New estimate of neutron background in the JLC detector

LC99
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Contents

1. n from QC generated by low energy e+e- pair

2. n from water dump generated by Beamstrahlung γ

Neutron Background

Requirement by CCD Vertex Detector:

Vertical CTI < 1×10^{-3} => Neutron flux < 1.5×10^{10} n/cm^2

Previous estimate:

Done by Y.Sugimoto, using
Geant3
neutron generation code by T.Maruyama(SLAC)

Result: 3.0×10^{7}/cm^{2}y by e+e- pair hitting QC

1.0×10^{7}/cm^{2}y by Beamstrahlung photon dumped water dump at 300 m from IP.

This study:

Similar analysis by Fluka-98
More realistic magnetic field map for QC and Detector Solenoid

Background Source

e+e- pair generated by CAIN

Input parameters:

Bunch population	$0.75\text{x}10^{10}$ / bunch
Ebeam	250 GeV (4.3 MW/beam)
Bunch Length	90 μm
Emittance $\gamma\varepsilon_{x/y}$	4/0.06 x 10^{-6}m
βx / βy	10/0.1mm
Luminosity	$0.64\text{x}10^{34}/\text{cm}^2\text{s}$

Pair background:

# of e^+e^-	$\sim 25\text{x}10^3$/BX
$<E_e>$	4 GeV
Total energy	100 TeV / BX

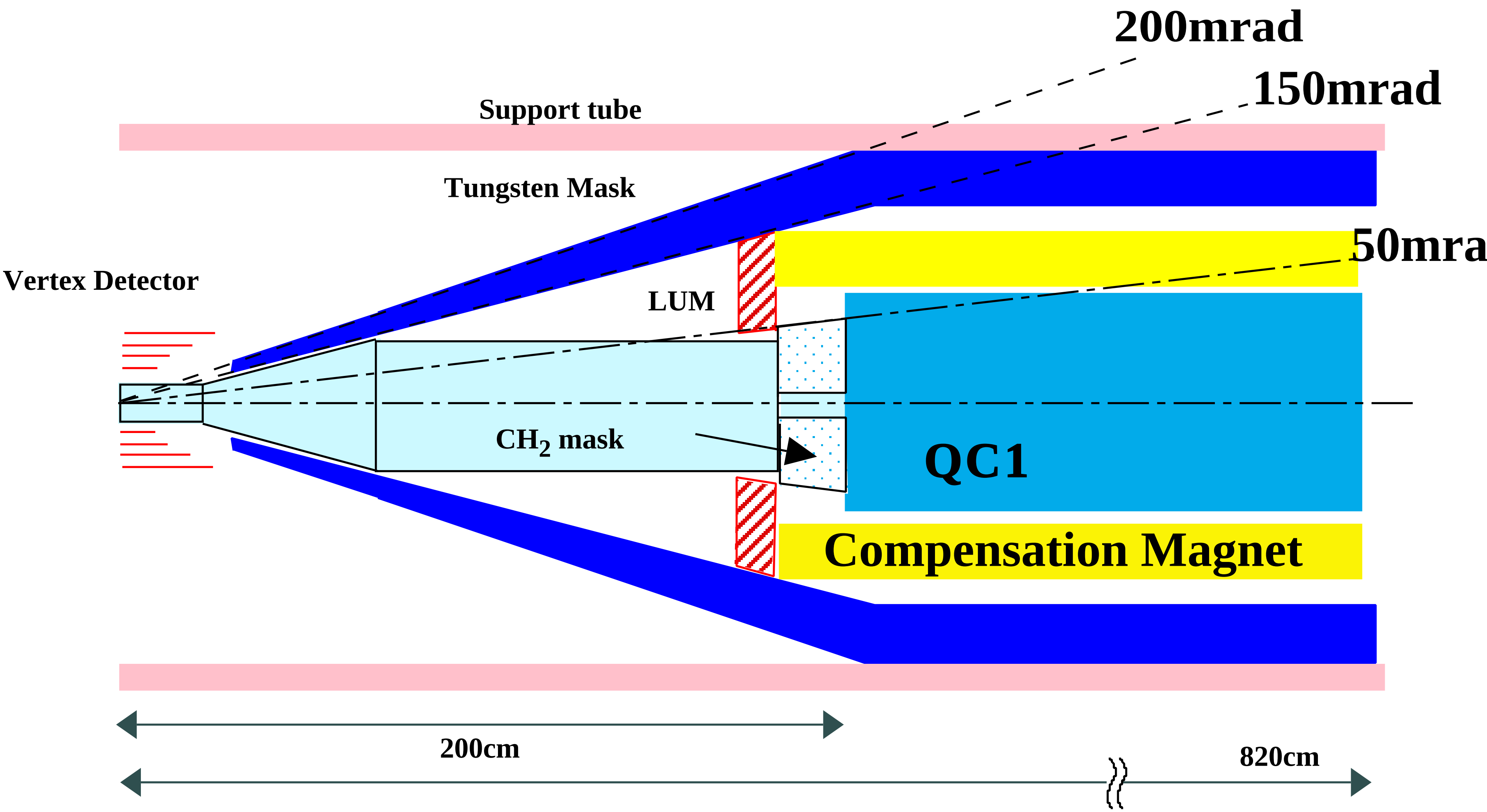
Beamstrahlung γ :

