

New estimate of neutron background in the JLC detector

LC99

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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:

$$\text{Vertical CTI} < 1 \times 10^{-3} \Rightarrow \text{Neutron flux} < 1.5 \times 10^{10} \text{ n/cm}^2$$

Previous estimate:

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

Result: $3.0 \times 10^7 / \text{cm}^2 \text{ y}$ by e+e- pair hitting QC

$1.0 \times 10^7 / \text{cm}^2 \text{ y}$ 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	0.75×10^{10} / bunch
Ebeam	250 GeV (4.3 MW/beam)
Bunch Length	90 μm
Emittance $\gamma\epsilon_{x/y}$	4/0.06 x 10^{-6} m
β_x / β_y	10/0.1mm
Luminosity	$0.64 \times 10^{34} / \text{cm}^2 \text{s}$

Pair background:

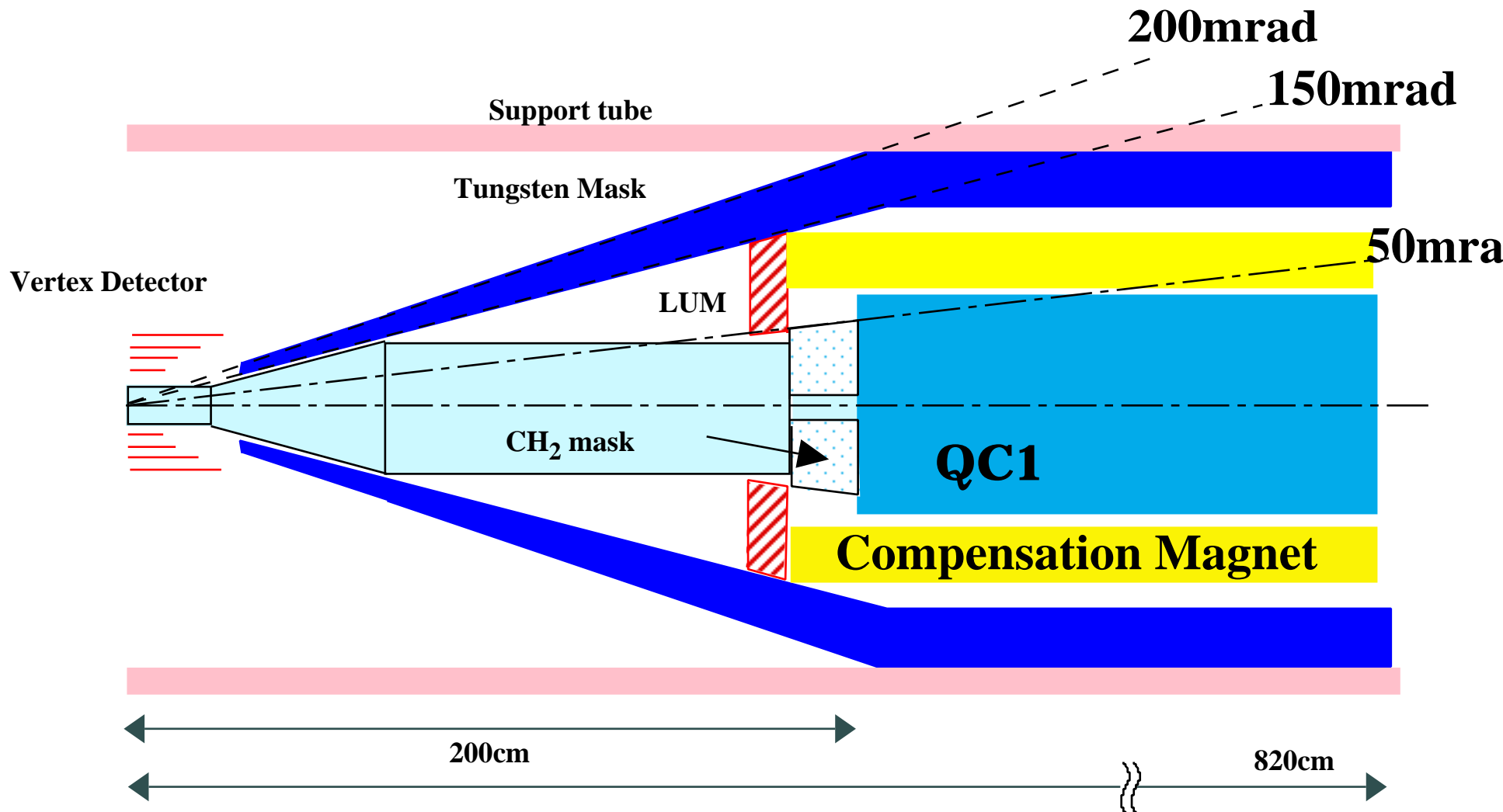
# of e^+e^-	$\sim 25 \times 10^3 / \text{BX}$
$\langle E_e \rangle$	4 GeV
Total energy	100 TeV / BX

