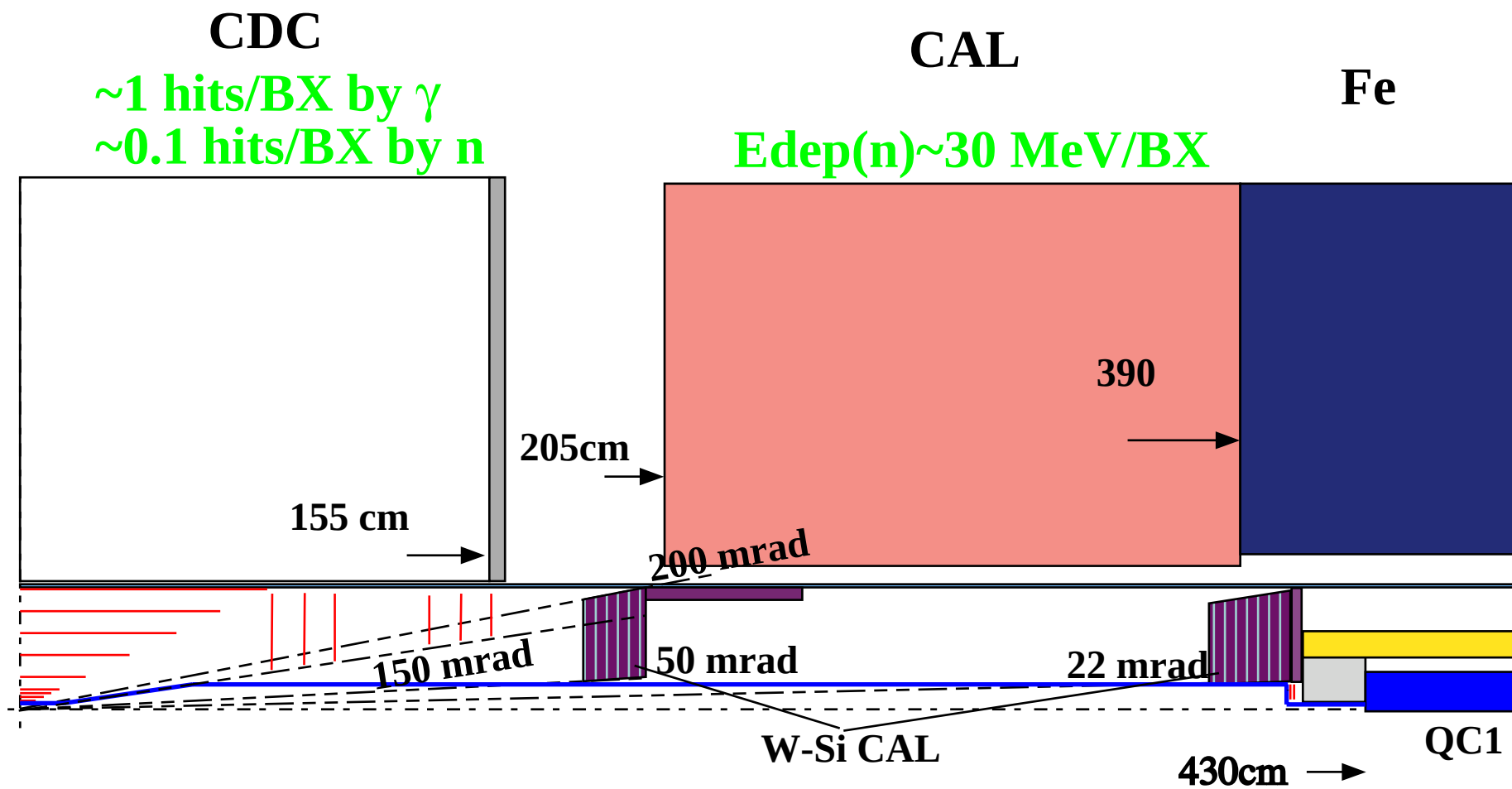
CH₂ Mask

200cm

QC1

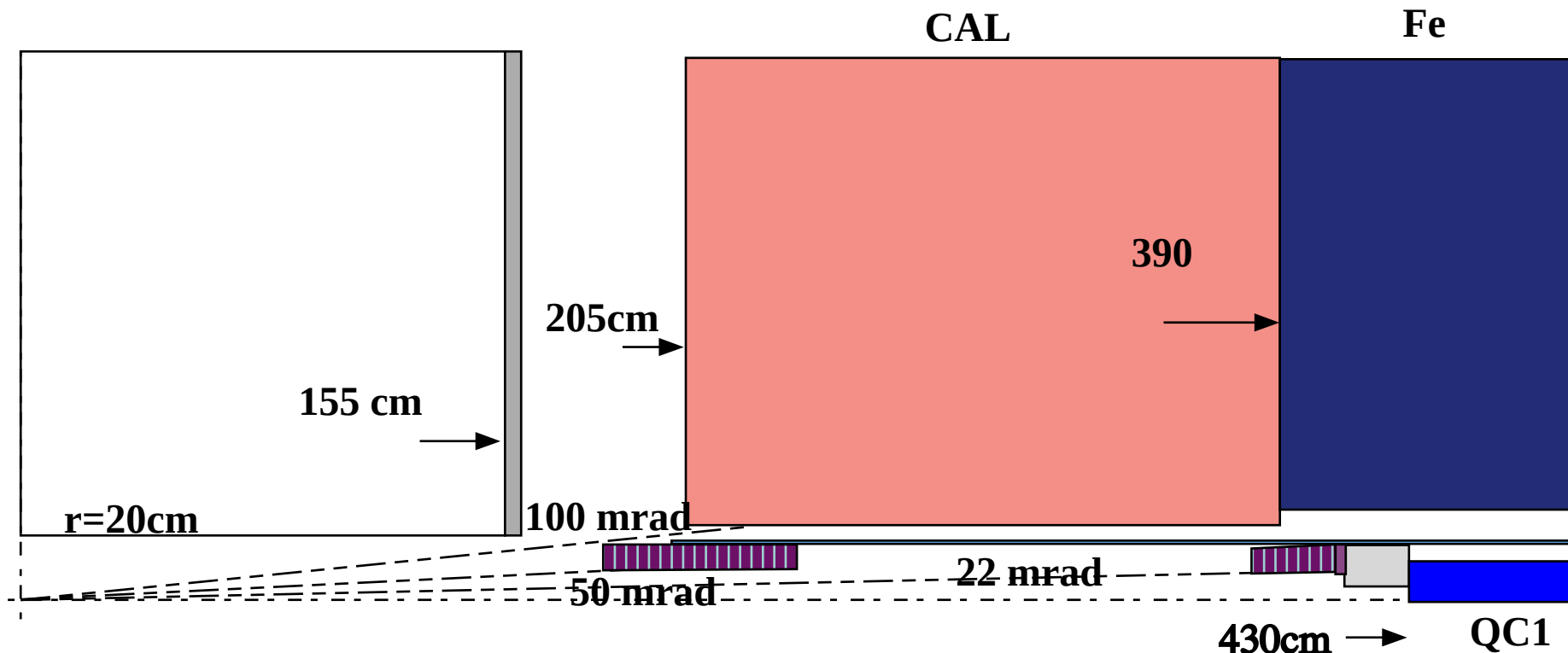


3T $I^*=4.3\text{m}$ Detector