# of γ	$\sim 1.5\text{x}10^{10}$/BX
$<E_\gamma>$	10 GeV
Total energy	340 kW

Detector for simulation

* Beam pipe: r=2.0(Be)/7.5(Al) cm

* Polyethylene(CH_2) mask, Z=180~200cm, r_{in}=2cm, r_{out}=50mrad
* Luminosity Monitor(W): Z=163~180cm, r=50~150mrad



Fluka-98 parameters

Cutoff

neutron transport:	> 1 keV
e+/e- transport:	> 10.511MeV
Photon transport:	> 4 MeV

Biases:

Interaction length of photon for neutron production: x 0.01

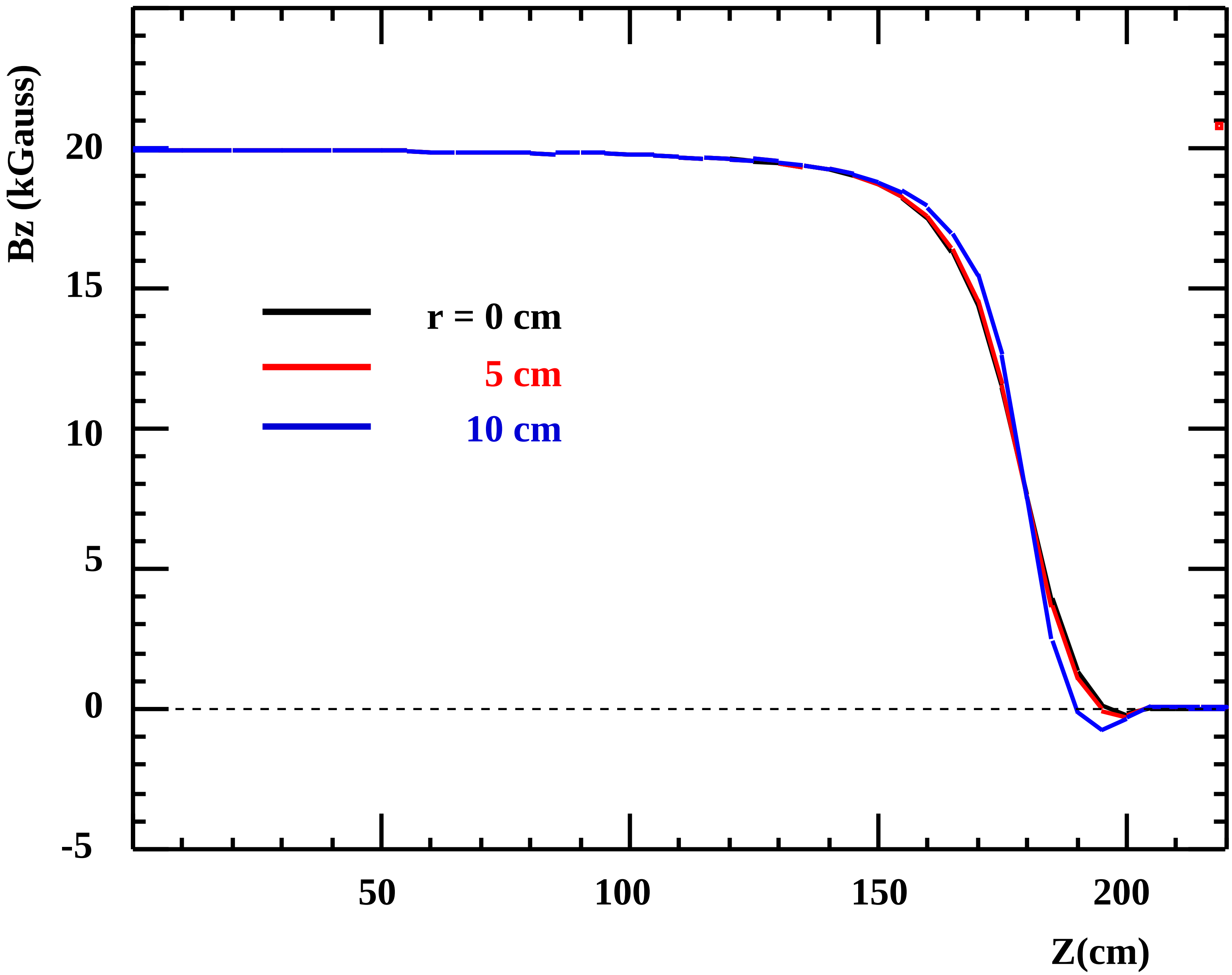
Leading particle bias for electron and photon.

