Full-detector simulation

Full simulation

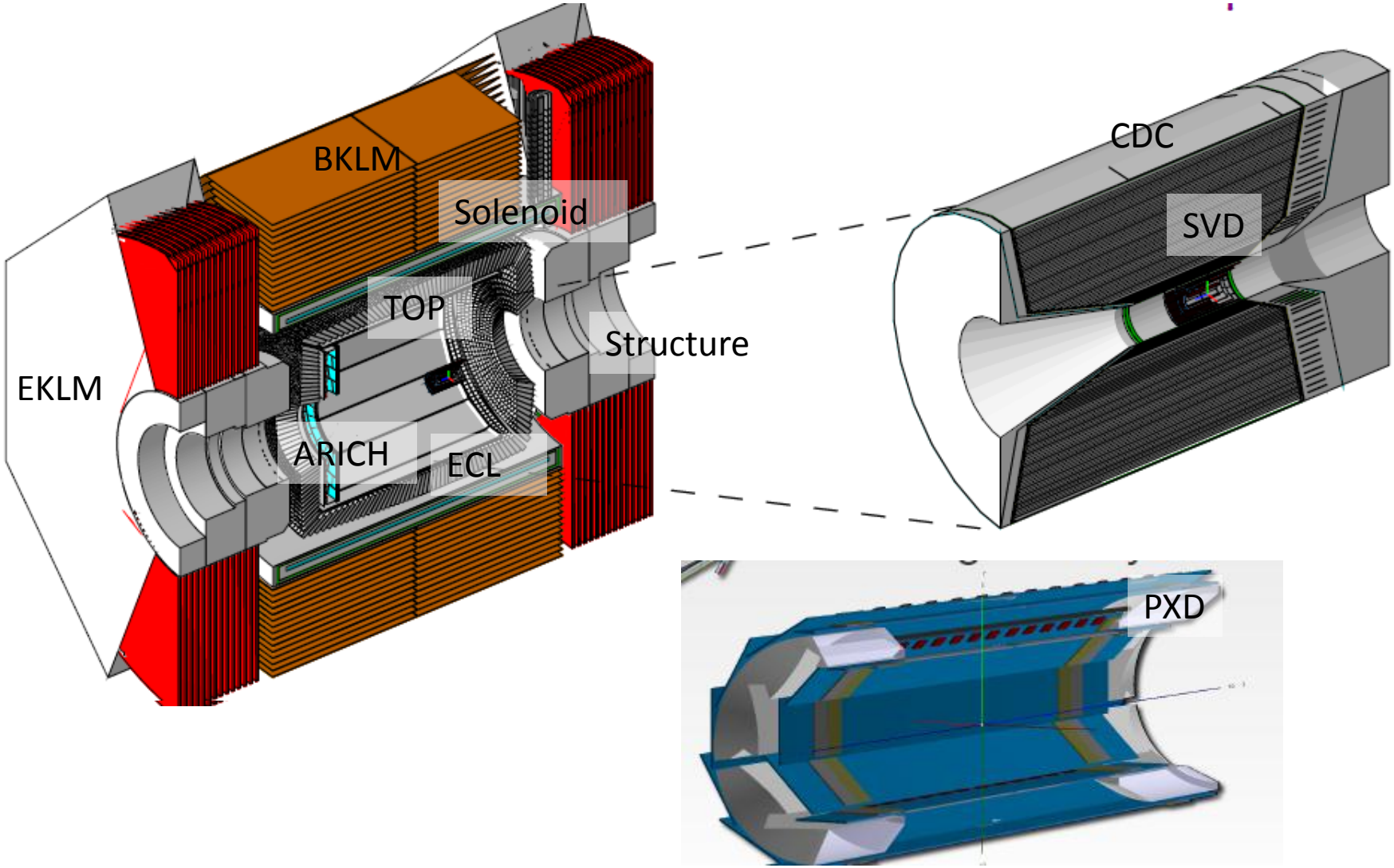
- GEANT4-based ("QGSP_BERT_HP")
- Whole detector implemented
- No beam line elements |z|>4m (further geometry is urgent)
  - No showers/neutrons from tunnel!
- Input:
  - –Track particles by SAD until they hit beam pipe wall, record position and momentum, then pass that information to GEANT4 (Touschek/Beam-gas)
  - –BBBrem particles are tracked from IP by SAD until they hit beam pipe wall, record position and momentum, then pass that information to GEANT4 (RBB)
  - –Use KoralW output directry in GEANT4 (2photon)

- First campaign was in Dec. 2011
  - 0.9GHz Touschek LER /2-photon
- Second Campaign in Feb. 2012 (coming soon)
  - Touschek/Beam-gas/Rad. Bhabha/2-photon

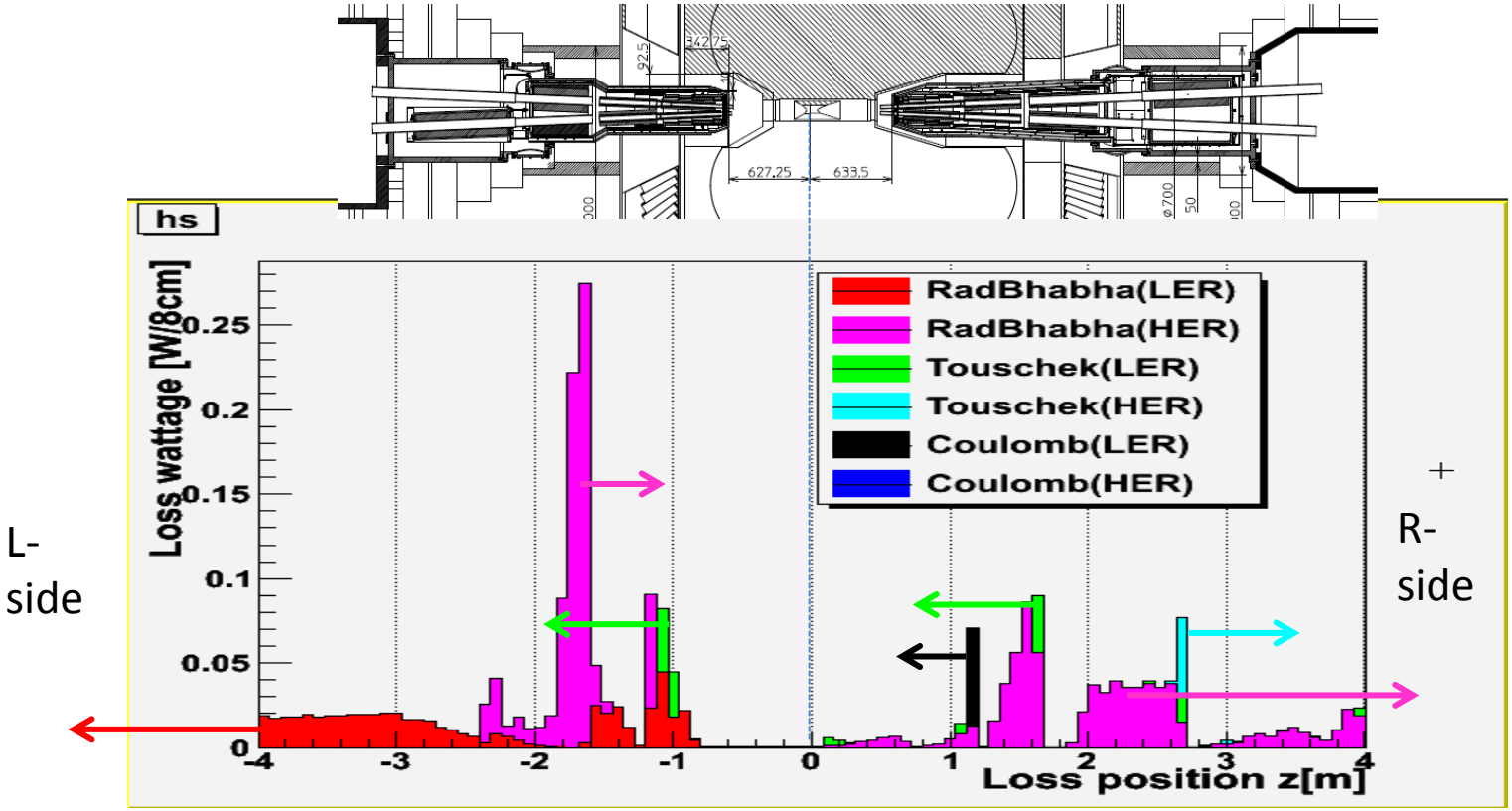
We need to check:

-True event signals are not hidden by fake background hits?
-Our detectors/readout electronics are not severely damaged by radiation or neutrons?

Whole geometry ready in GEANT4



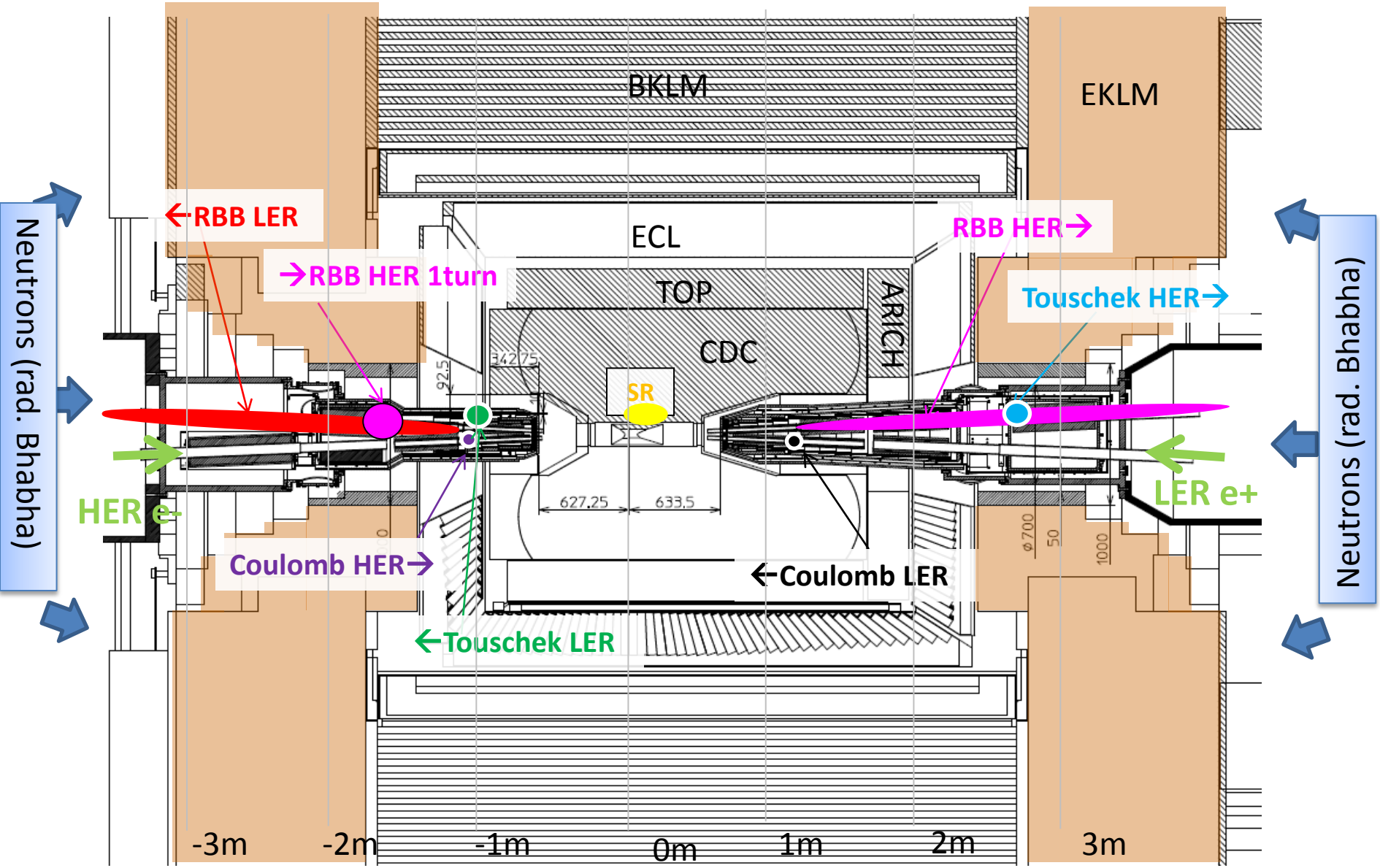
Total BG



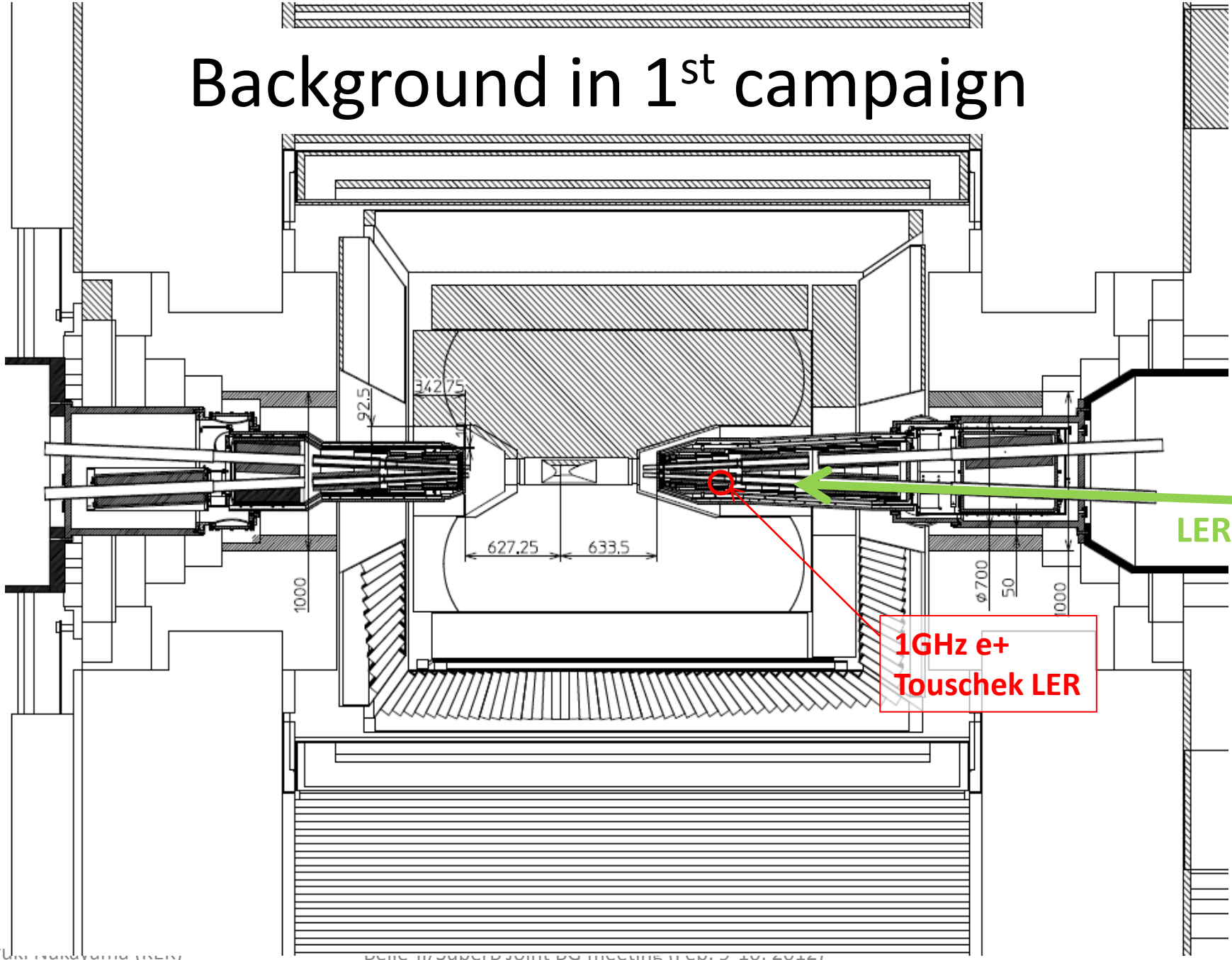
	LER (4GeV e+)	HER (7GeV e-)
Rad. Bhabha	0.55 W (eff. 0.9GHz)	1.60W (eff. 1.4GHz)
Touschek	0.10 W (0.16GHz)	0.05 W (0.05GHz)
Coulomb	0.06 W (0.09GHz)	0.001W (0.001GHz)