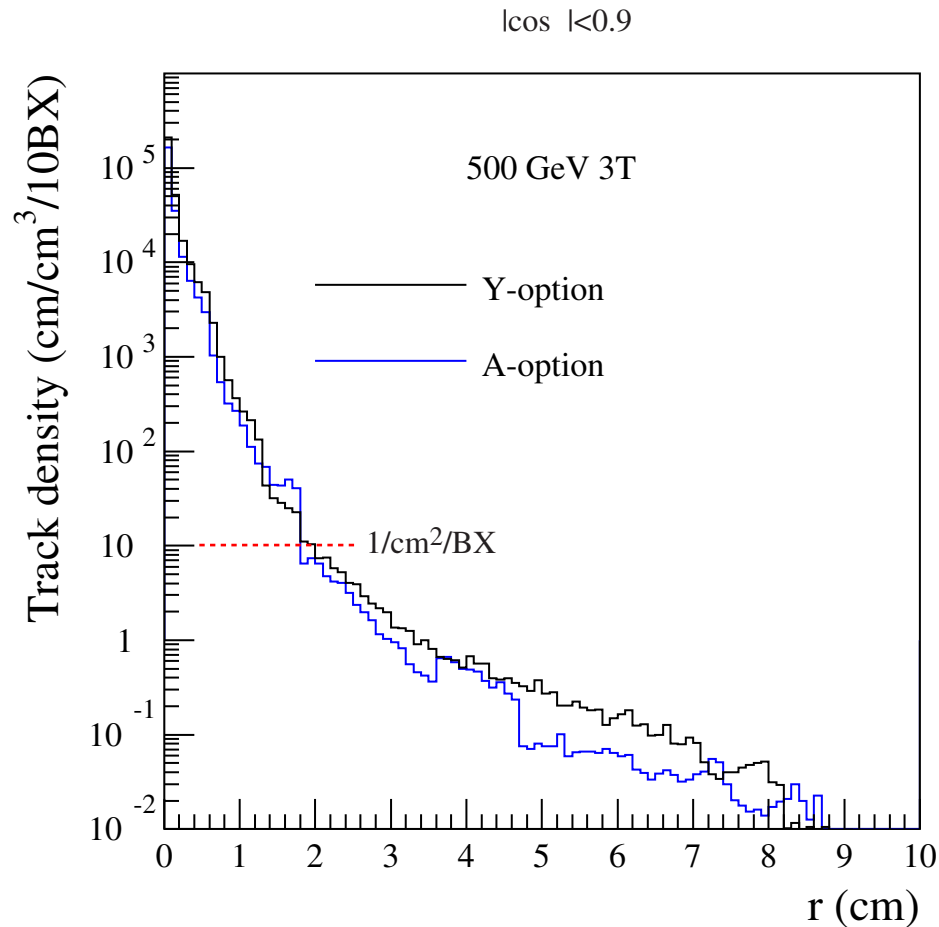


Impact of the new optics ($l^*=4.3\text{m}$) on the detector

- 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