Beamstrahlung γ :

# of γ	$\sim 1.5 \times 10^{10} / \text{BX}$
$\langle E_\gamma \rangle$	10 GeV
Total energy	340 kW

Detector for simulation

- * Beam pipe: $r=2.0(\text{Be})/7.5(\text{Al})$ cm
- * Polyethylene(CH_2) mask, $Z=180\sim 200\text{cm}$, $r_{\text{in}}=2\text{cm}$, $r_{\text{out}}=50\text{mrad}$
- * Luminosity Monitor(W): $Z=163\sim 180\text{cm}$, $r=50\sim 150\text{mrad}$



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

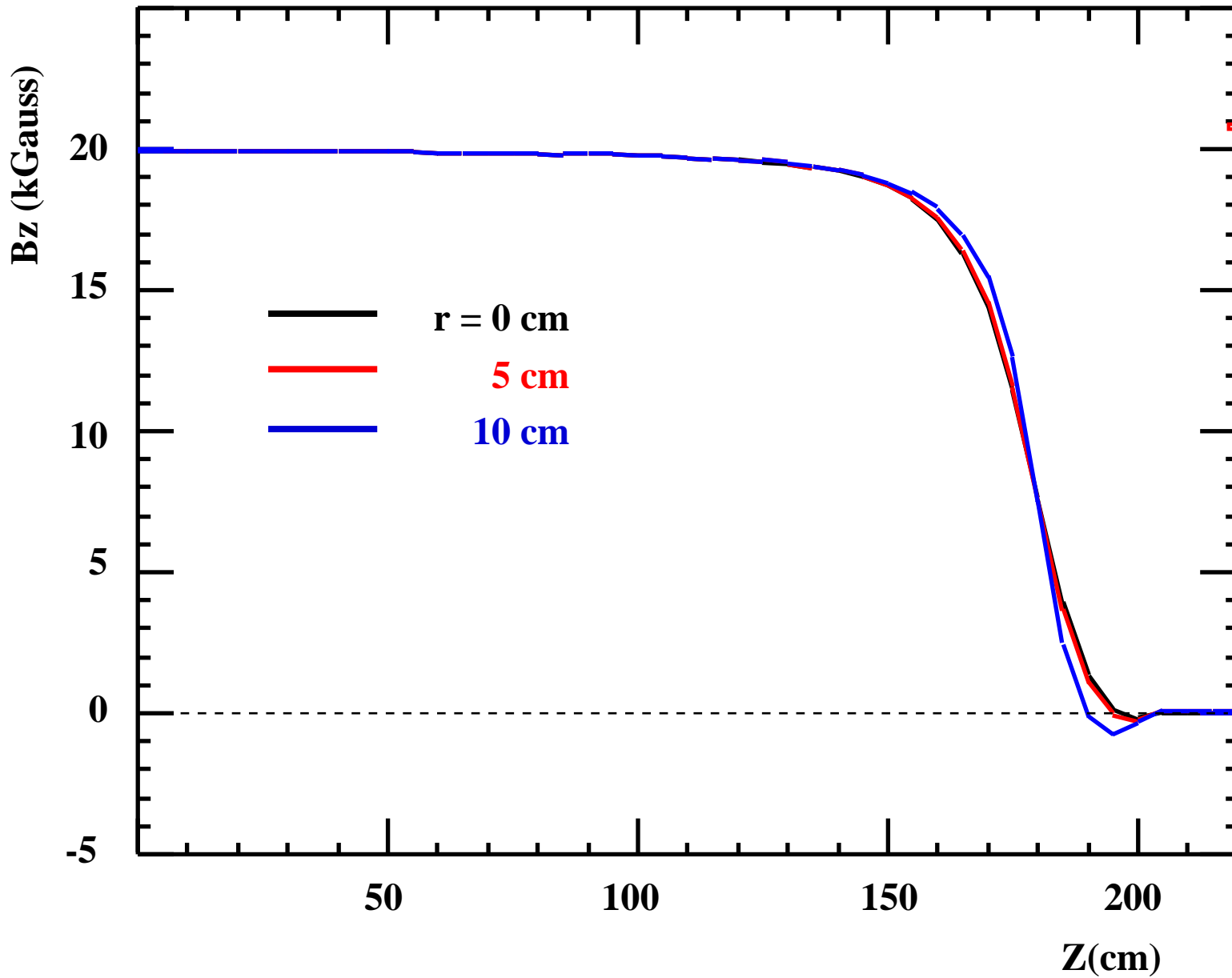
Leading particle bias for electron and photon.