1GeV ,1GHz
= 0.16W

Background picture at Belle-II

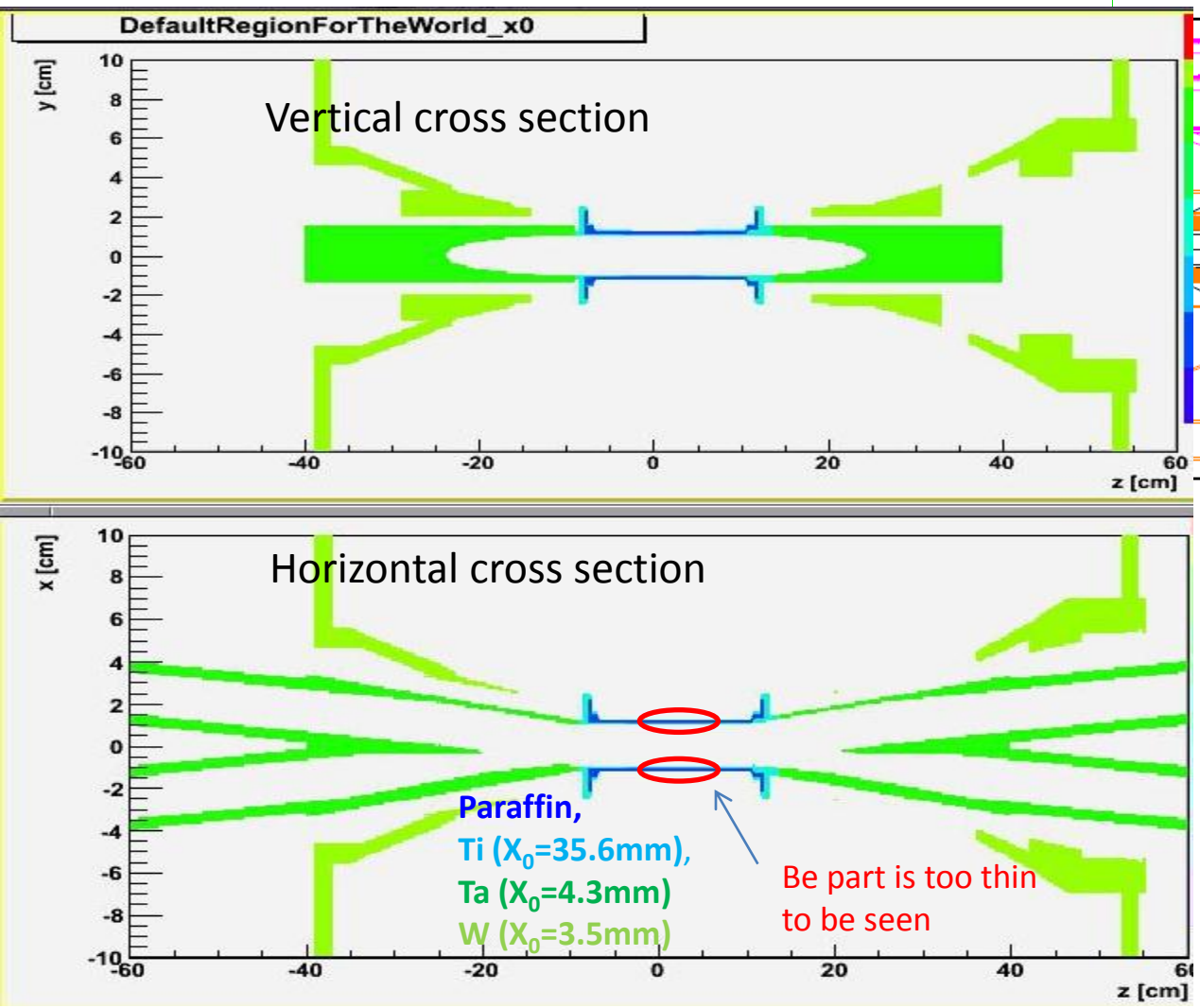


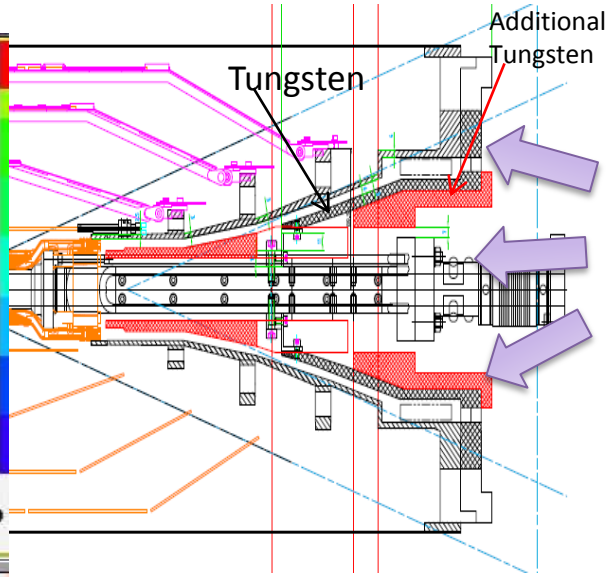
Background in 1st campaign



Materials in simulation

Beam pipe and Tungsten shield

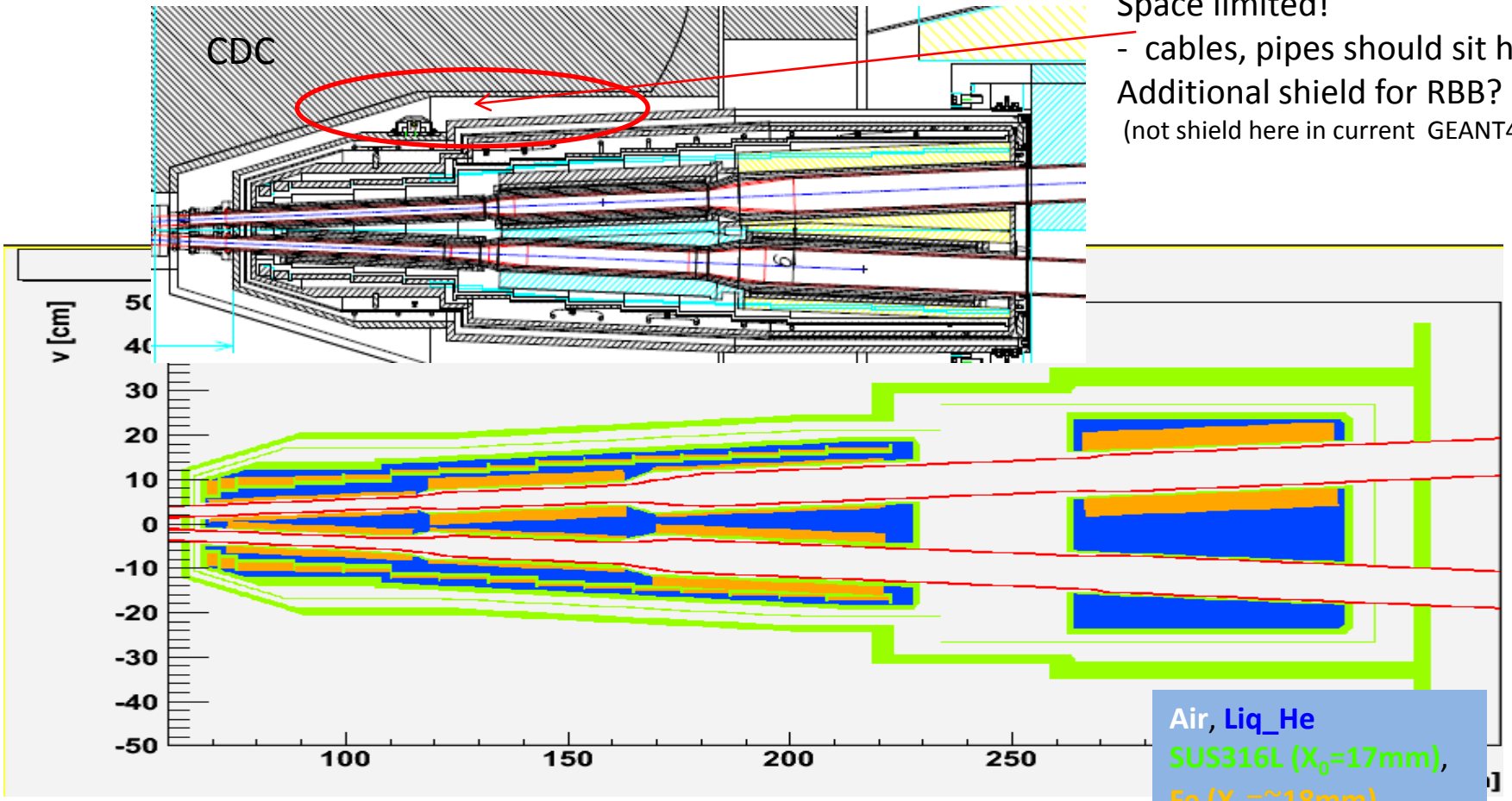




4mm of Ta beam pipe($1X_0$),
~1cm of Tungsten shield($\sim 3X_0$)

Protect PXD/SVD
from EM showers
generated by IR loss

QCS cryostat



Space limited!
- cables, pipes should sit here

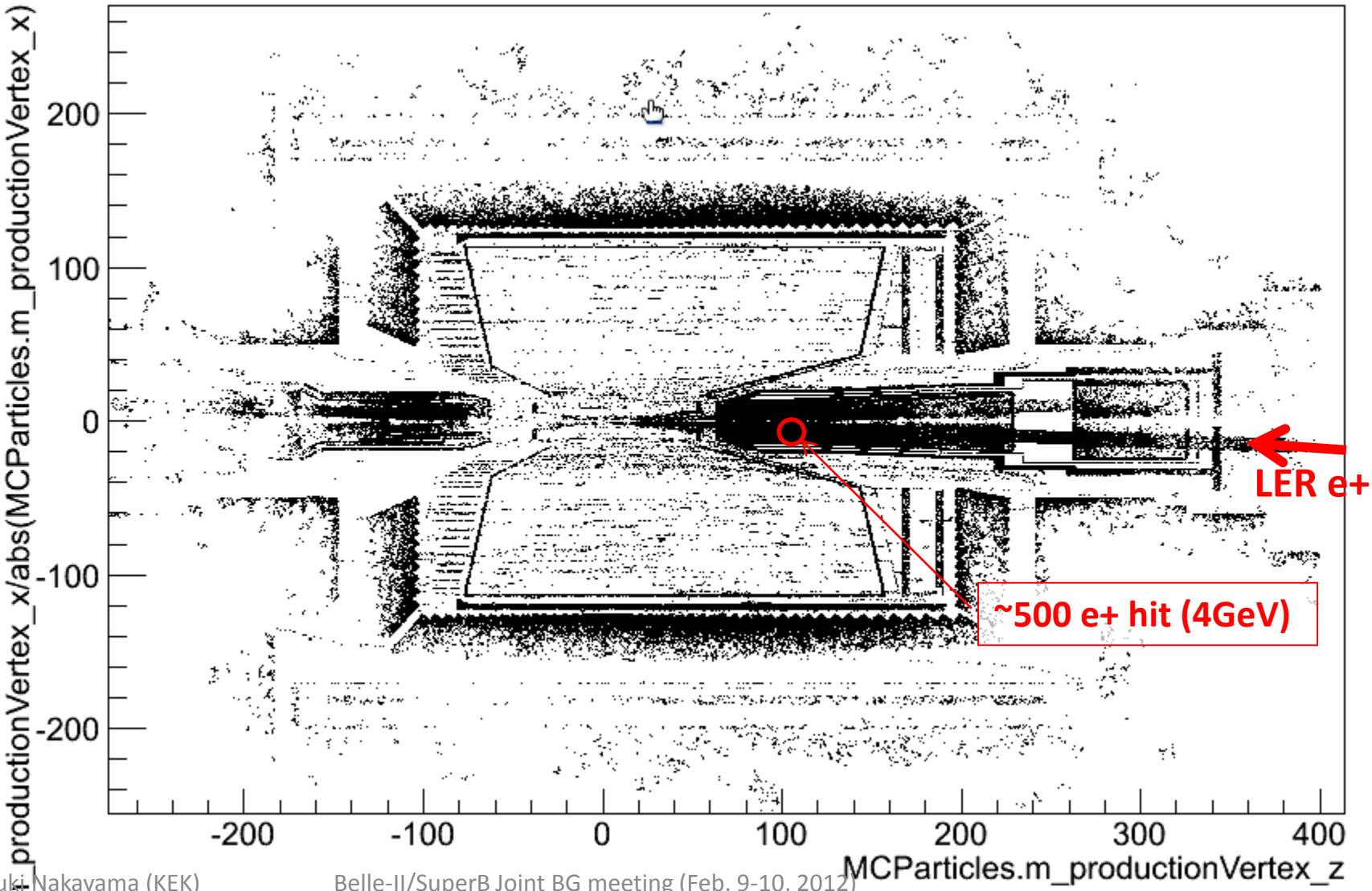
Additional shield for RBB?
(not shield here in current GEANT4)