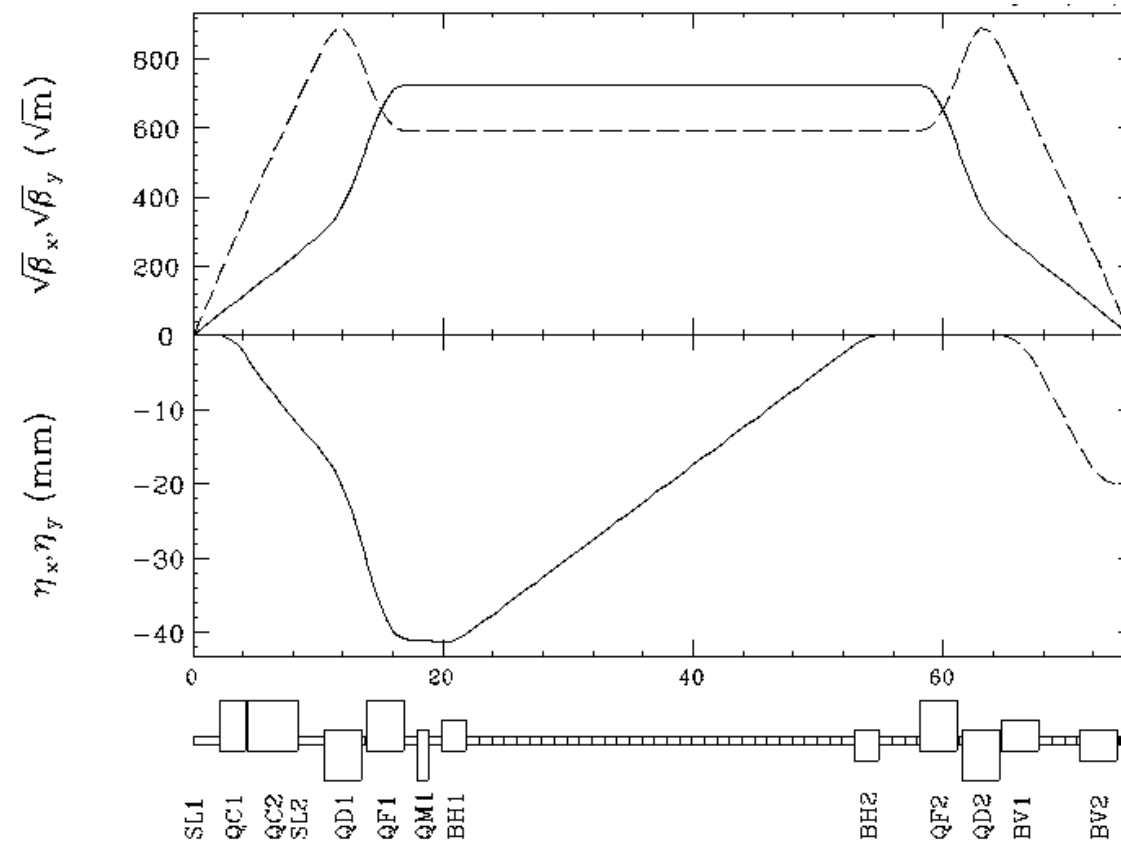


**~ x2 more background
than "A" option**

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