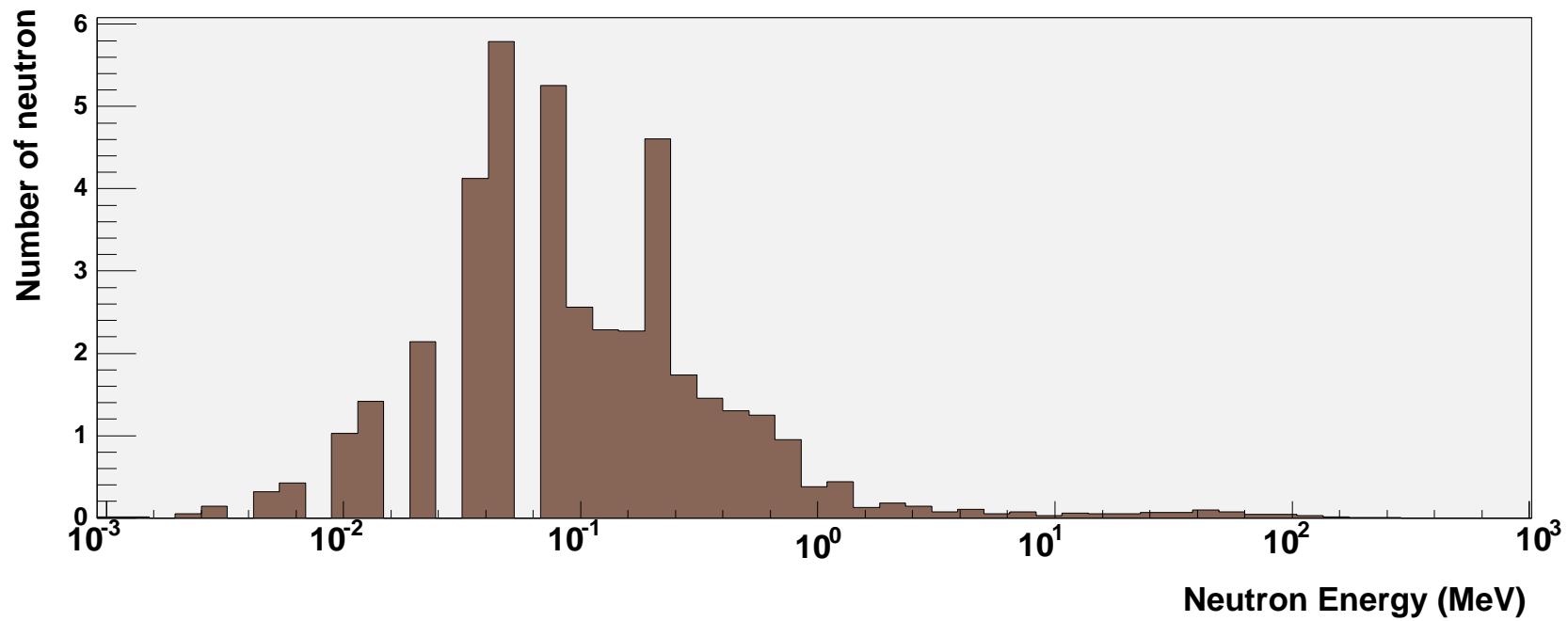