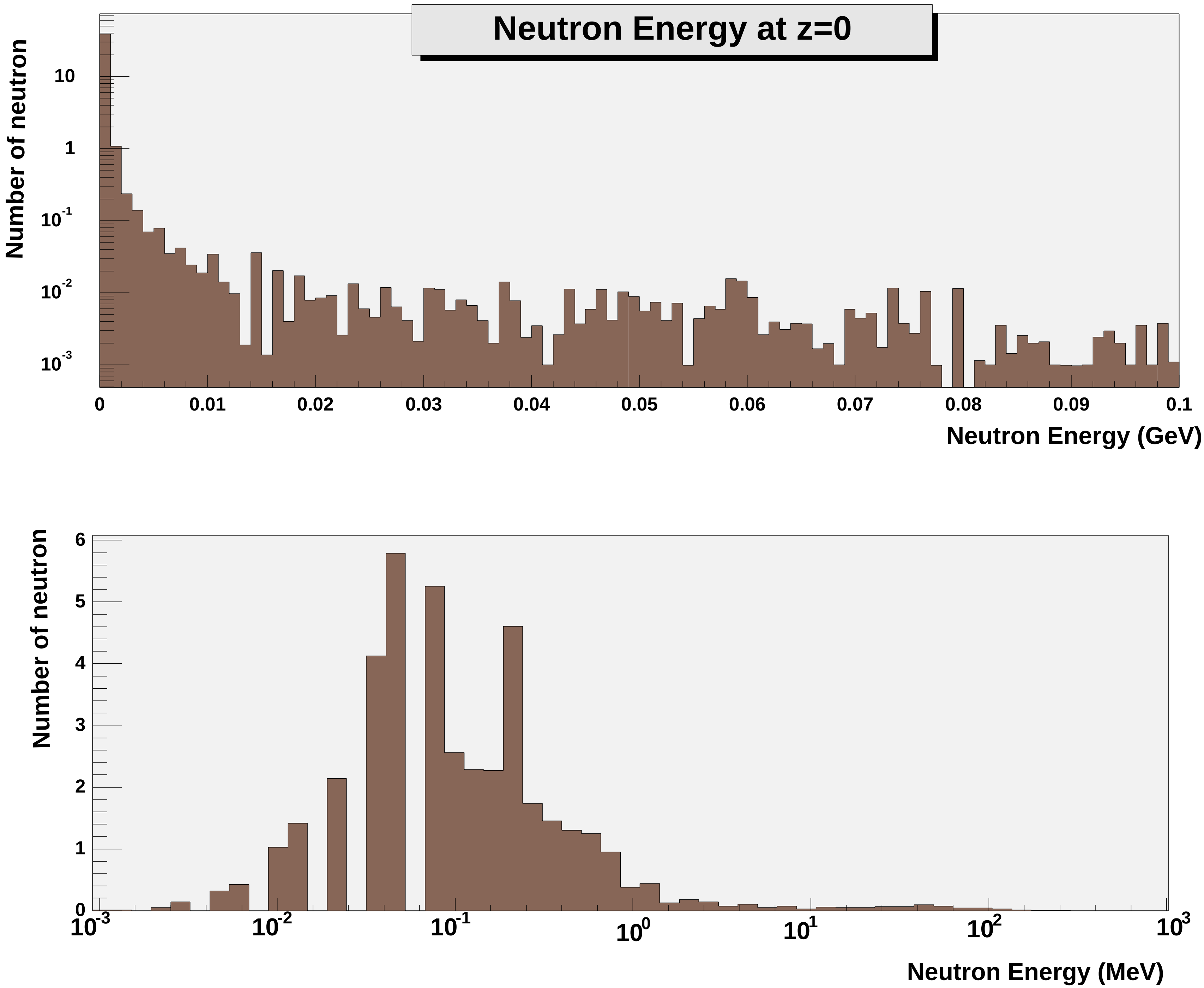
Magnetic Field:

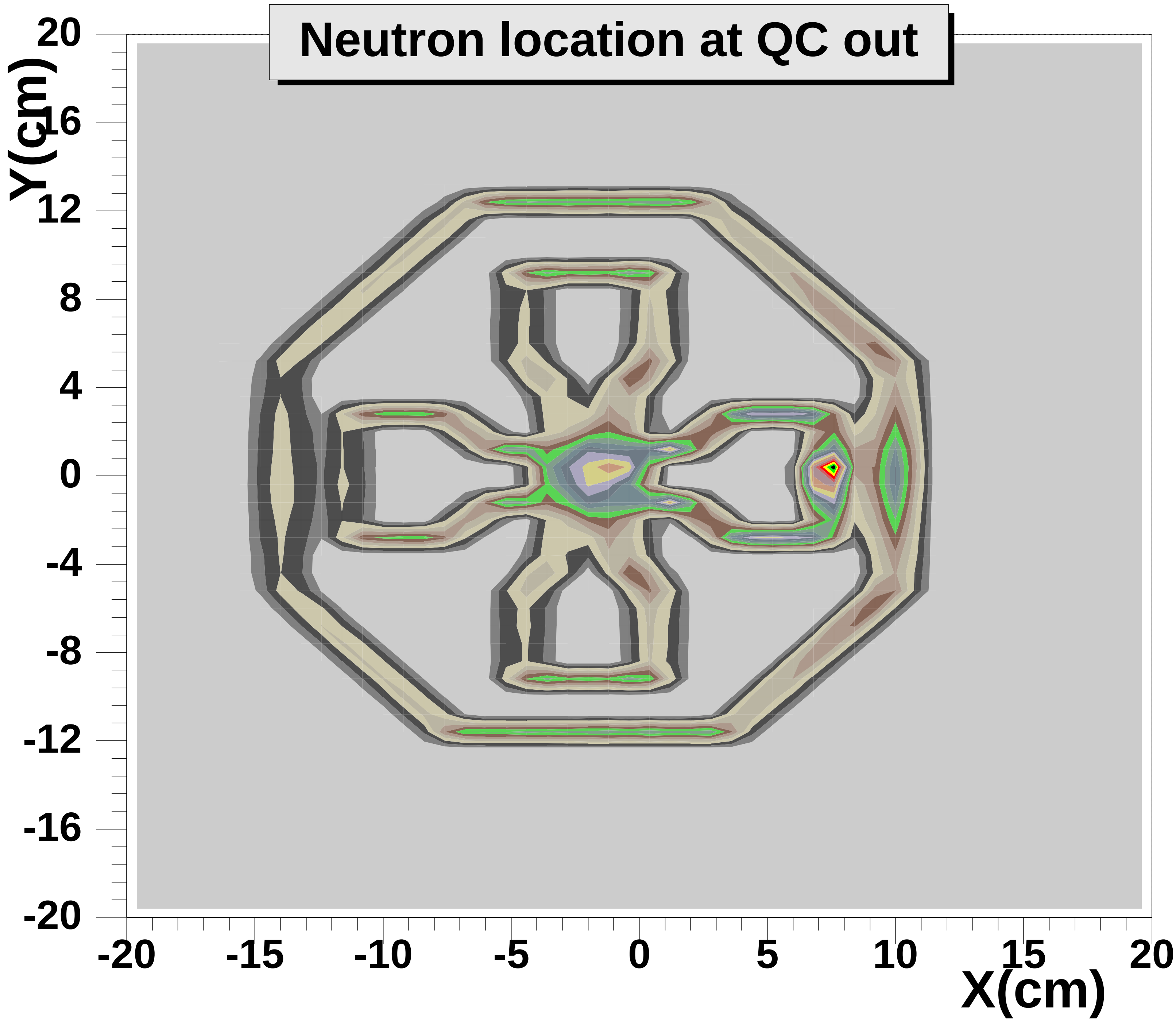
2 Tesla solenoid in whole region.