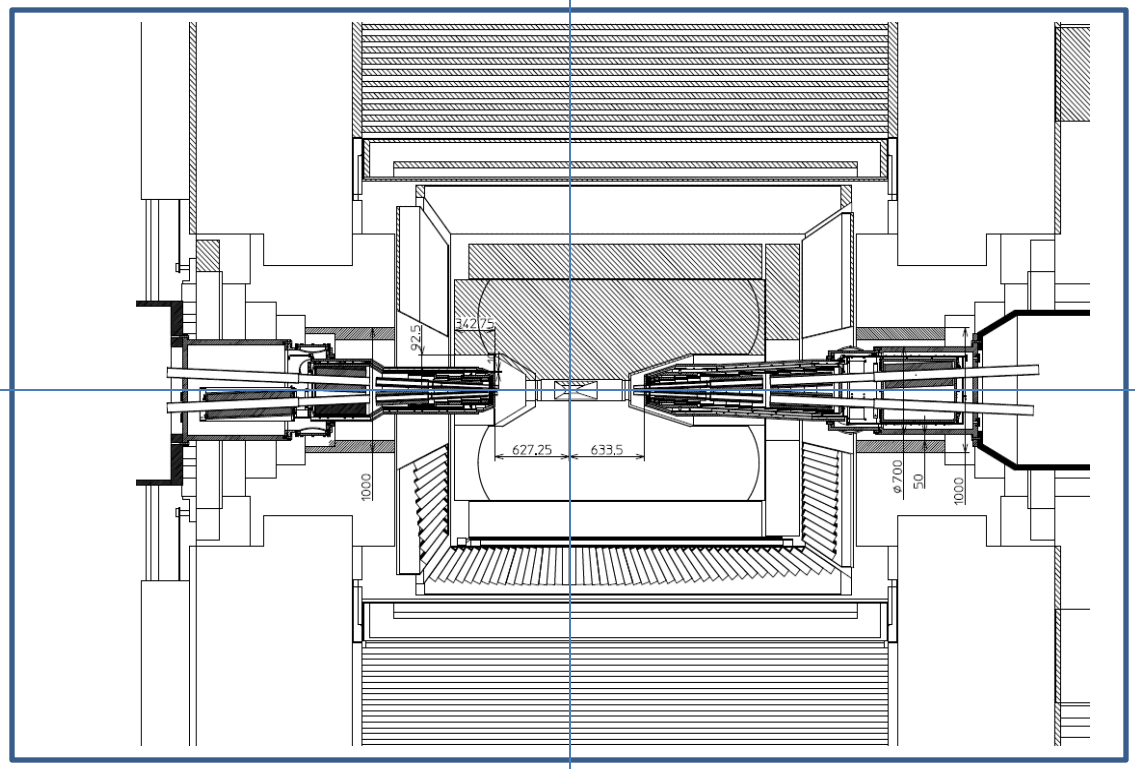
Air, Liq_He
SUS316L (X_0=17mm),
Fe (X_0=~18mm)
SC_COIL(X_0=~16mm),
Ta (X_0=4.3mm)

4mm of Ta beam pipe (1X_0), few cm of iron+coil (~2X_0) ,
and few cm of SUS structure(~2X_0)