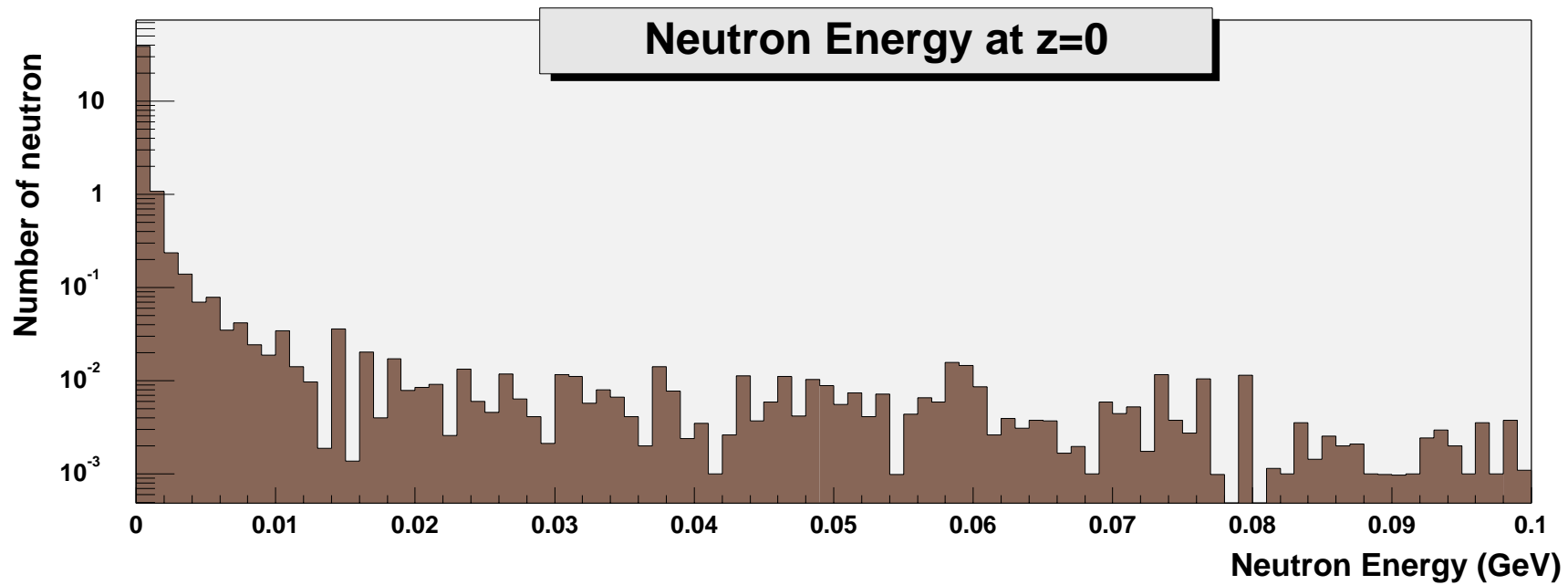
Magnetic Field:

2 Tesla solenoid in whole region.

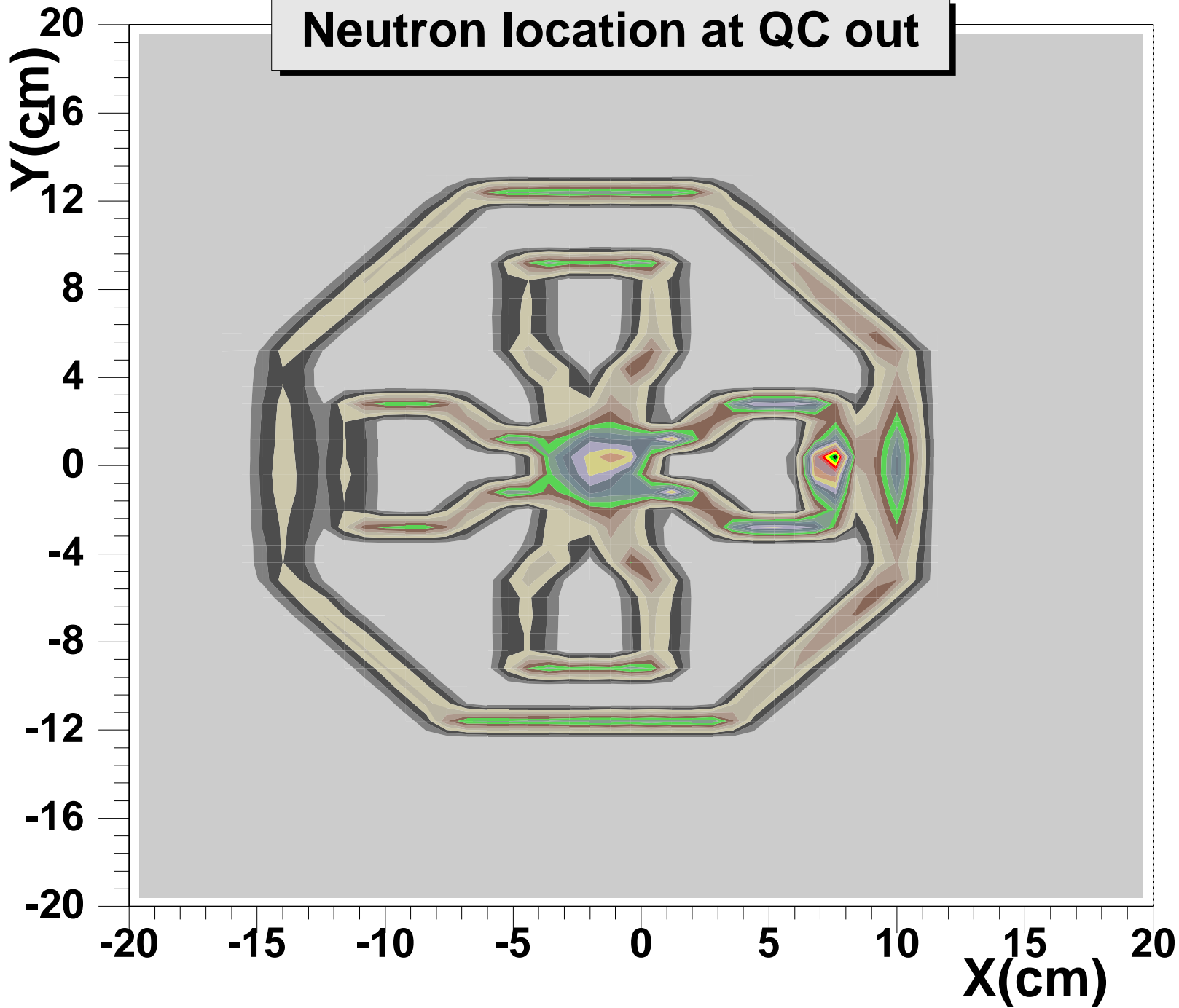
2 Tesla solenoid + Compensation Magnet + QC field