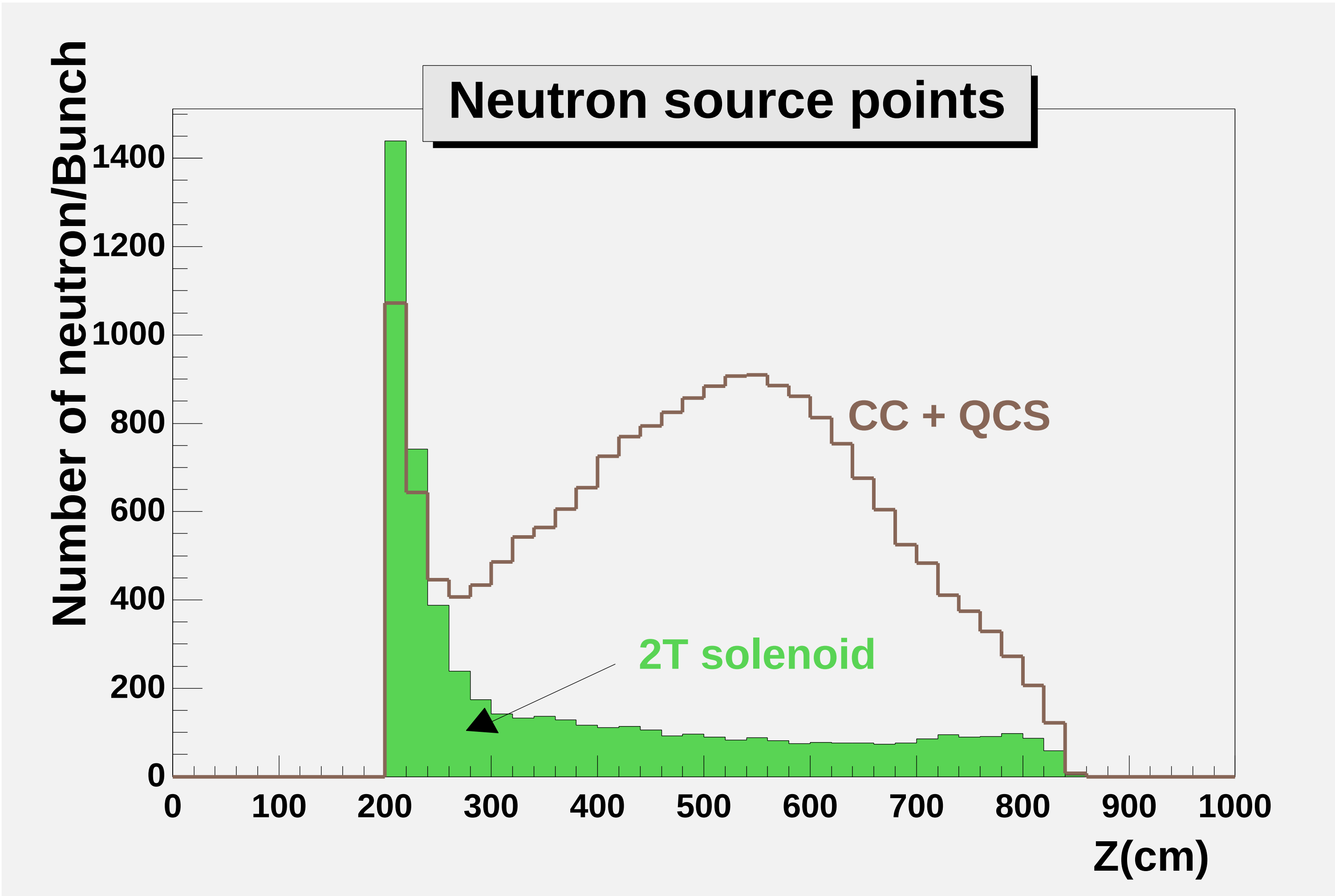
2 Tesla solenoid + Conpensation Magnet + QC field