Full-detector simulation

Generated vertex of all MC particles

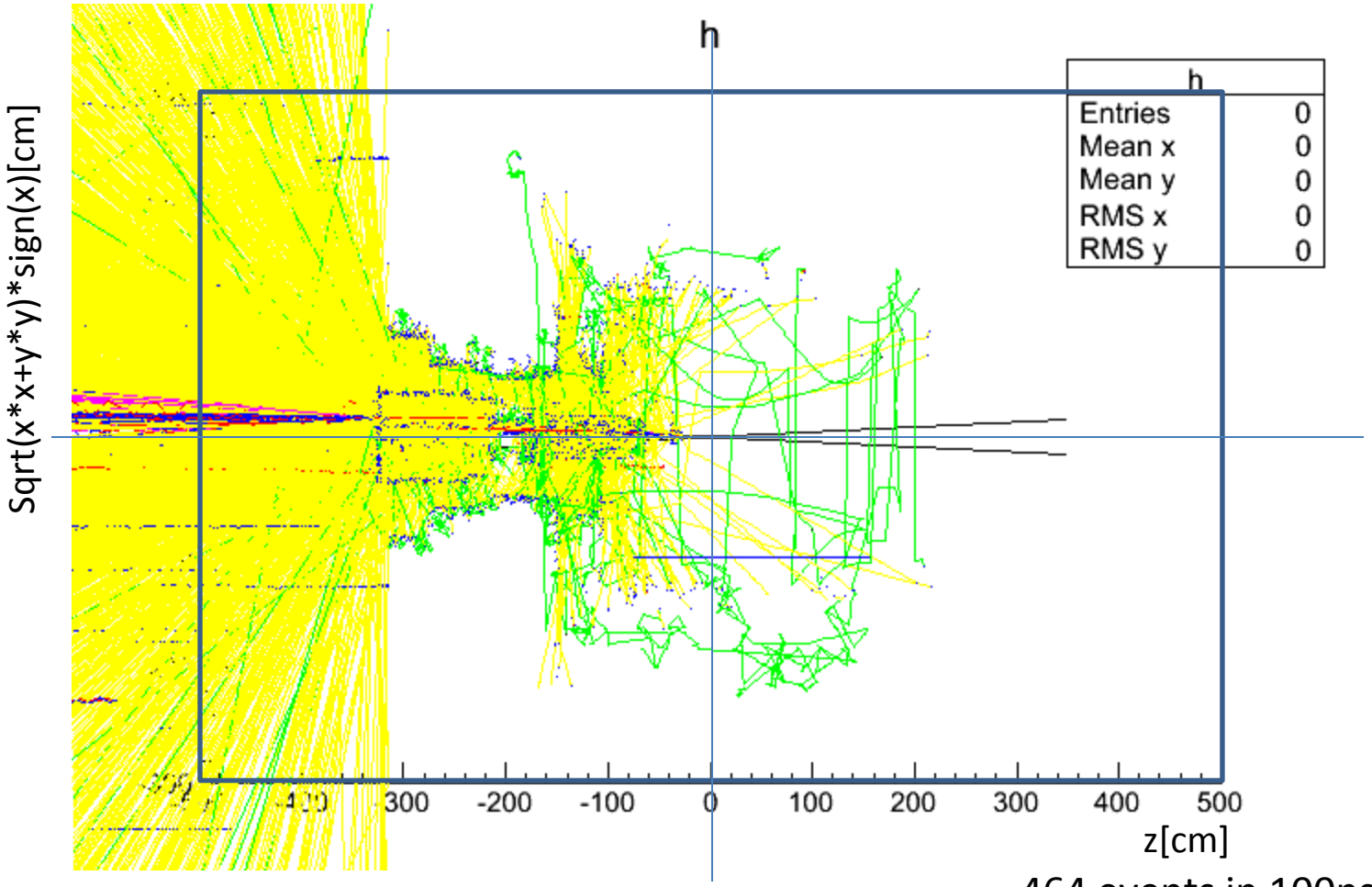



92.5
342.75
627.25
633.5
1000
ø 700
50
1000

Rad. Bhabha LER

Magenta: primary particle
Red: e+
Blue: e-
Yellow: gamma
Green: neutron

Show particles with E>1MeV

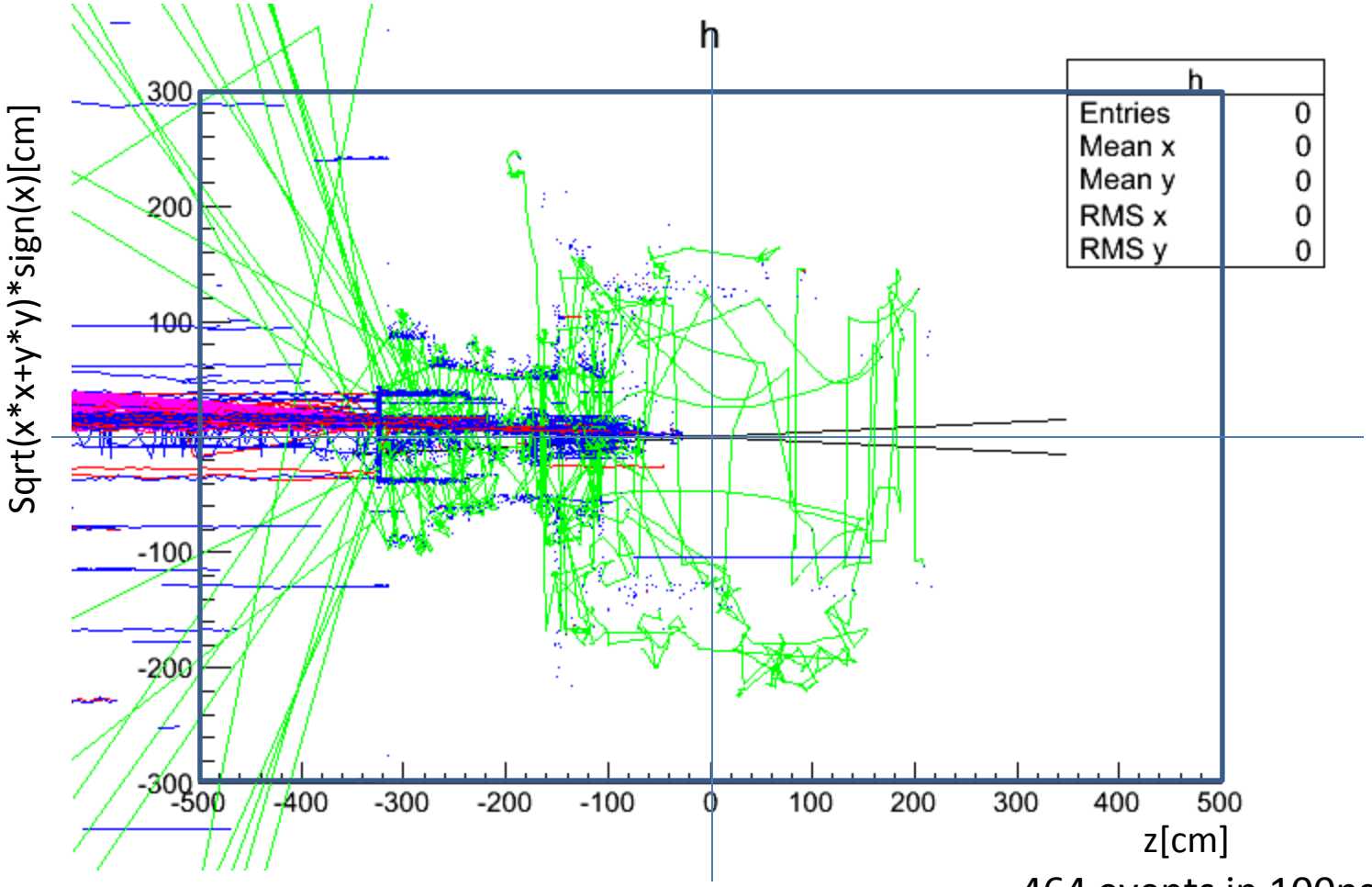


464 events in 100ns

Rad. Bhabha LER

Magenta: primary particle
Red: e+
Blue: e-
Yellow: gamma
Green: neutron

Show particles with E>1MeV

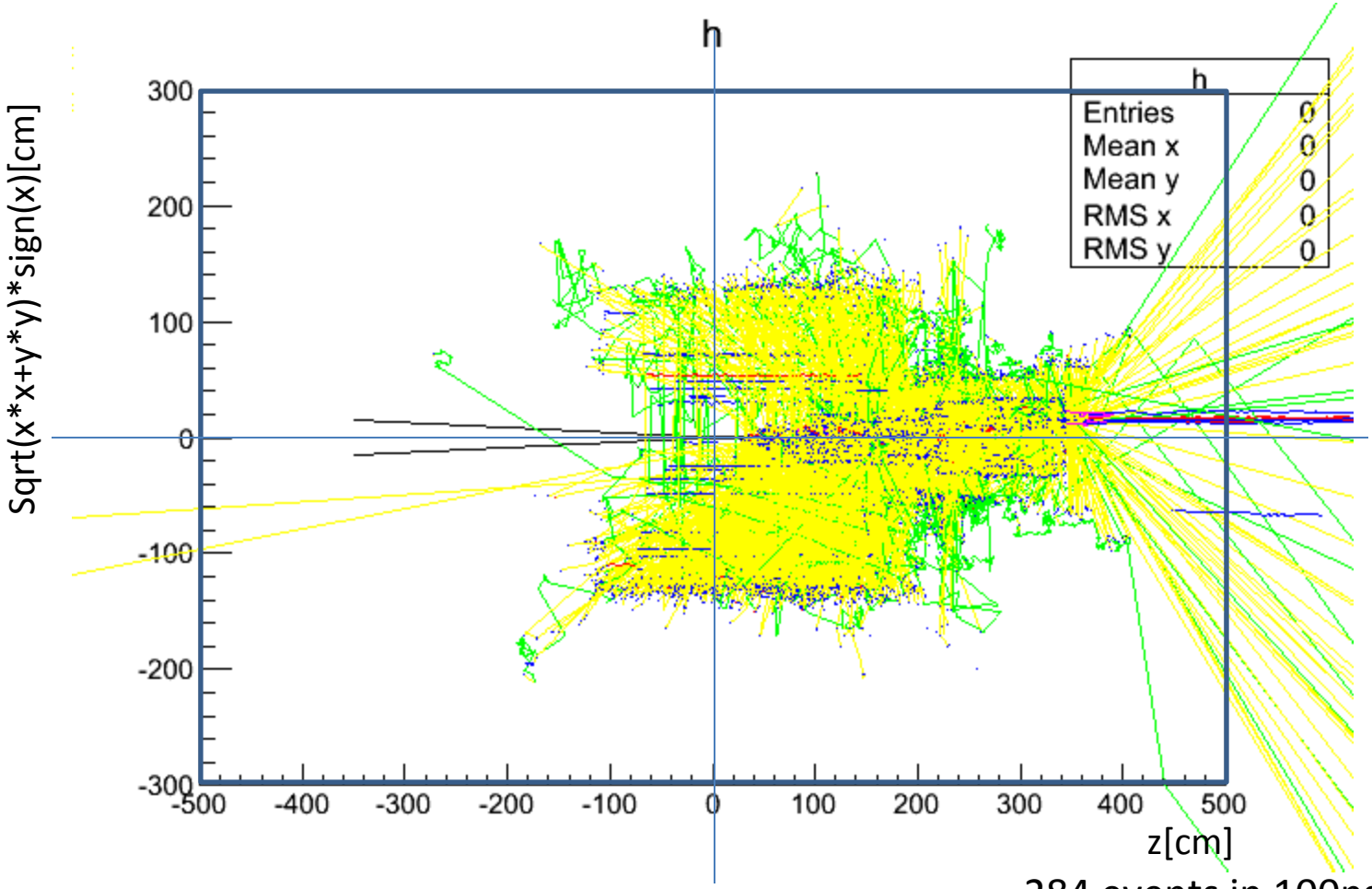


464 events in 100ns

Rad. Bhabha HER

Magenta: primary particle
Red: e+
Blue: e-
Yellow: gamma
Green: neutron

Show particles with E>1MeV

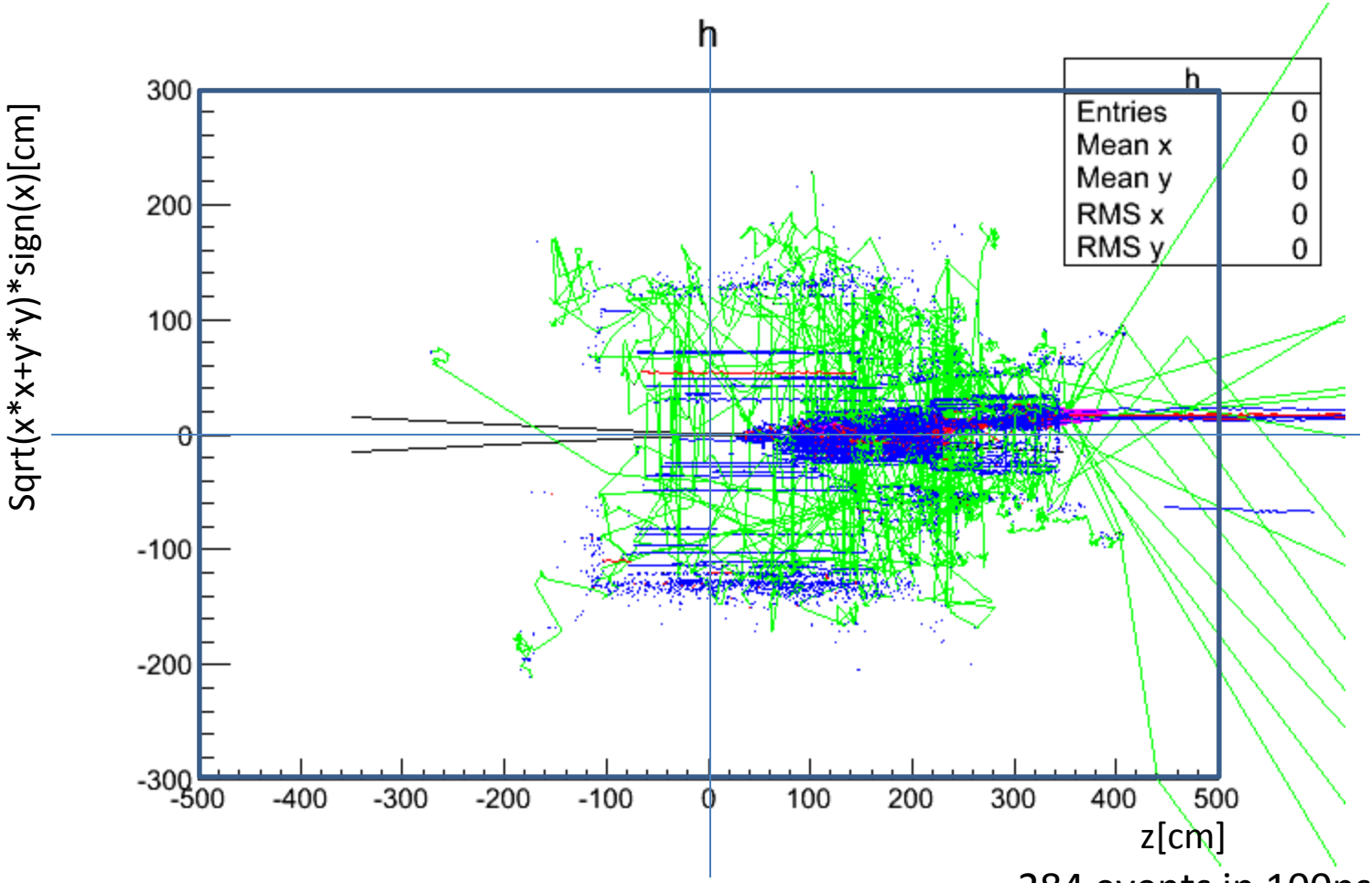


284 events in 100ns

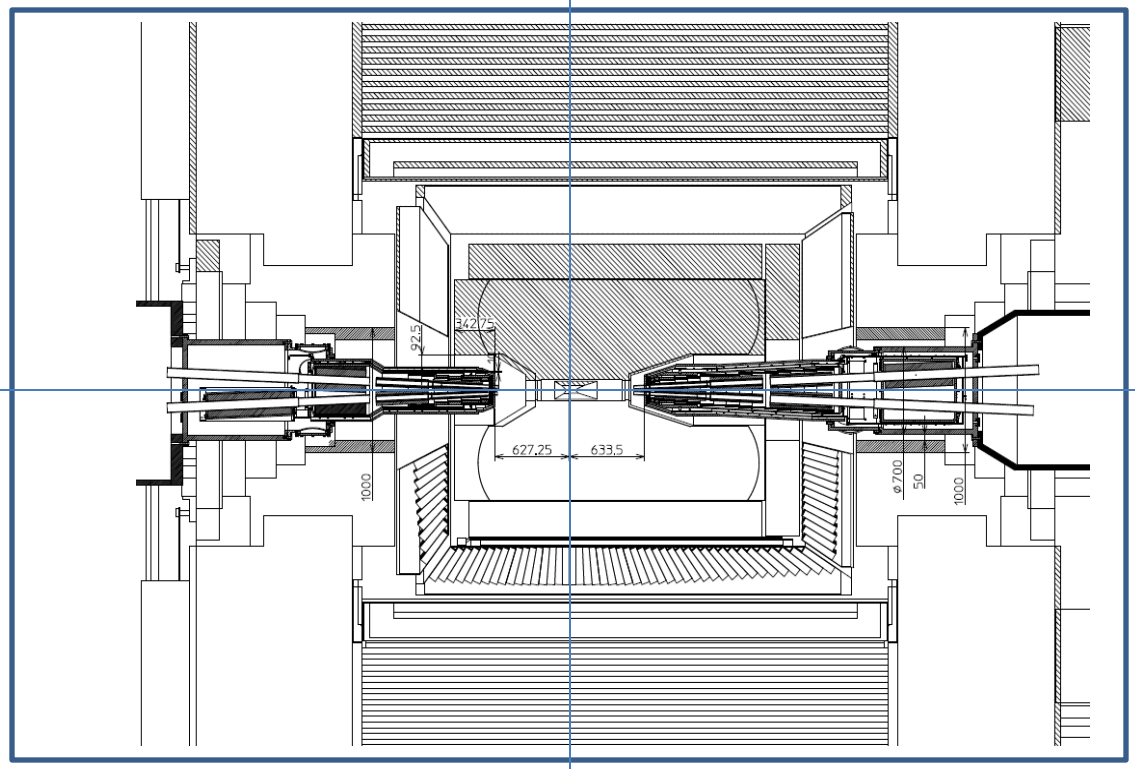
Rad. Bhabha HER

Magenta: primary particle
Red: e+
Blue: e-
Yellow: gamma
Green: neutron

Show particles with E>1MeV

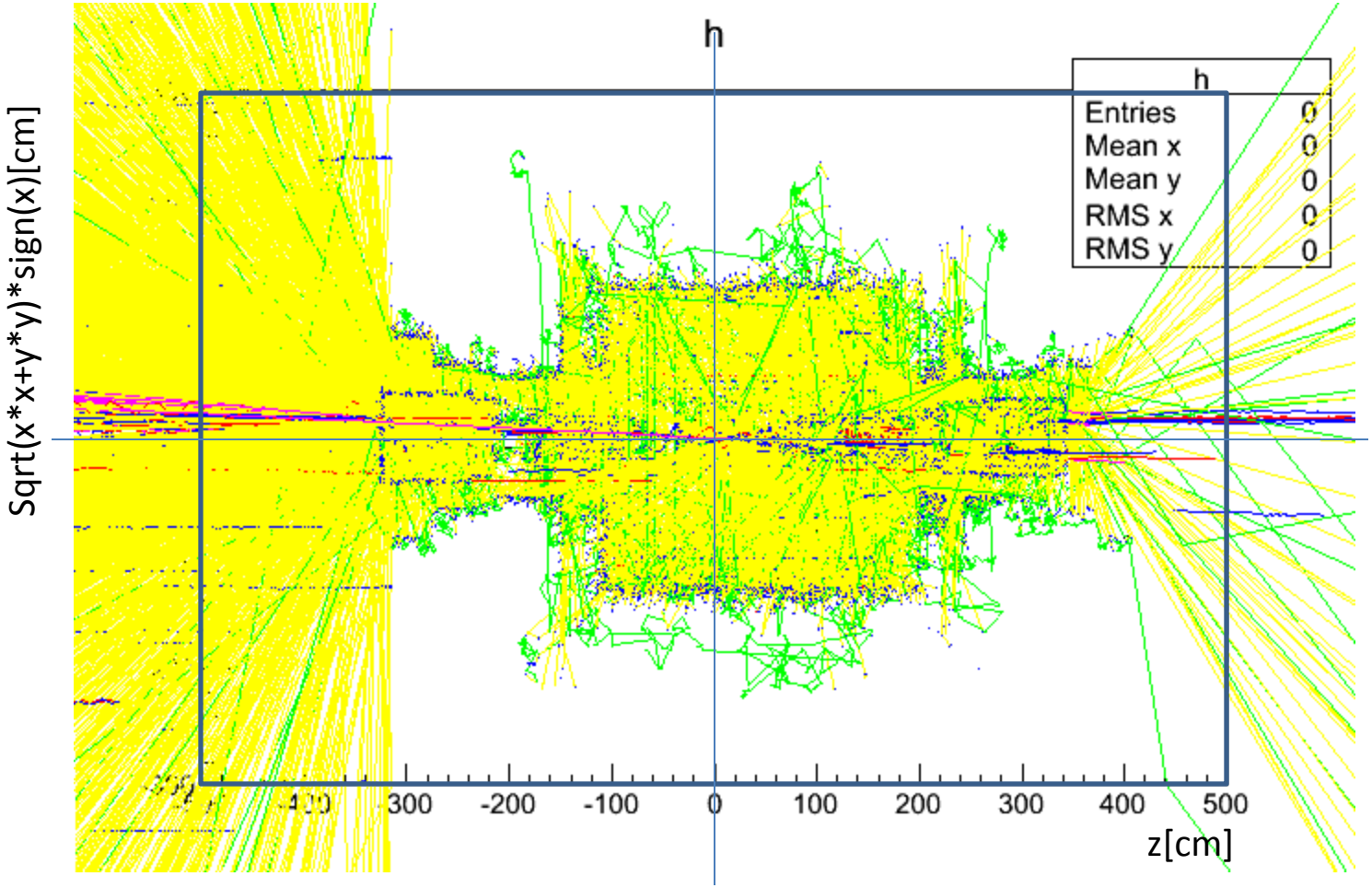


284 events in 100ns


92.5
342.75
627.25
633.5
1000
ø 700
50
1000

Total (w/o SR, 2-photon)

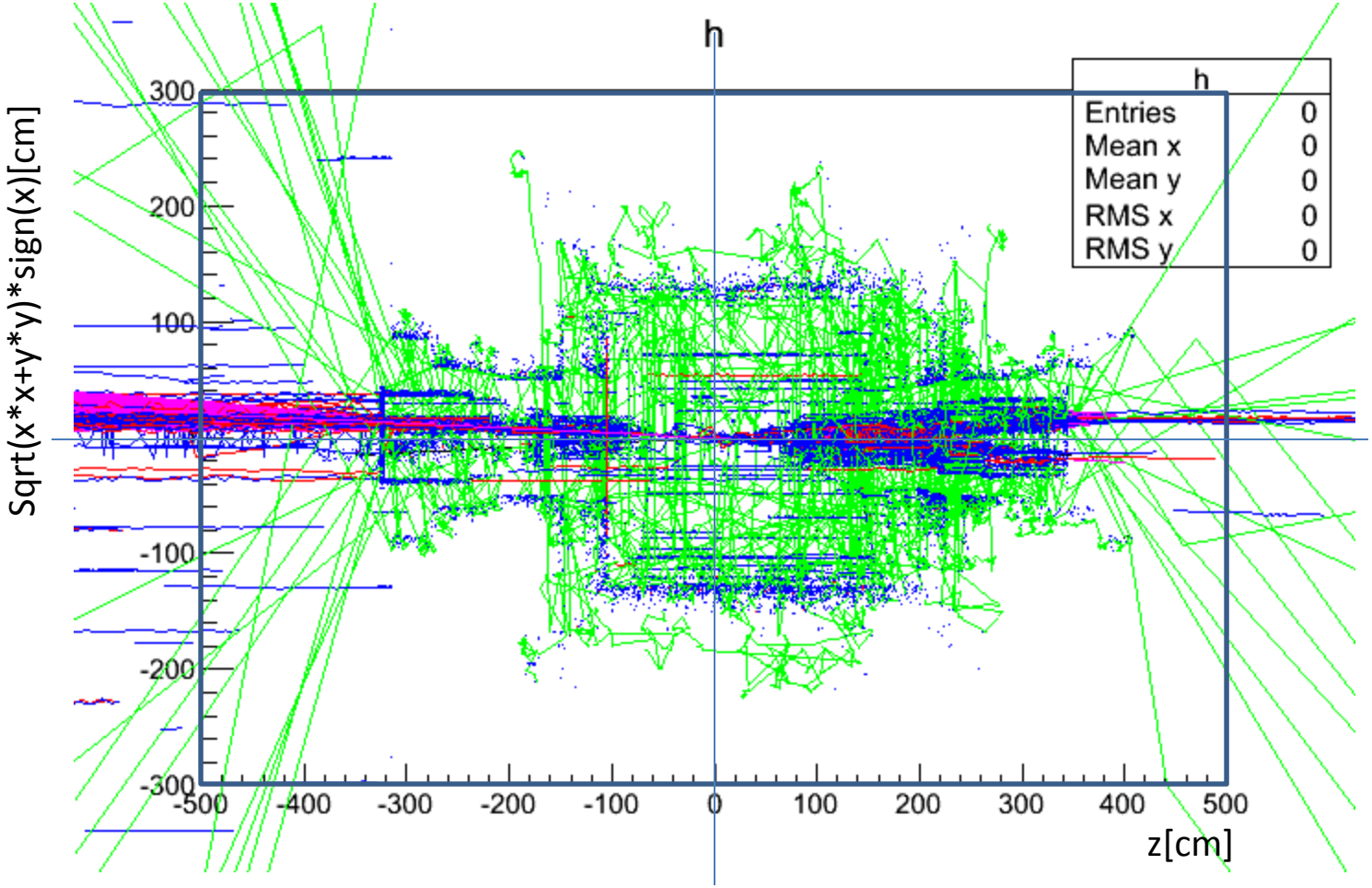
Show particles with E>1MeV



in 100ns

Total (w/o SR, 2-photon)