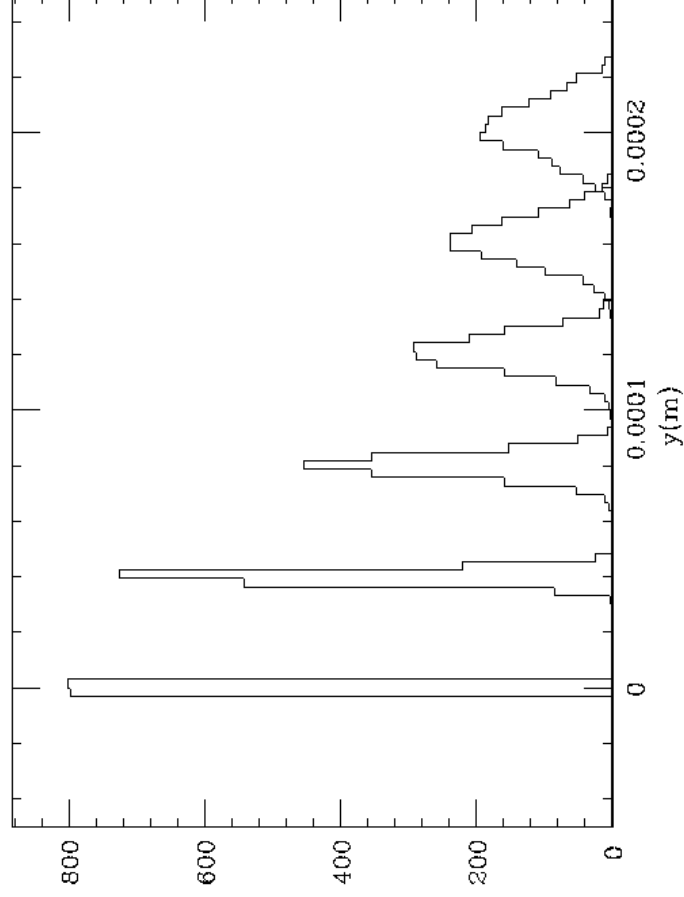
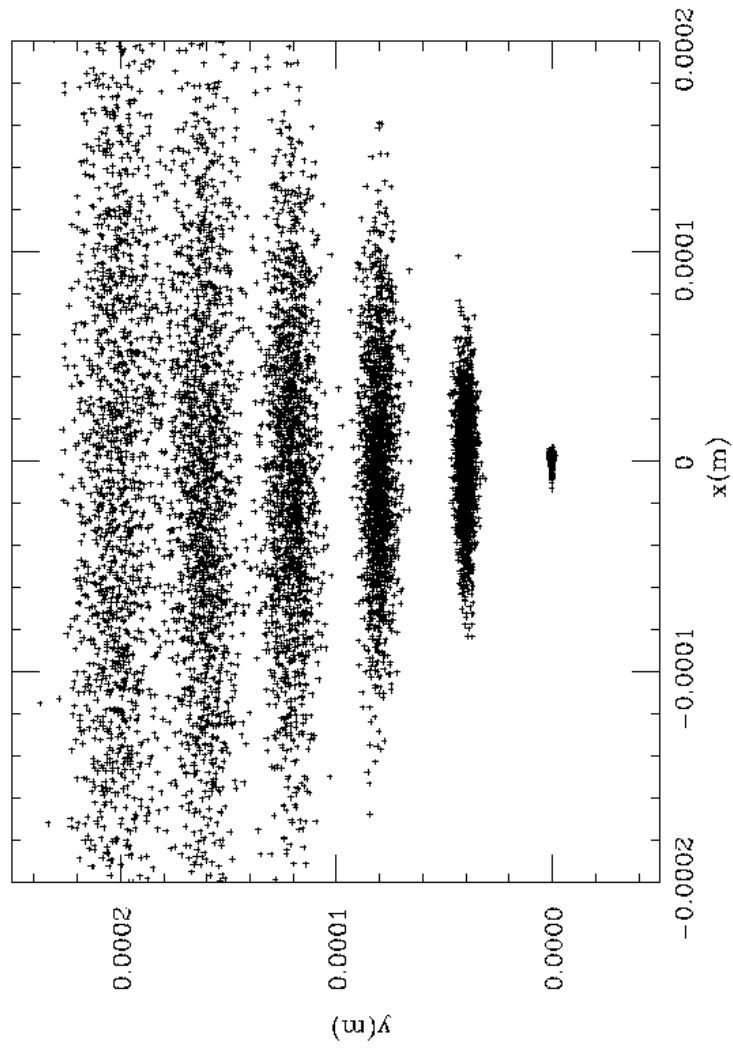
Beam extraction line with energy measurement