Magnetic field(Bz) distribution

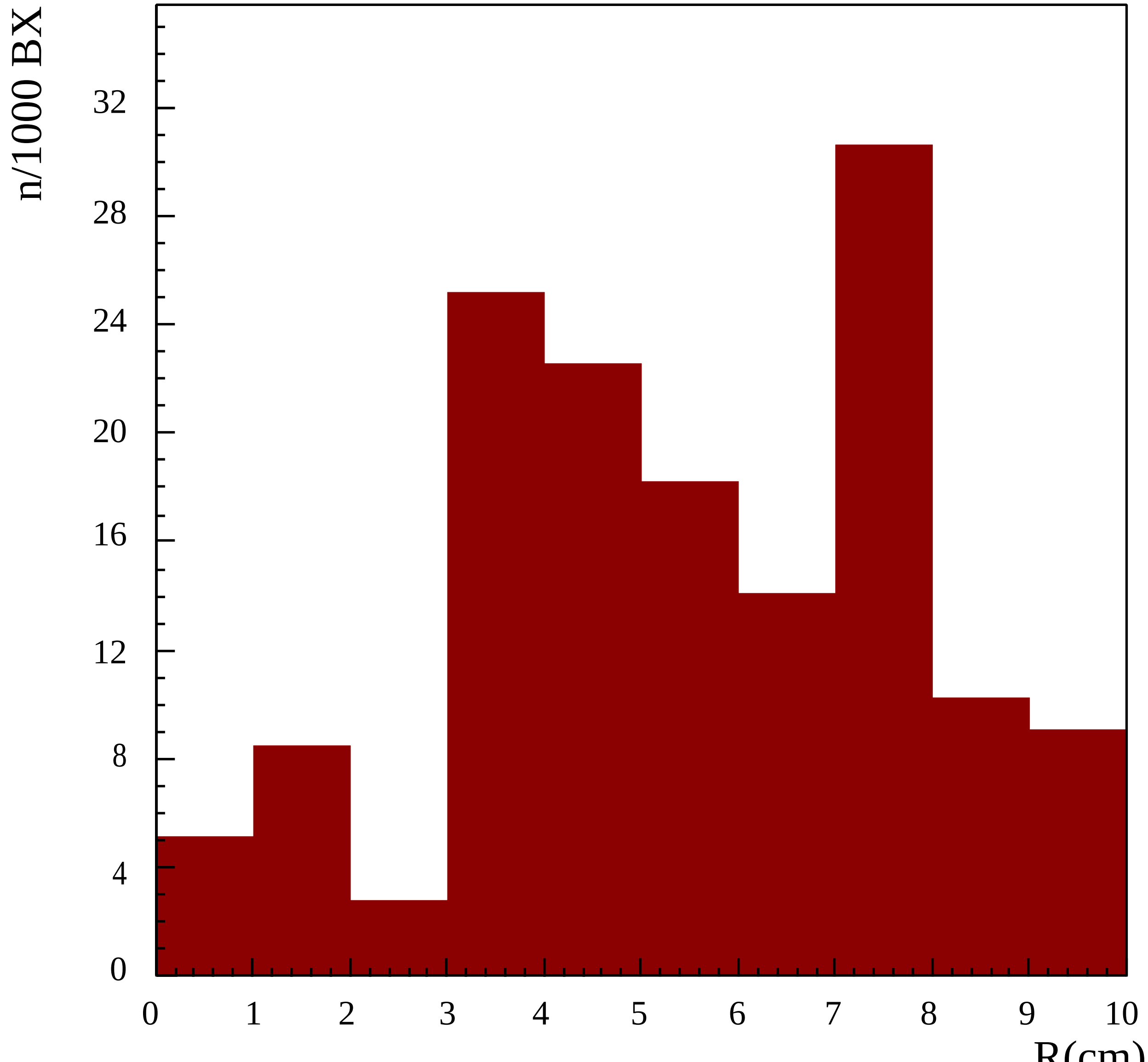



Neutron Energy at z=0
Number of neutron
10
1
10^-1
10^-2
10^-3
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
Neutron Energy (GeV)
Number of neutron
6
5
4
3
2
1
0
10^-3
10^-2
10^-1
10^0
10^1
10^2
10^3
Neutron Energy (MeV)


Neutron location at QC out
Y(cm)
X(cm)
20
16
12
8
4
0
-4
-8
-12
-16
-20
-20
-15
-10
-5
0
5
10
15
20


Neutron source points
Number of neutron/Bunch
1400
1200
1000
800
600
400
200
0
0
100
200
300
400
500
600
700
800
900
1000
Z(cm)
CC + QCS
2T solenoid