Show particles with E>1MeV



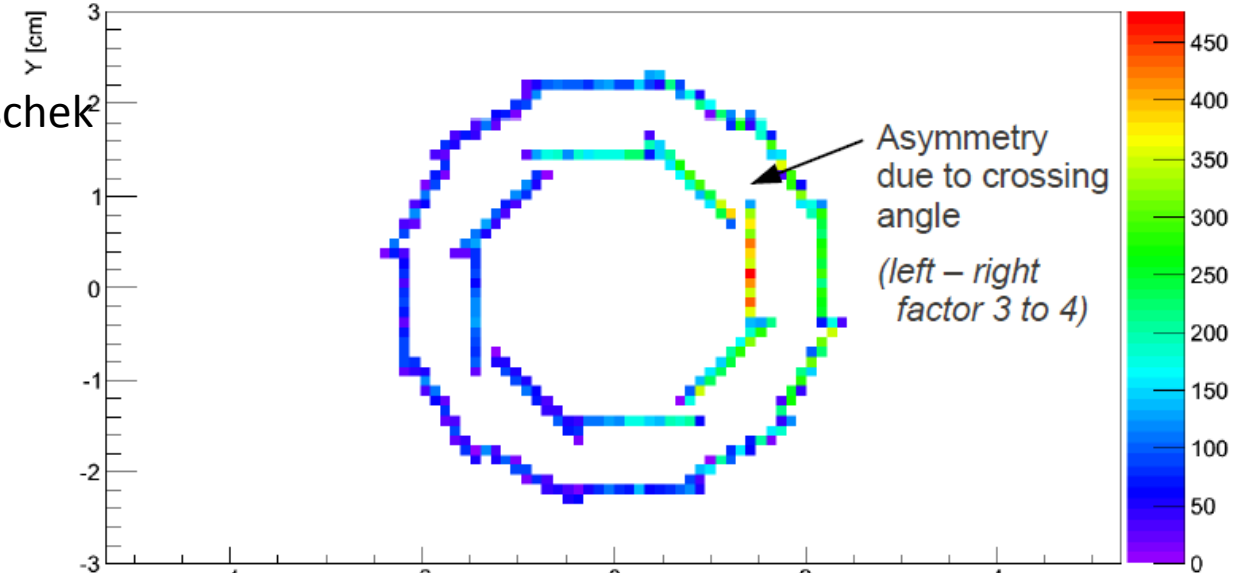
in 100ns

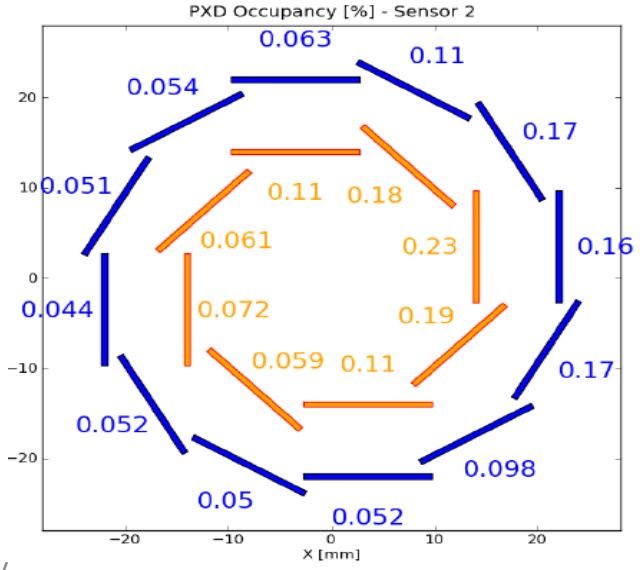
2nd campaign

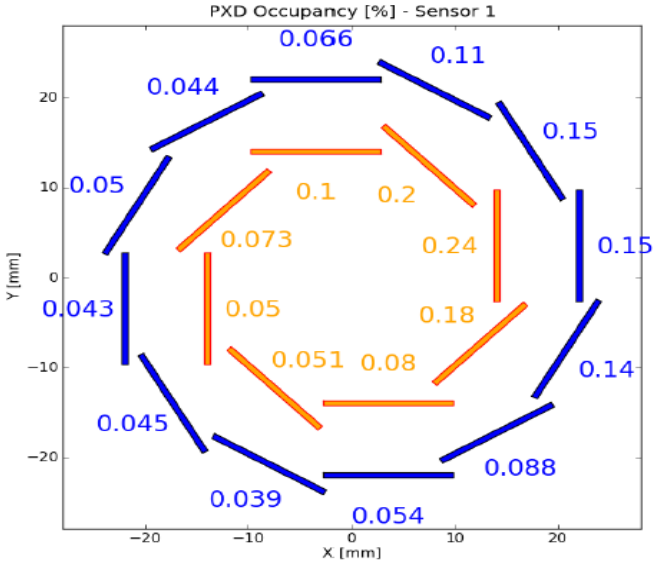
A. Moll (MPI)
VXD meeting on 7th Feb. 2012

PXD

LER Touschek (0.2GHz)







2nd campaign

PXD

A. Moll (MPI)
VXD meeting on 7th Feb. 2012

Occupancy – Summary 17

		Layer 1	Layer 2
Touschek	LER	**0.12 %**	**0.09%**
Touschek	HER	0.0 %	0.0 %
Beam-Gas Coulomb	LER	0.0 %	0.0 %
Beam-Gas Coulomb	HER	0.0 %	0.0 %
Radiative Bhabha	LER	10^{-4} %	10^{-4} %
Radiative Bhabha	HER	10^{-3} %	10^{-3} %
4-fermion final state QED		**0.64 %**	**0.23 %**
Total		**0.76 %**	**0.32 %**

Requirement: occupancy <2%

1st campaign

SVD

P. Kvanicica
10th Belle2 General Meeting
(19 Nov. 2011)

CU Prague

Background occupancies

Percentage of strips fired by background radiation.
The two columns show data for 1 μs and for 50 ns.
Acceptance threshold is 5000 e-; strong influence on results.
Not to be taken for granted! (sorry): the digitizer is not validated.

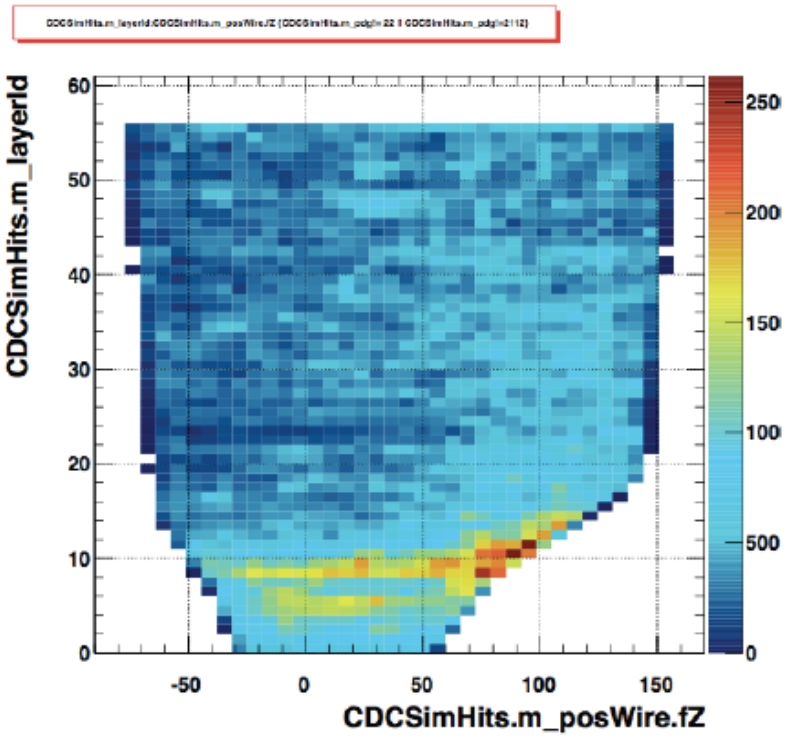
Layer	Occupancy 1 μs	Occupancy 50 ns
3	0.6%	0.03%
4	0.2%	0.01%
5	0.2%	0.01%
6	0.2%	0.01%

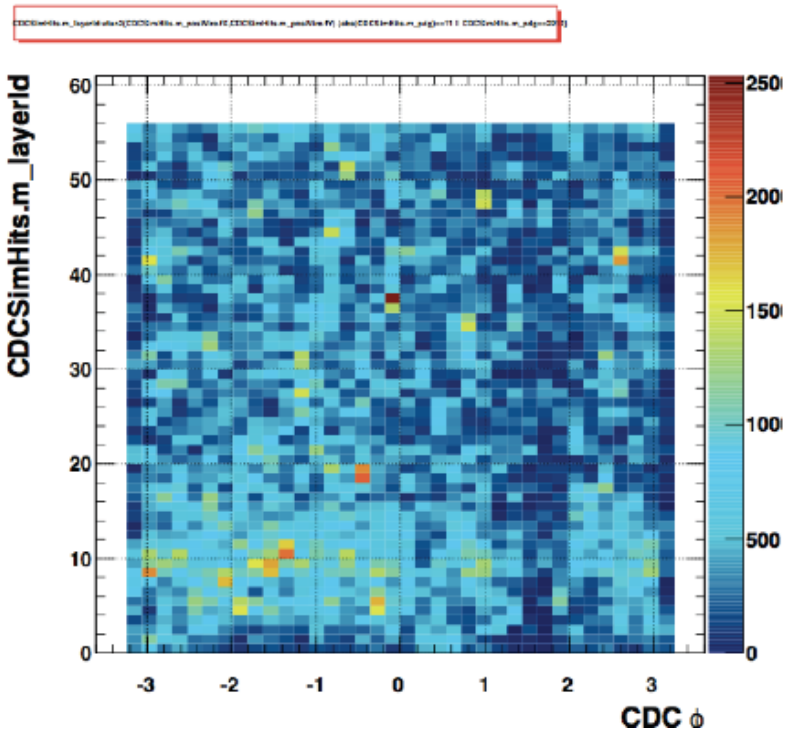
1st campaign

CDC

M. Uchida
10th Belle2 General Meeting
(19 Nov. 2011)

Hit rate

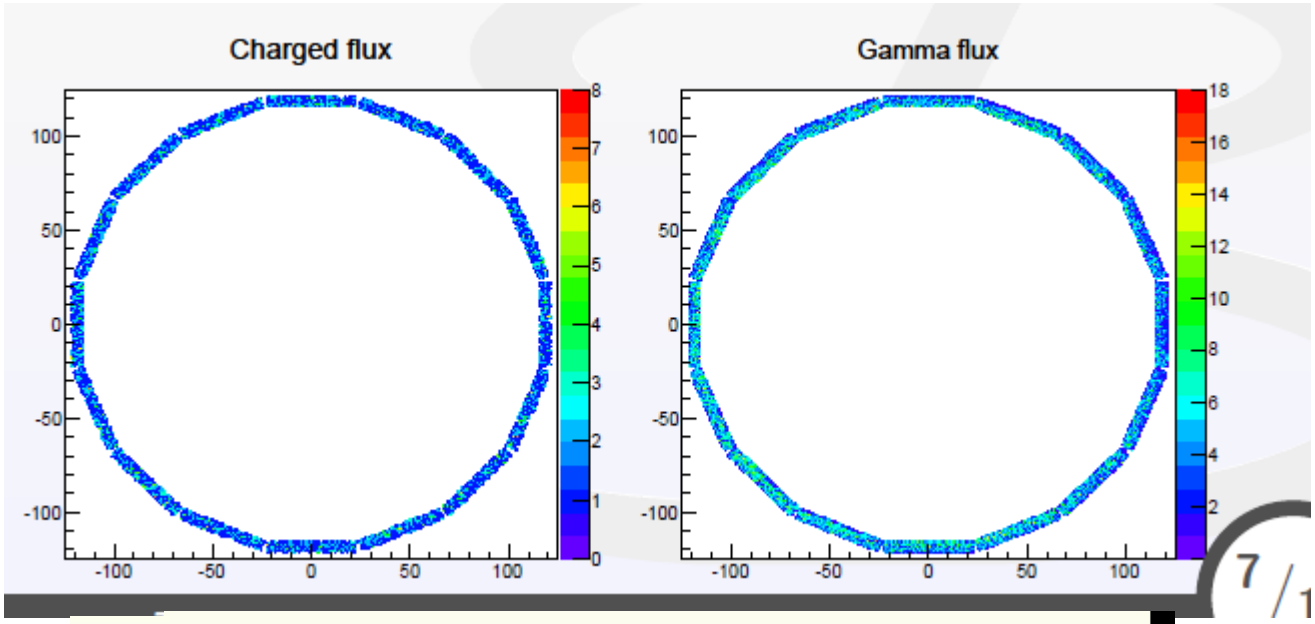


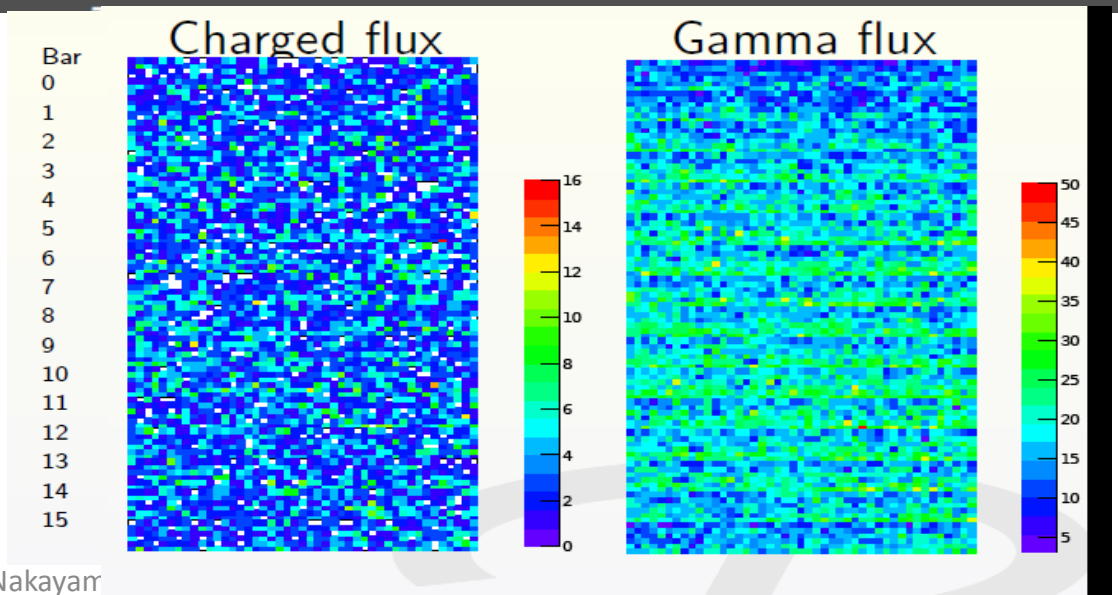


Code under development ..

TOP

M. Petric
10th Belle2 General Meeting
(19 Nov. 2011)





n $[Hz/cm^{-2}]$	2100
$\pm$ $[Hz/cm^{-2}]$	17000
γ $[Hz/cm^{-2}]$	104000

1st campaign

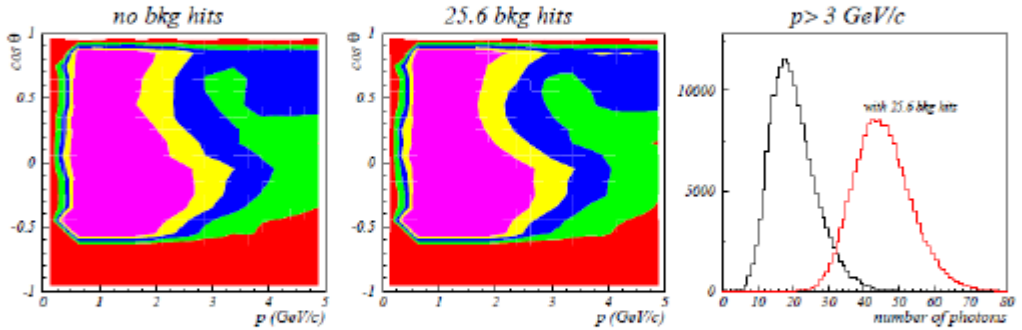
K/pi separation

K. Inami
10th Belle2 General Meeting
(19 Nov. 2011)

- Number of background photons per bar in 50 ns:

$$N_{bkg} = 16\ \mathrm{MHz/PMT} \times 32\ \mathrm{PMT} \times 50\mathrm{ns} = 25.6$$

- additional 25.6 photons on average (Poisson) generated uniformly over PMT channels and time



	$B^0 \to \pi^+\pi^-$		$B^0 \to \rho\gamma$		$D^0 \to K^-\pi^+$	
	π effi	K fake	π effi	K fake	K effi	π fake
no background	92.1	6.8	98.3	1.4	96.7	2.8
16 MHz/PMT	90.8	7.6	97.5	1.9	96.4	3.5

almost no performance degradation at all!