by K. Kubo

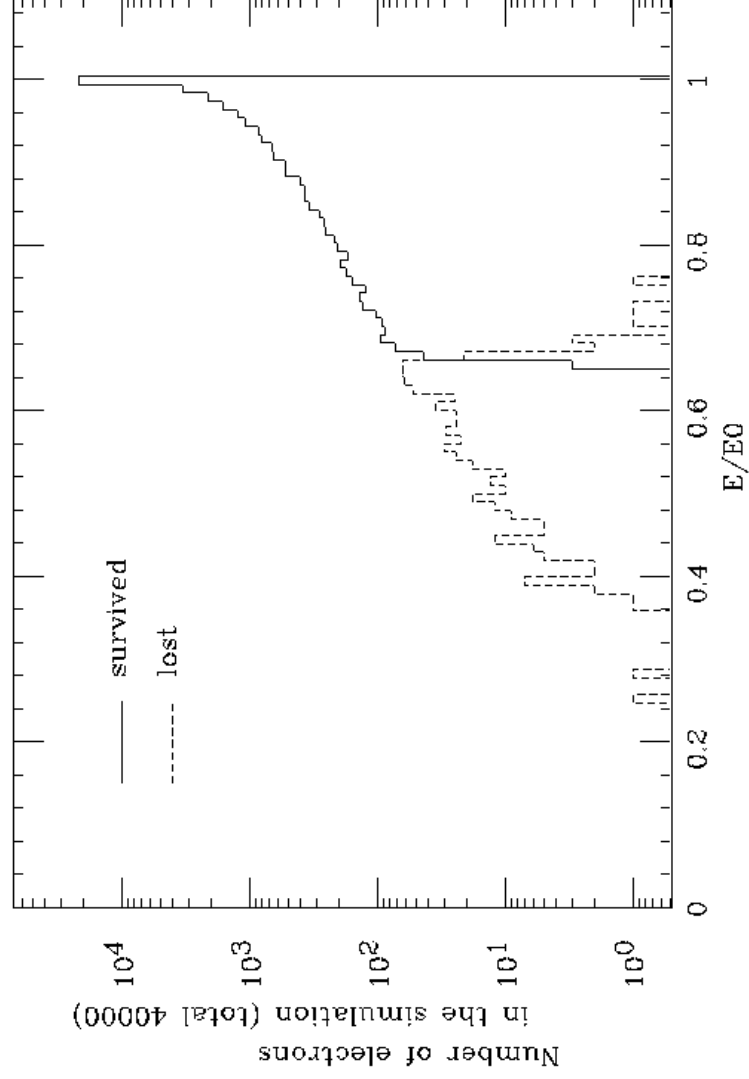


Distribution at the 2nd focal point for
monochromatic beams