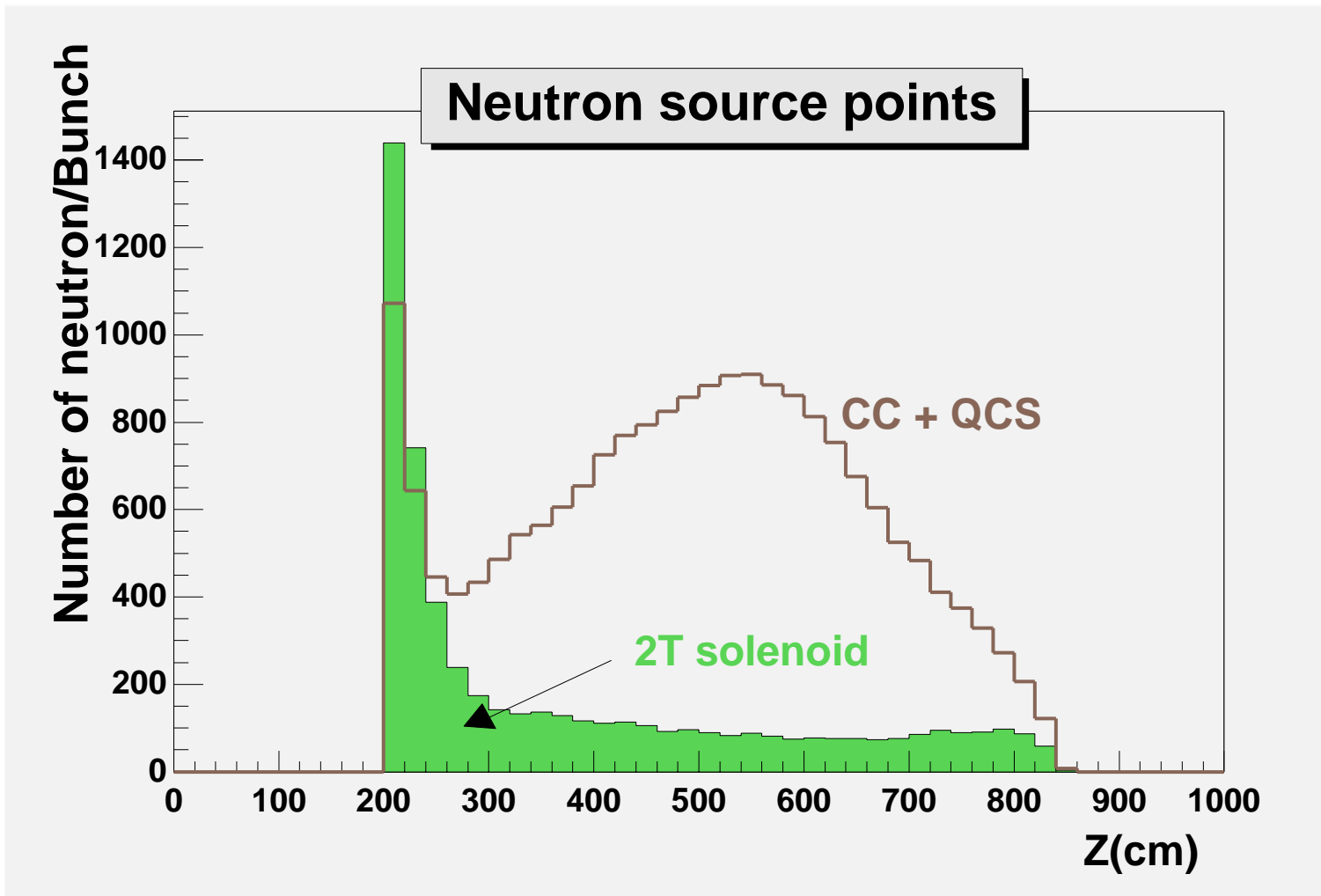
Magnetic field(B_z) distribution



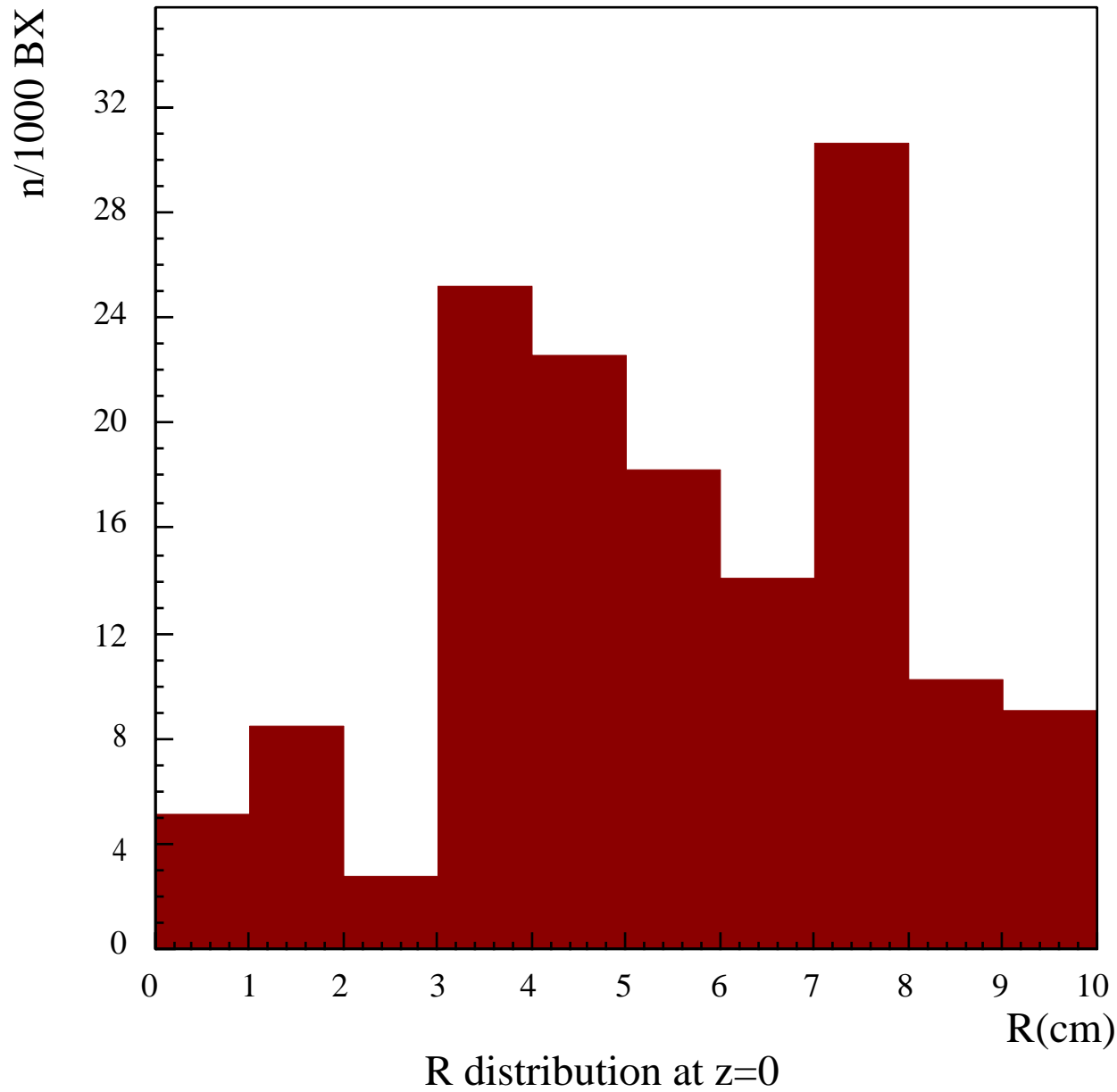


Neutron location at QC out





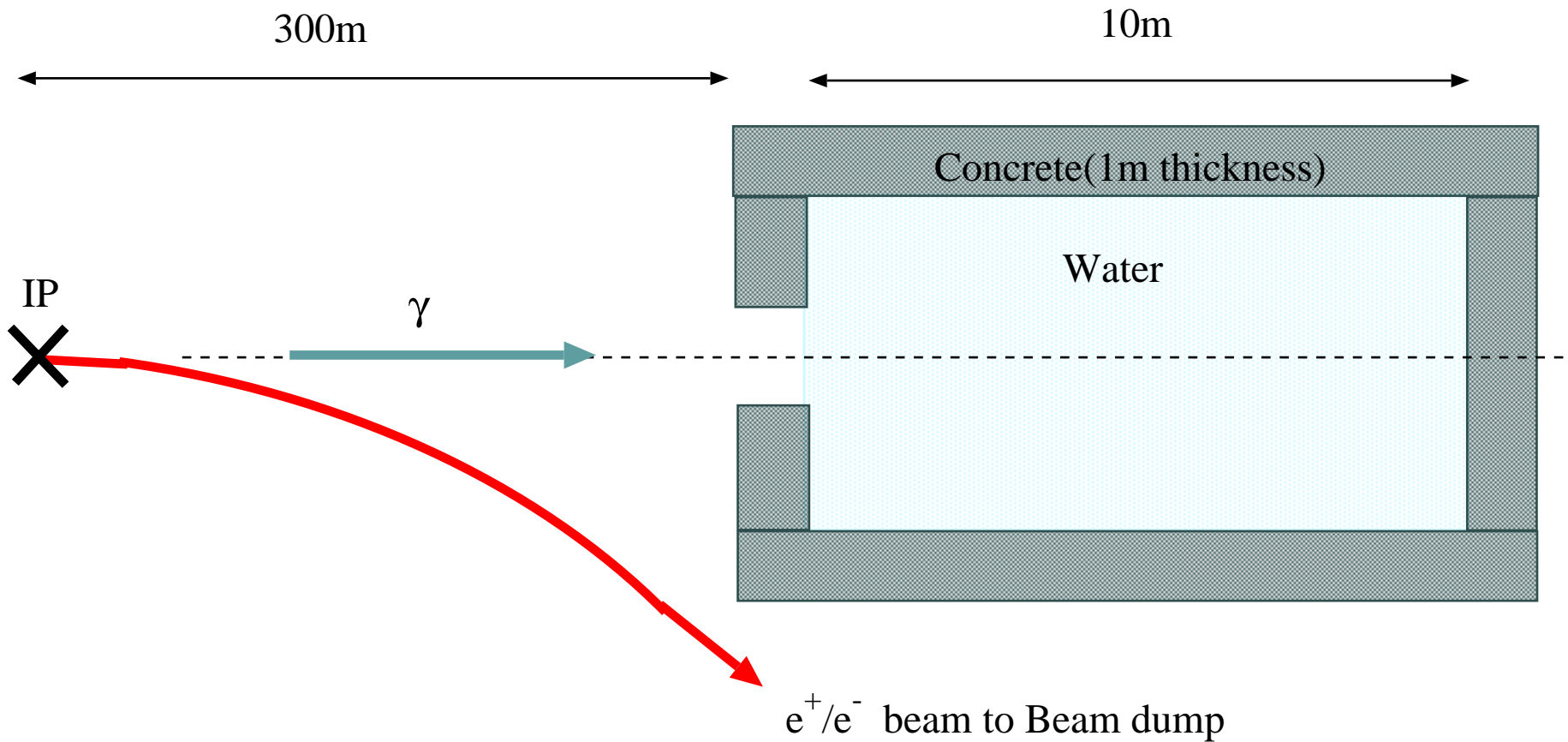
Neutron flux at IP



$$n \text{ flux/BX} : 146/\pi r(=10\text{cm})^2 /1000 \quad \text{-->} \quad 7 \times 10^7 \text{ n/cm}^2\text{y}$$

Neutron background from a water dump for Beamstrahlung γ

Beamstrahlung γ $\langle E_\gamma \rangle \sim 10$ GeV, Total Energy 340 kW



Neutron flux from water dump: 2.8×10^{17} n/year \longrightarrow at IP 2.5×10^7 n/cm²

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
beamstrahlung:	Old	1x10 ⁷
	New	2.5x10 ⁷

Statistical error of new estimate is roughly a few x 10⁷ (guess)

New estimate is well below the requirement,

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

for the CCD vertex detector

Neutron background from other sources are under study.