1st campaign

ARICH

L. Santej
10th Belle2 General Meeting
(19 Nov. 2011)

Simulation

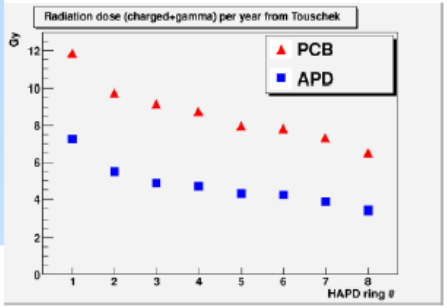
ARICH simulation SANTELJ, Luka

- Together this two backgrounds are giving radiation dose **~10 Gy per year,**
- and neutron flux **~7x10^10 / cm2 per year**.
- Beam-gas background has still to be included.

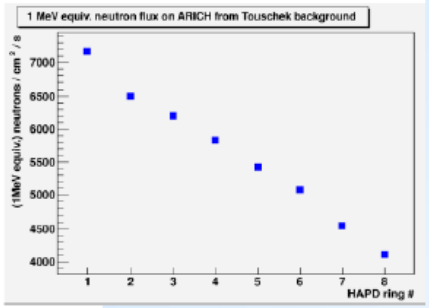
- radiation dose is an order of magnitude smaller than estimated
- neutron flux is on the same order or somewhat larger than estimated
- detailed studies of the origin of the radiation will be done

Touschek background

Dose from **charged+gamma**

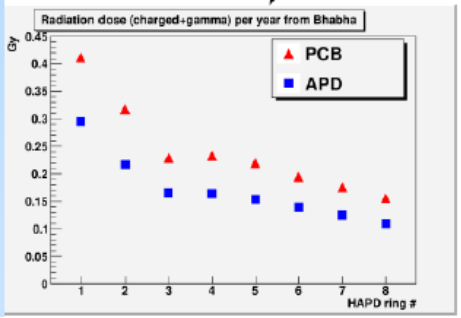


1MeV equiv. **neutron flux**

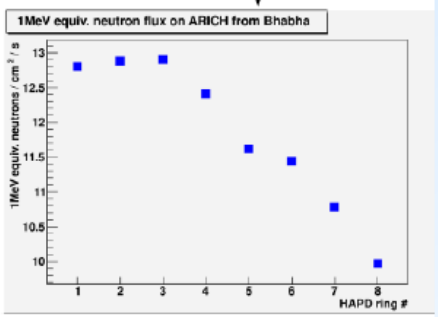


Bhabha background

Dose from **charged+gamma**



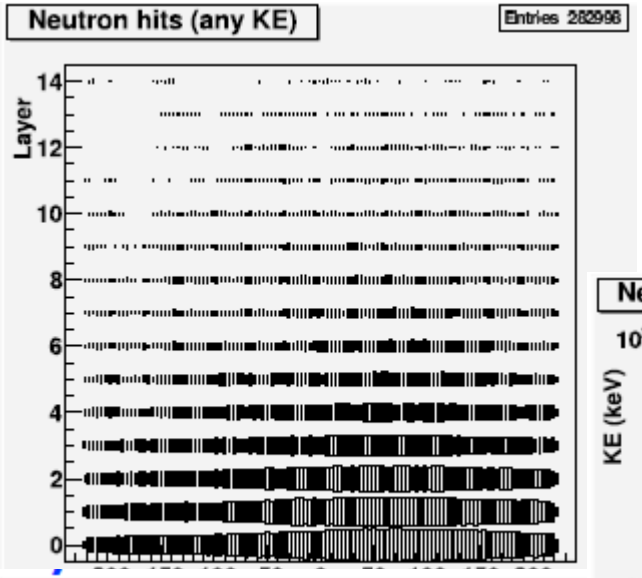
1MeV equiv. **neutron flux**

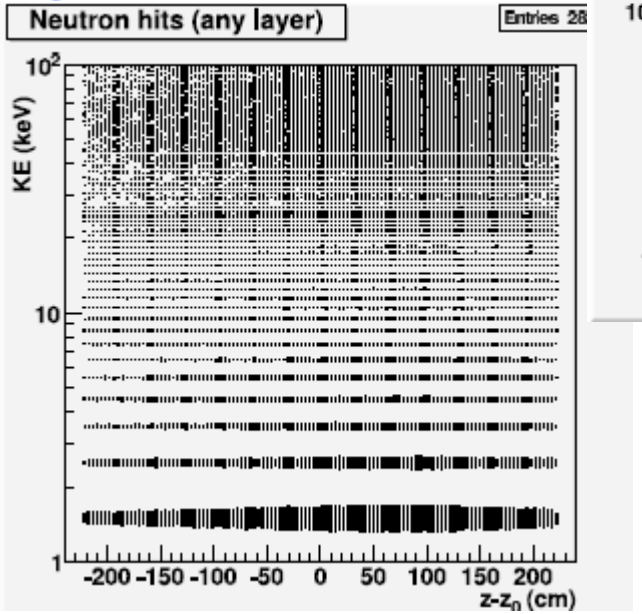


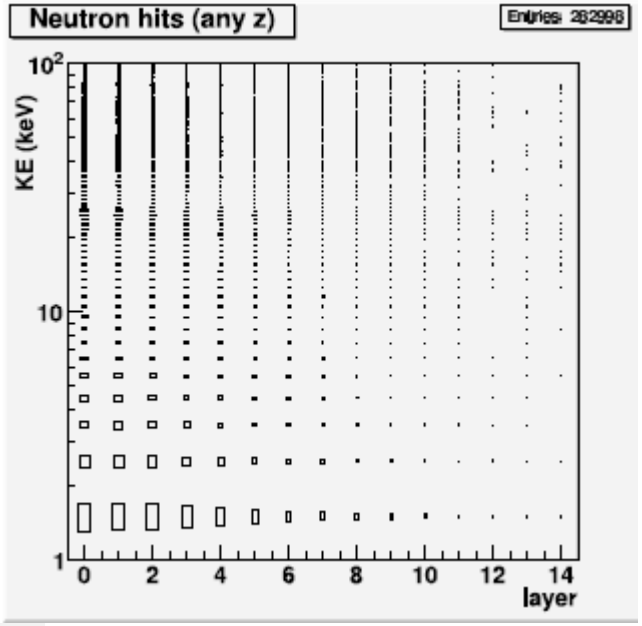
1st campaign

BKLM

L. Piilonen
10th Belle2 General Meeting
(19 Nov. 2011)





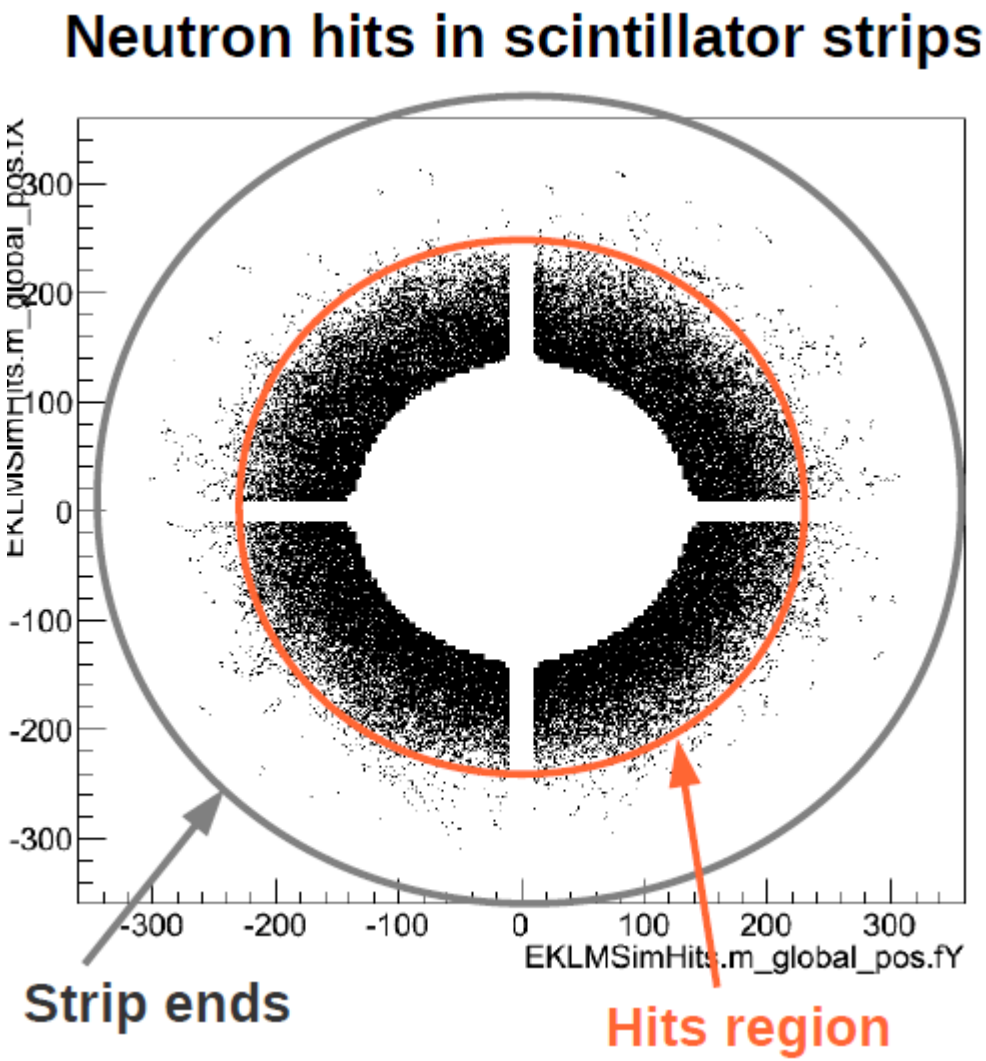


BKLM Layer	Touschek-induced RPC Rate (Hz/cm^2)	Touschek-induced RPC Efficiency
0	17.3	0.58
1	12.7	0.69
2	8.8	0.78
3	5.6	0.86
4	3.6	0.91
5	2.1	0.95
6	1.2	0.97
7	0.7	0.98
8	0.5	0.98
9	0.3	0.99
10	0.1	0.99
11	0.1	0.99
12	0.1	0.99
13	0.0	0.99
14	0.0	0.99

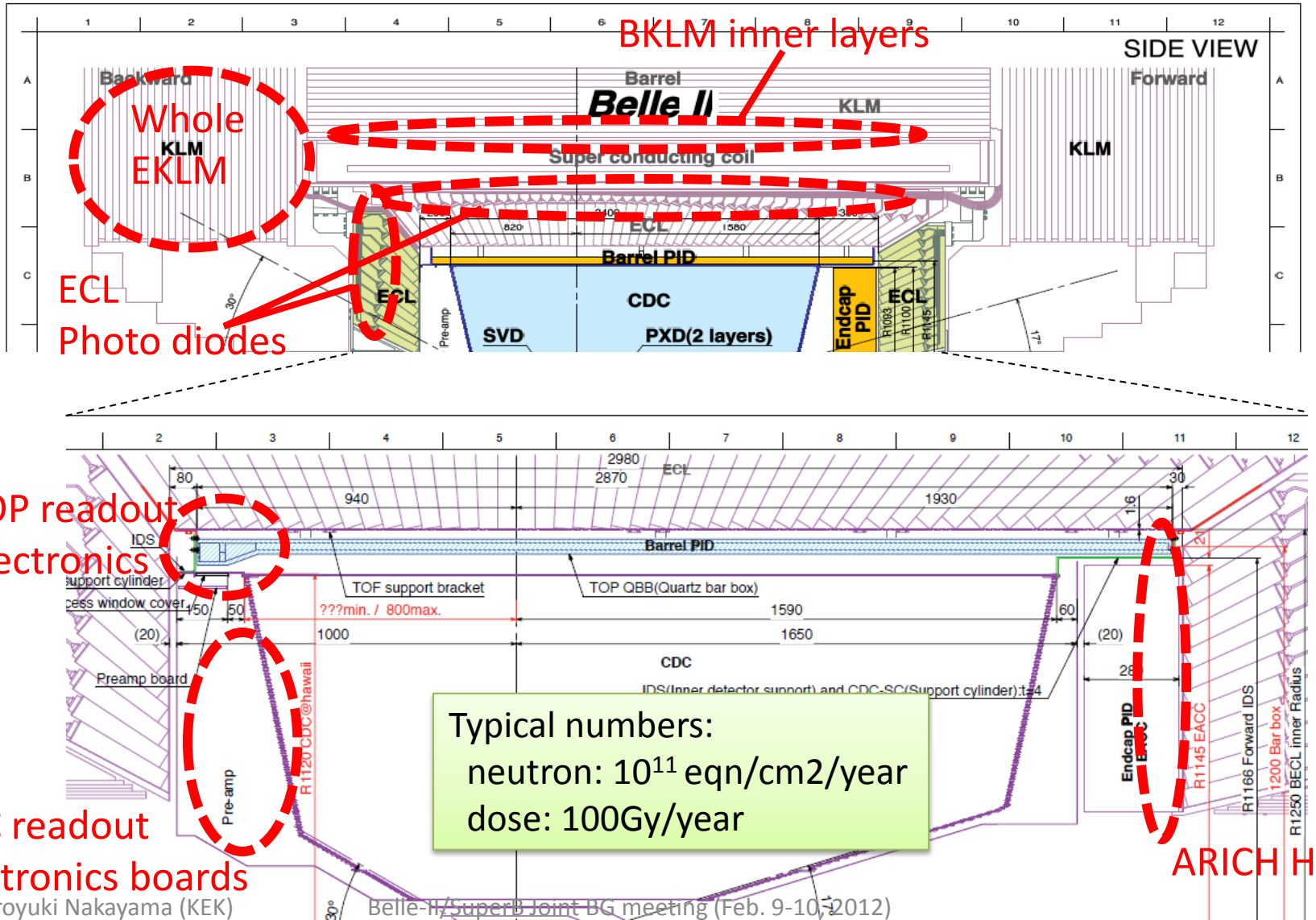
1st campaign

EKLM

T. Uglov
10th Belle2 General Meeting
(19 Nov. 2011)



neutron damage /radiation dose



Neutron flux

1st campaign

1MeV equivalent rate

1 year = 10^7 sec

	Region	Simulation (Touschek BG)	Assumption used for R&D	Life time by irradiation test based on the assumption
PXD	Sensors, readout	2×10^{11}/cm2/year (+0.7×10^{11} from 2-photon)	10^{12} /cm2/year	OK for at least 10 years (10^{13} n/cm2)
SVD	Sensors, chips	3 x 10^{11}/cm2/year	-	ould be OK ted in ATLAS/CMS)
CDC	Readout Boards	~1×10^{10}/cm2/year	10^{11} /c	PGA) is OK for at least 2(5)
TOP	Readout electronics	~ 5×10^{10}/cm2/year		e tested
ARICH	HAPD/ASIC	~7×10^{10}/c	year	OK for at least 4 years
ECL	Diodes		10^{11} /cm2/year	OK for at least 40 years
EKLM	SiPMs	<2 - up bserved no hits - not neutrons which travel ore than 10us	10^9/cm2/year	OK for at least 10 years
BKLM	SiPMs	2~8×10^9/cm2/year	2×10^{10}/cm2/year	OK for at least 10 years

Should be updated in 2nd campaign

1st campaign

These numbers were not correct. Need to be updated in 2nd campaign.