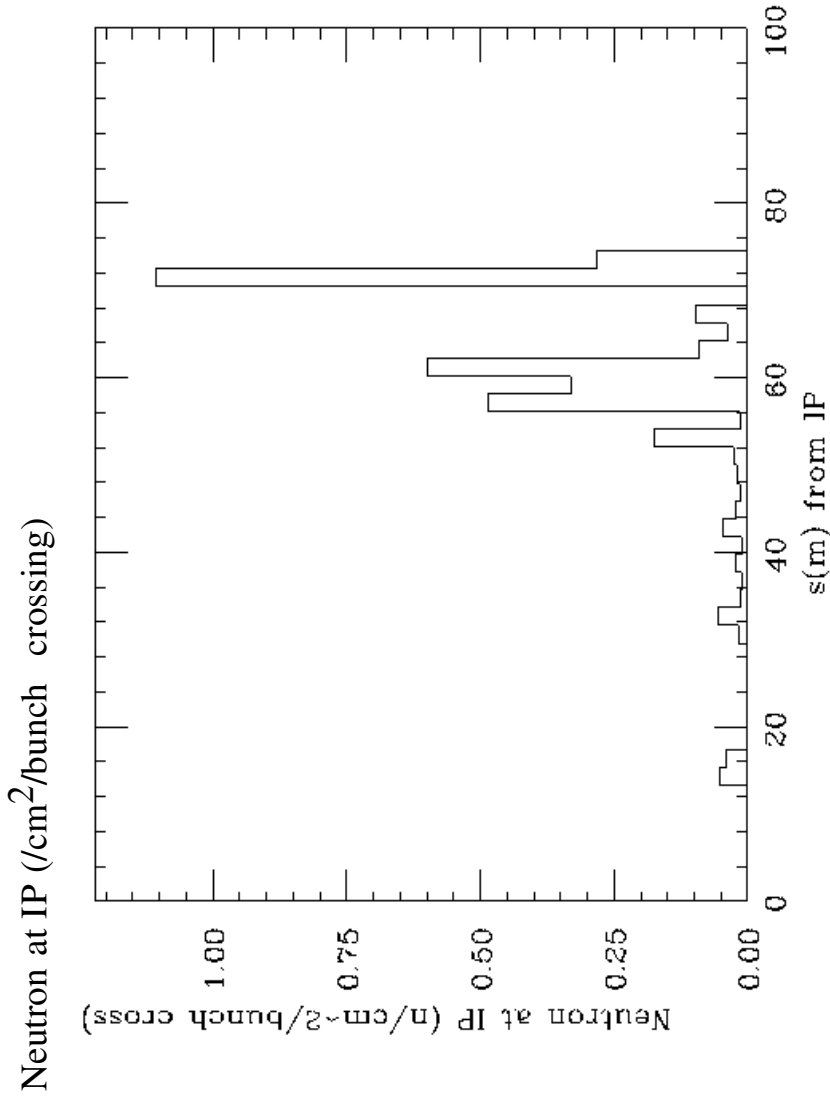
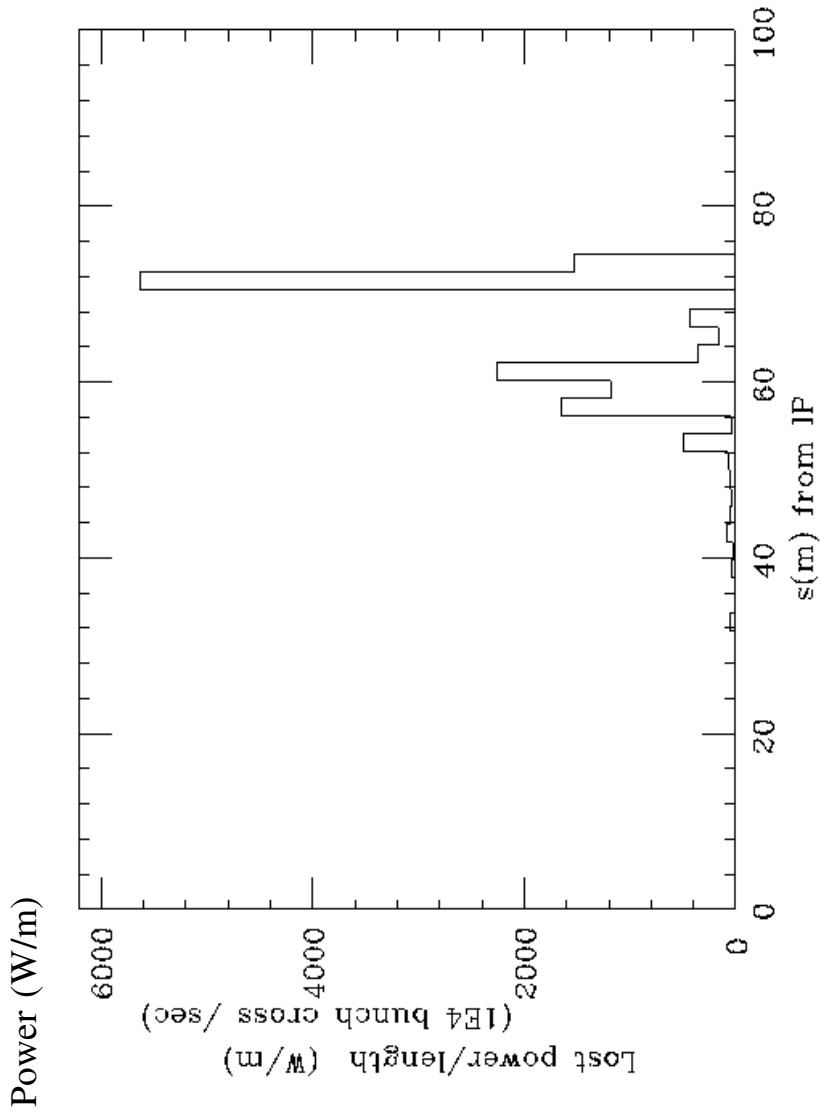
$-dE/E = 0, 0.2, 0.4, 0.6, 0.8, 1.0\%$