Neutron flux at IP

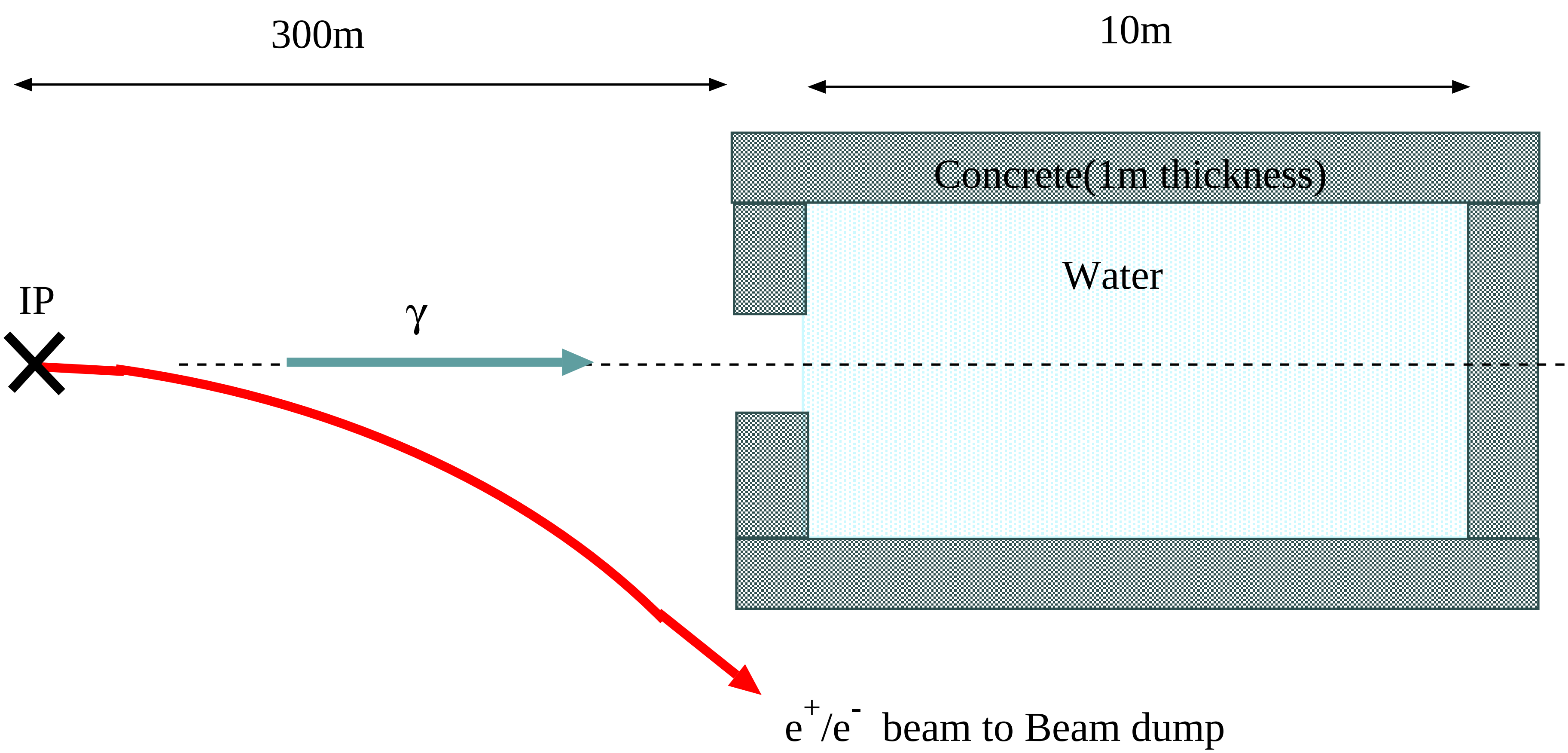


R distribution at z=0

n flux/BX : 146/πr(=10cm)^2 /1000 --> 7 x 10^7 n/cm^{2}y

Neutron background from a water dump for Beamstruhlung γ

Beamstrahlung γ $<E_\gamma>$ ~ 10 GeV, Total Energy 340 kW



Neutron flux from water dump: $2.8\text{x}10^{17}$n/year → at IP $2.5\text{x}10^{7}$n/cm

Summary

		Neutron yield at IP($/cm^2 y$)
e^+e^-:	Old	$3x10^7$
	New w 2T solenoid	$5\ x10^7$
	New w. CC and QC	$7\ x10^7$
beamstrahllung:	Old	$1x10^7$
	New	$2.5x10^7$

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

New estimate is well below the requirement,

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

for the CCD vertex detector

Neutron background from other sources are under study.