Radiation dose

1 year = 10^7 sec

	Region	Simulation (Touschek BG)	Assumption used for R&D	Life time by irradiation test based on the assumption
PXD	DCD, DHP, switchers	~~~2 Gy/year~~ ~~(+2 Gy/y from 2-photon)~~ ~~Only from neutron~~	10,000 Gy/year (conservative)	OK up to at least 10 years
SVD	APV	3.5 kGy/year	-	more than 100Gy
CDC	Readout boards	~50 Gy/year		Optical receivers killed by ~3 year-dose, trying other products
TOP	Readout electronics	~1	/year	OK up to at least 10 years
ARICH	PCB,APDs	~10	100 Gy/year	OK up to at least 10 years
ECL	Crystals	~8 Gy/year	40 Gy/year	OK up to at least 10 years

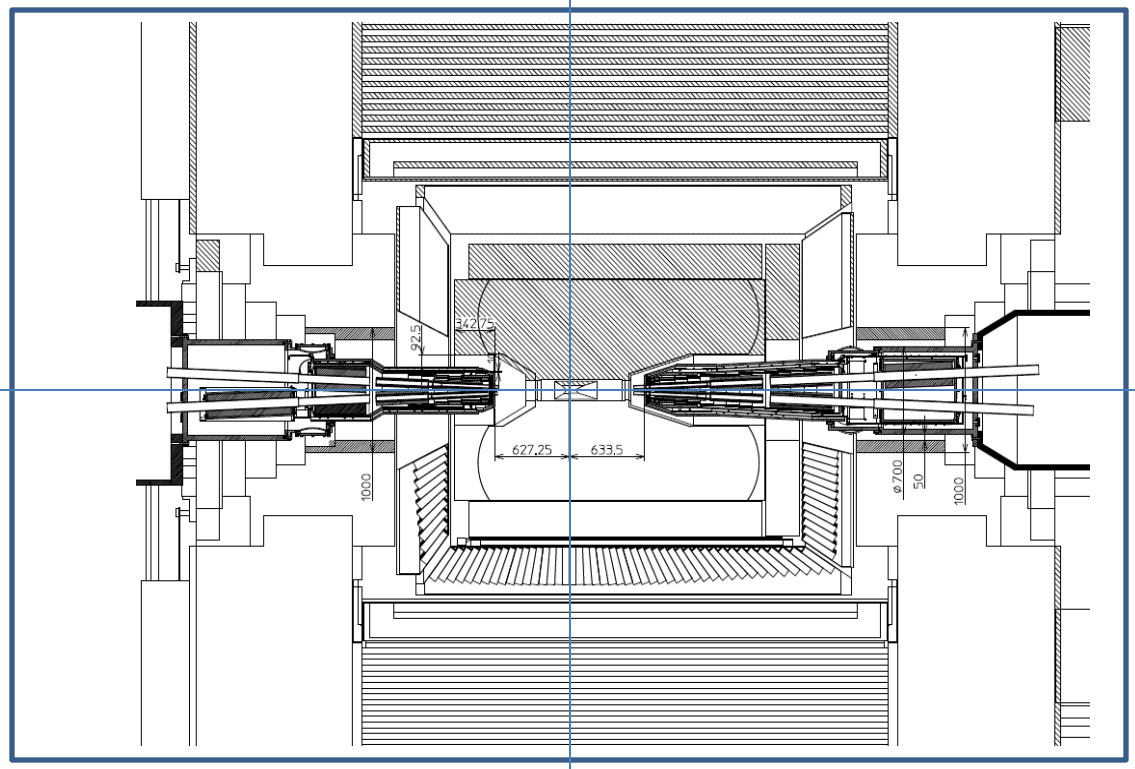
Should be updated in 2nd campaign

Impact from Touschek BG is tolerable in terms of neutron/radiation dose.
Next step is to see the impact from other BG sources, such as beam-gas BG, radiative Bhabha BG, SR, etc..

Summary

- Touschek, beam-gas have been reduced, now radiative Bhabha dominates. (Same as SuperB!)
- I hope we can understand the 2-photon number discrepancy today
- SR simulation in full simulation started recently
- Full detector simulation campain ongoing