E/E0 distribution

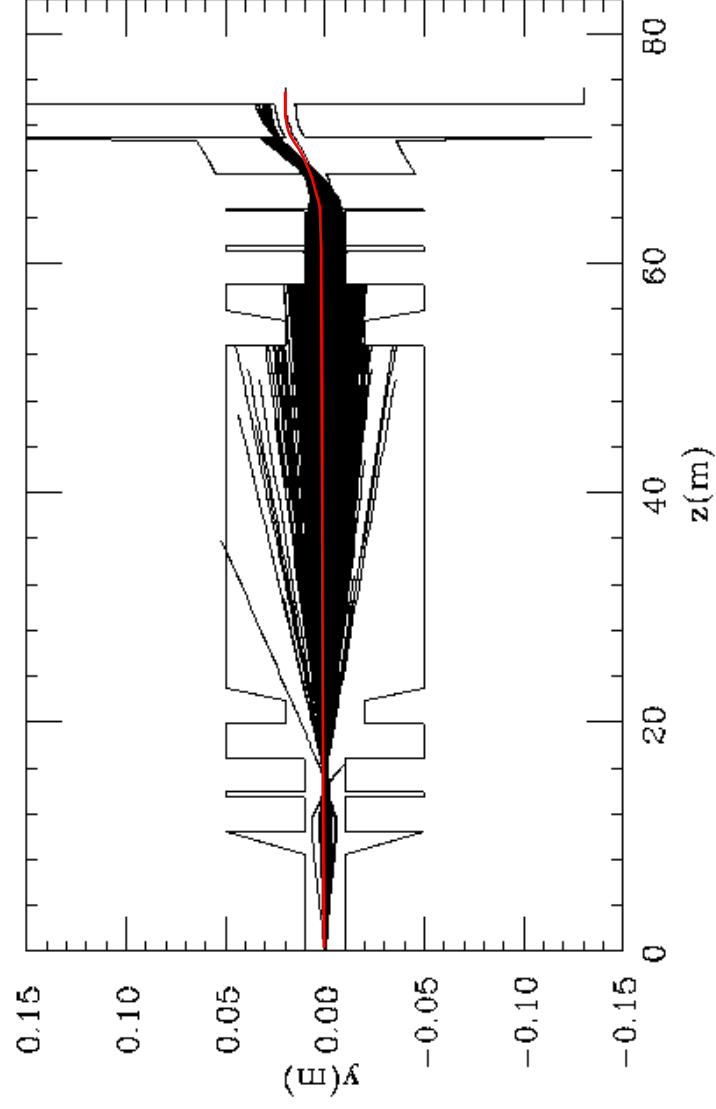
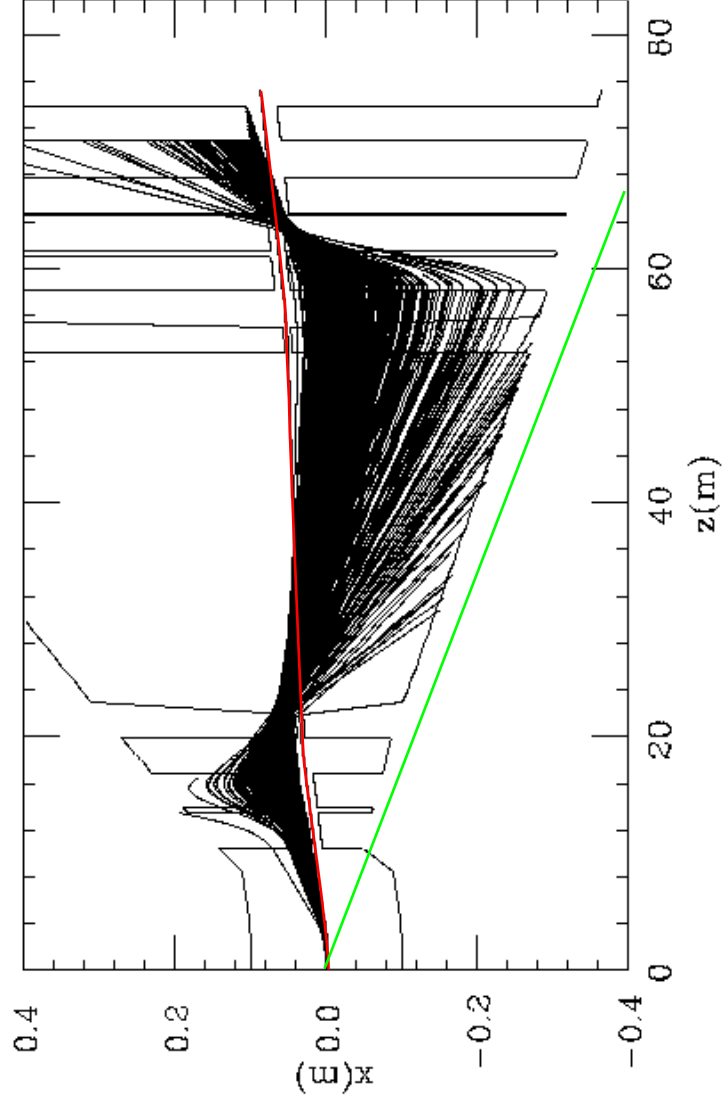


Beam loss along the extraction line



0.1 n/GeV is assumed (self shielding effect NOT included)
Total = 4×10^{11} /cm²/y at IP $\rightarrow$ 1/100 attenuation is enough

Trajectories of the lost electrons



Summary

- VTX hit density in 3T detector is $\sim 1/2$ of that in 2T detector. Low-Z mask at $B \sim 0$ is important to suppress backscattered $e^{\pm}$.
- 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		CAL Edep (GeV / BX)	
	(γ)	(n)	(γ)	(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 ($\times 3$) luminosity option, background hits becomes $\sim \times 2$
- Design of beam extraction line with energy measurement capability has been started. Neutron background produced by disrupt beam along the extraction line is $4 \times 10^{11}/\text{cm}^2/\text{y}$ at IP **without any shielding**.