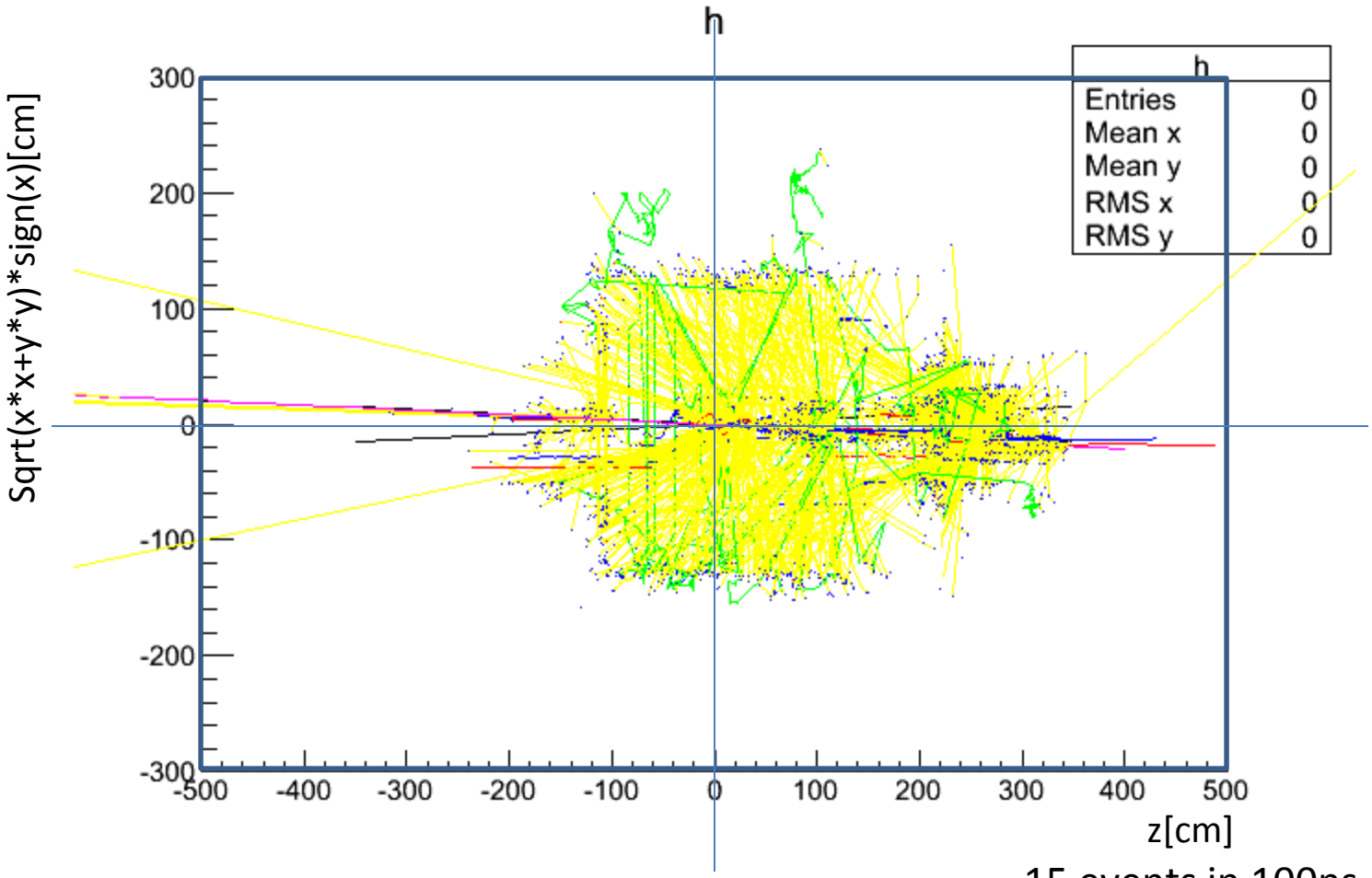
backup


92.5
342.75
627.25
633.5
1000
ø 700
50
1000

Touschek LER

Magenta: primary particle
Red: e+
Blue: e-
Yellow: gamma
Green: neutron

Show particles with E>1MeV

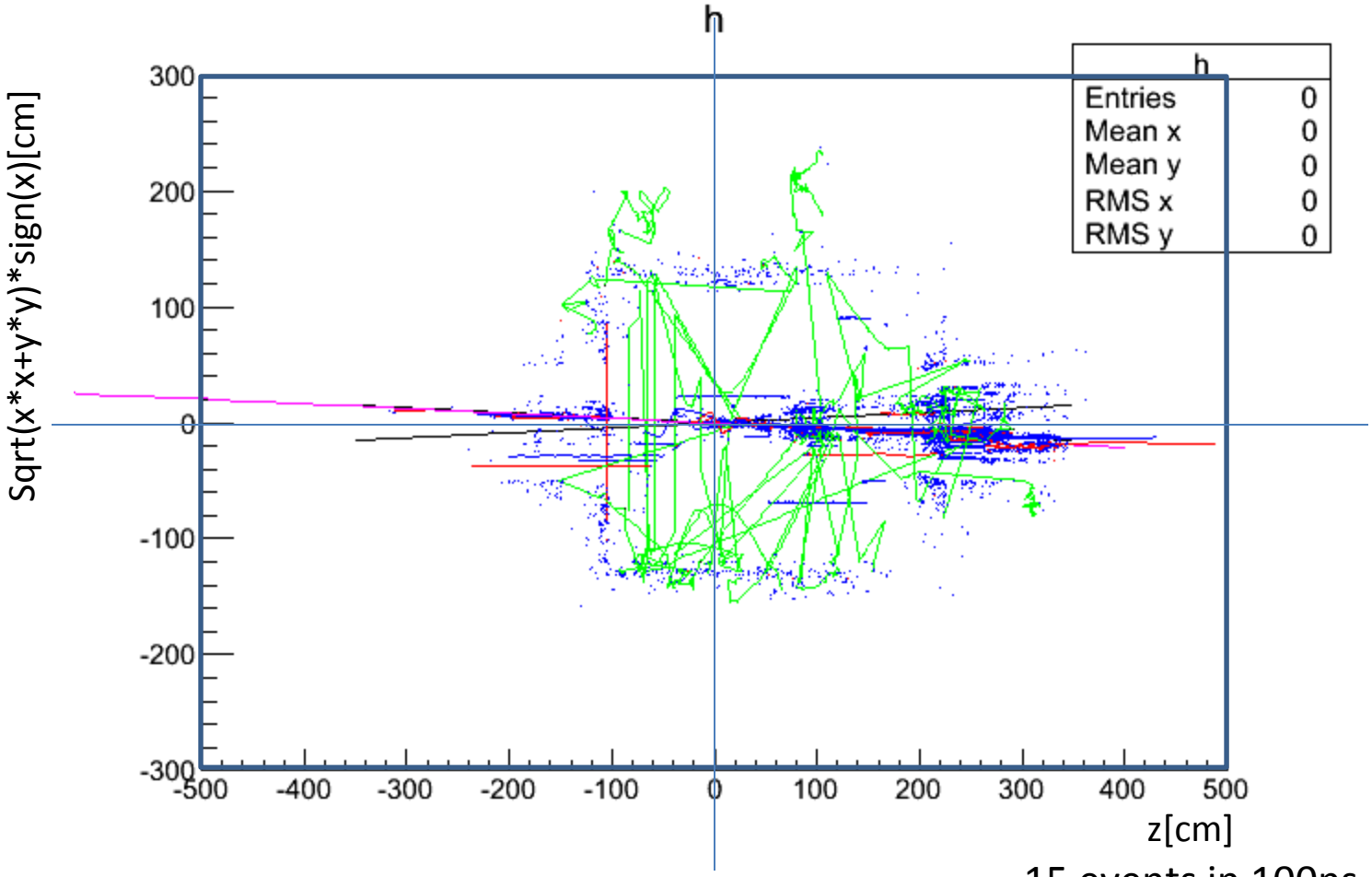


15 events in 100ns

Touschek LER

Magenta: primary particle
Red: e+
Blue: e-
Yellow: gamma
Green: neutron

Show particles with E>1MeV

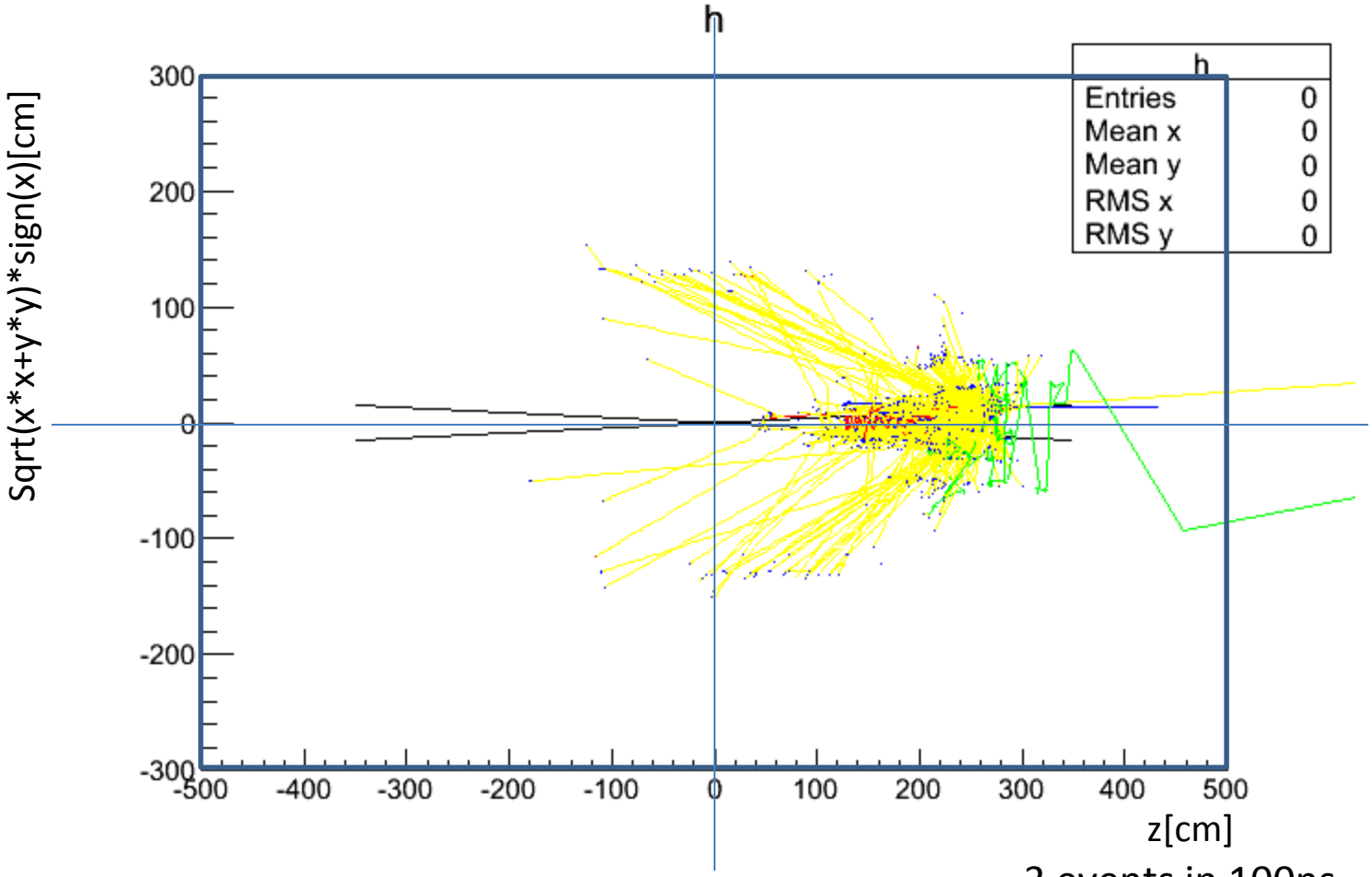


15 events in 100ns

Touschek HER

Magenta: primary particle
Red: e+
Blue: e-
Yellow: gamma
Green: neutron

Show particles with E>1MeV

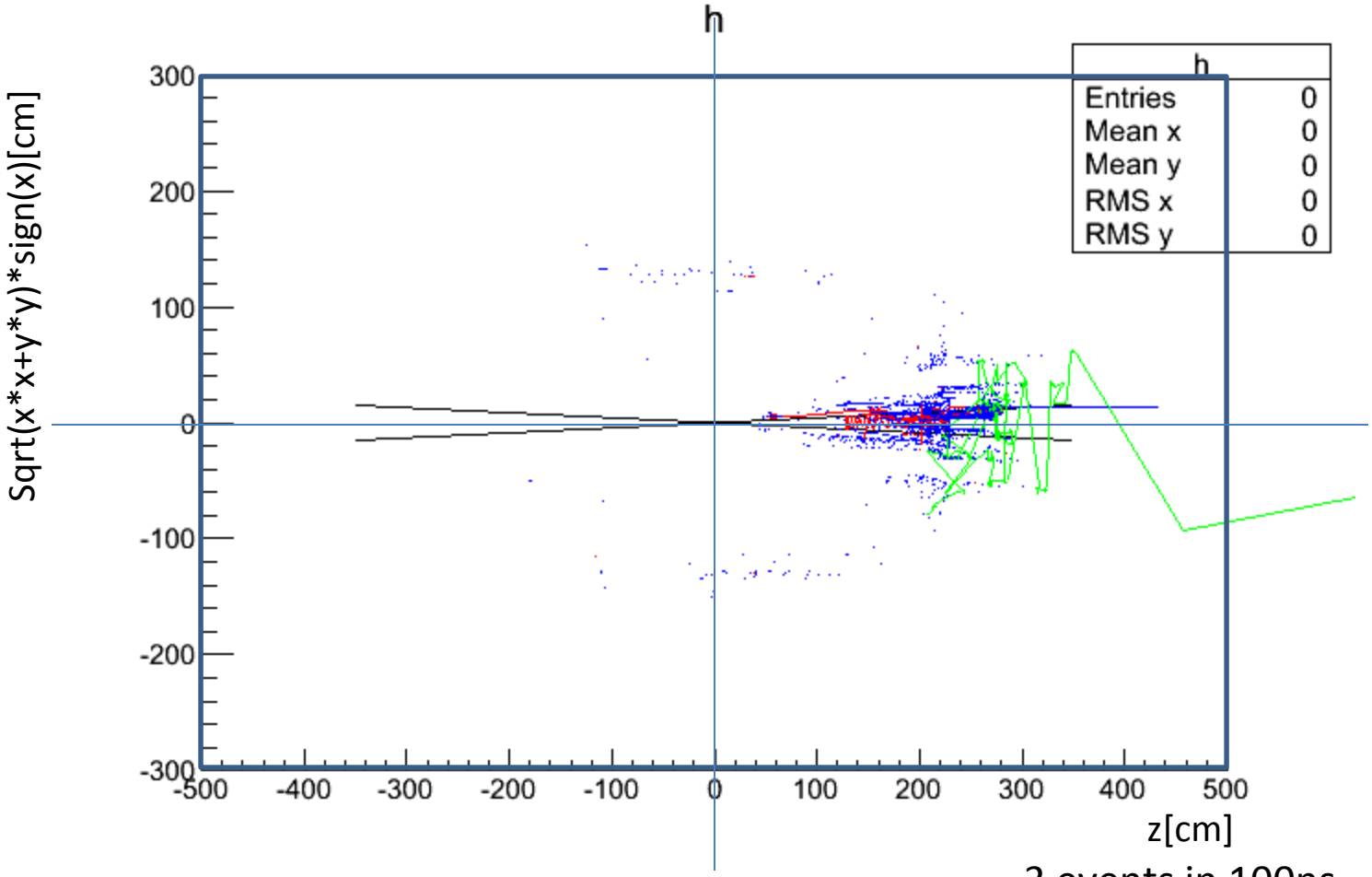


3 events in 100ns

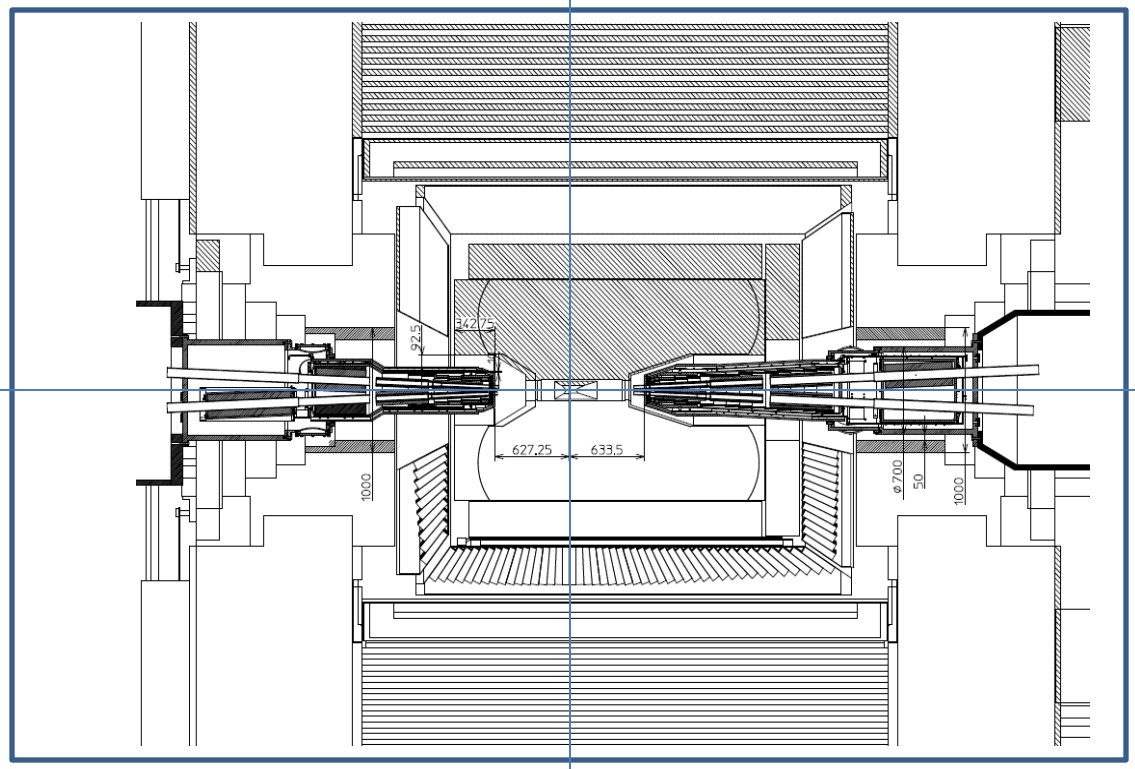
Touschek HER

Magenta: primary particle
Red: e+
Blue: e-
Yellow: gamma
Green: neutron

Show particles with E>1MeV



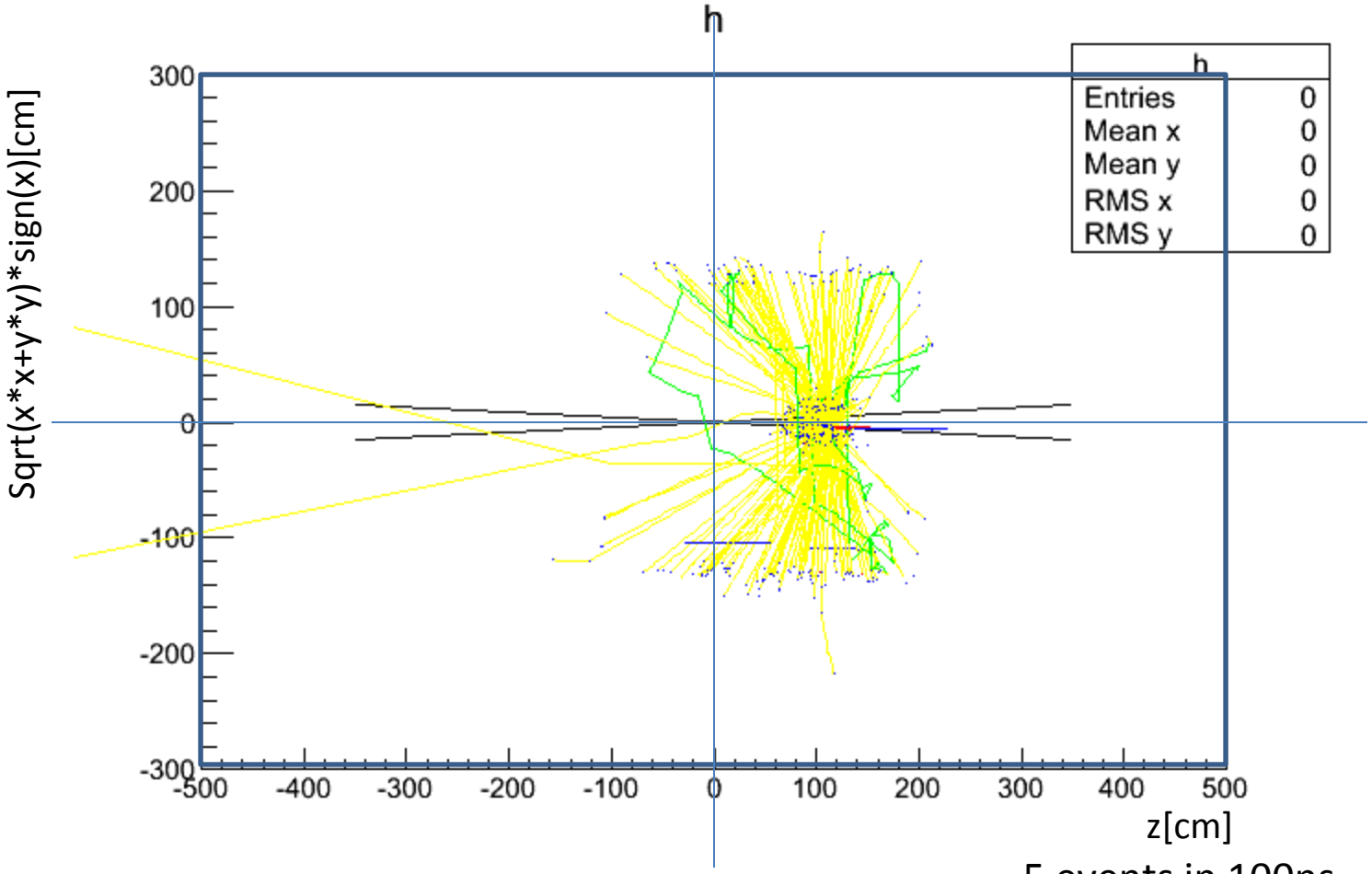
3 events in 100ns


92.5
342.75
627.25
633.5
1000
ø 700
50
1000

Coulomb LER

Magenta: primary particle
Red: e+
Blue: e-
Yellow: gamma
Green: neutron

Show particles with E>1MeV

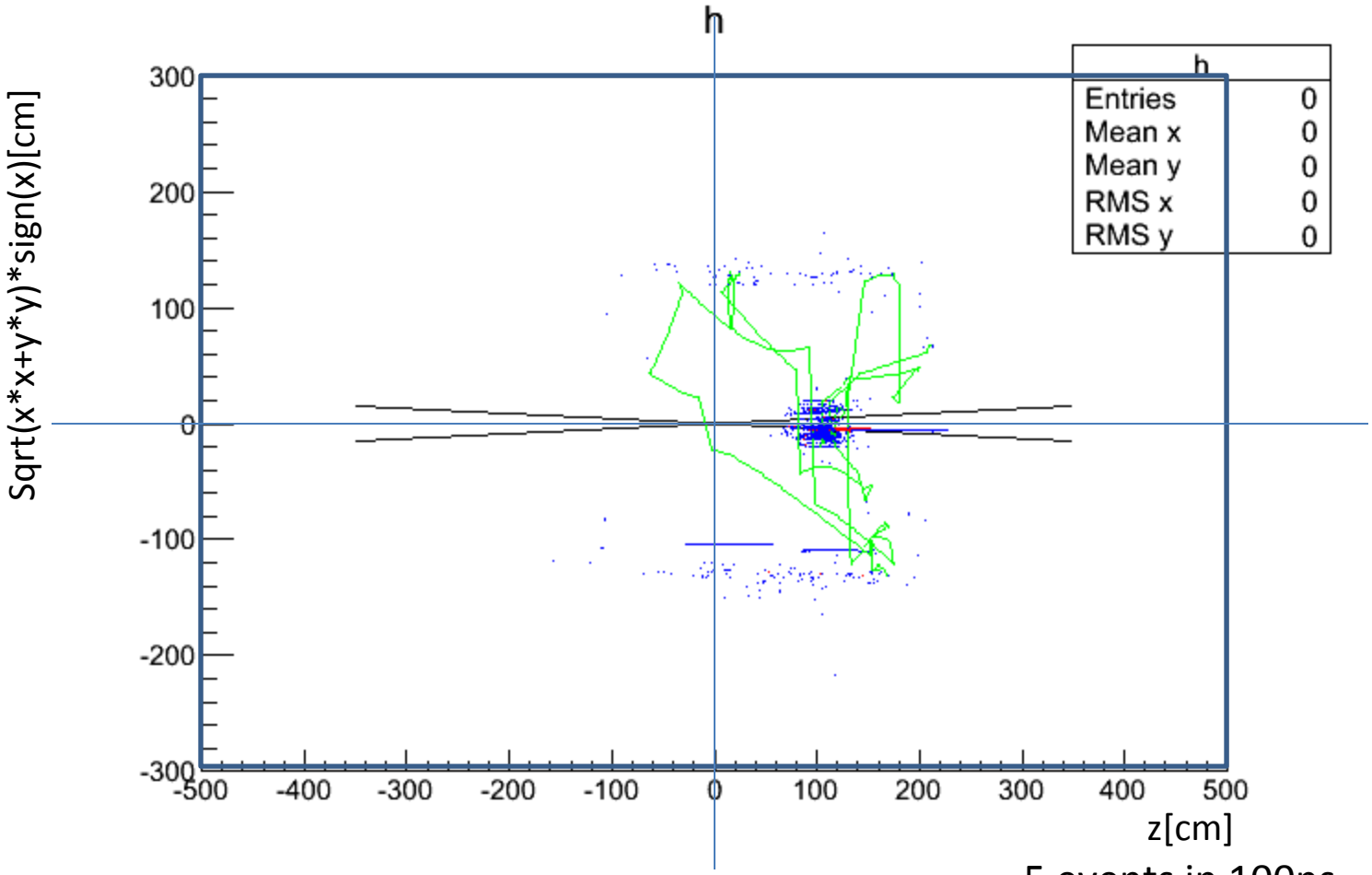


5 events in 100ns

Coulomb LER

Magenta: primary particle
Red: e+
Blue: e-
Yellow: gamma
Green: neutron

Show particles with E>1MeV



5 events in 100ns

- 0 event generated for Coulomb HER in 100ns