Update of

Synchrotron BG

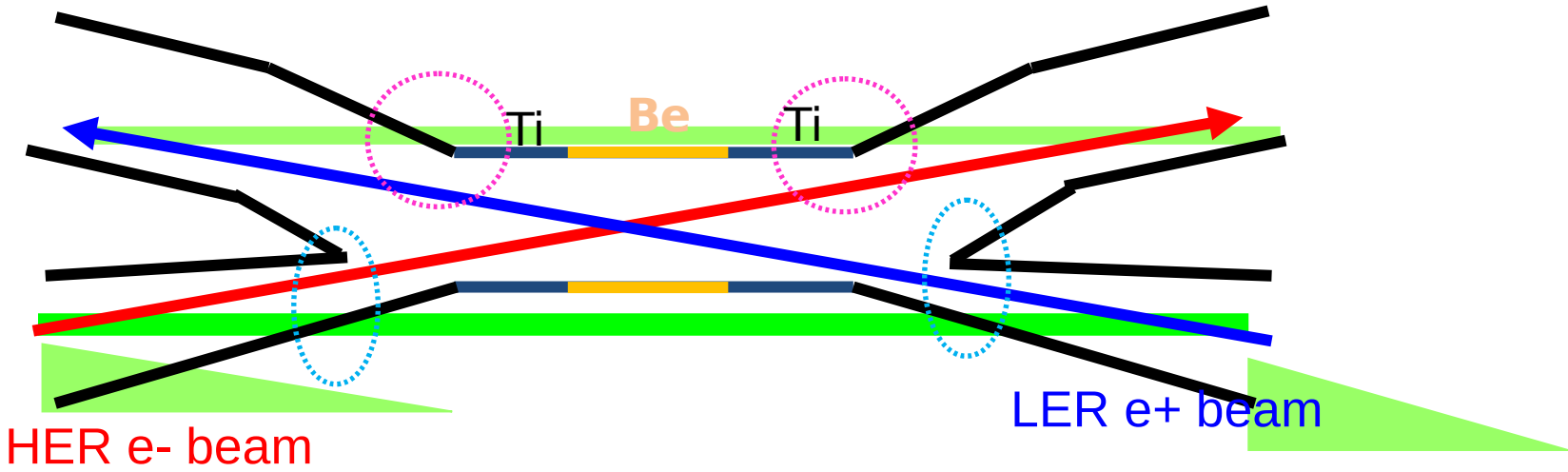
mainly from HER

1. Orbit with 2D solenoid field. X and Y planes

2. Validation of GEANT4 SR model. Angular distribution.

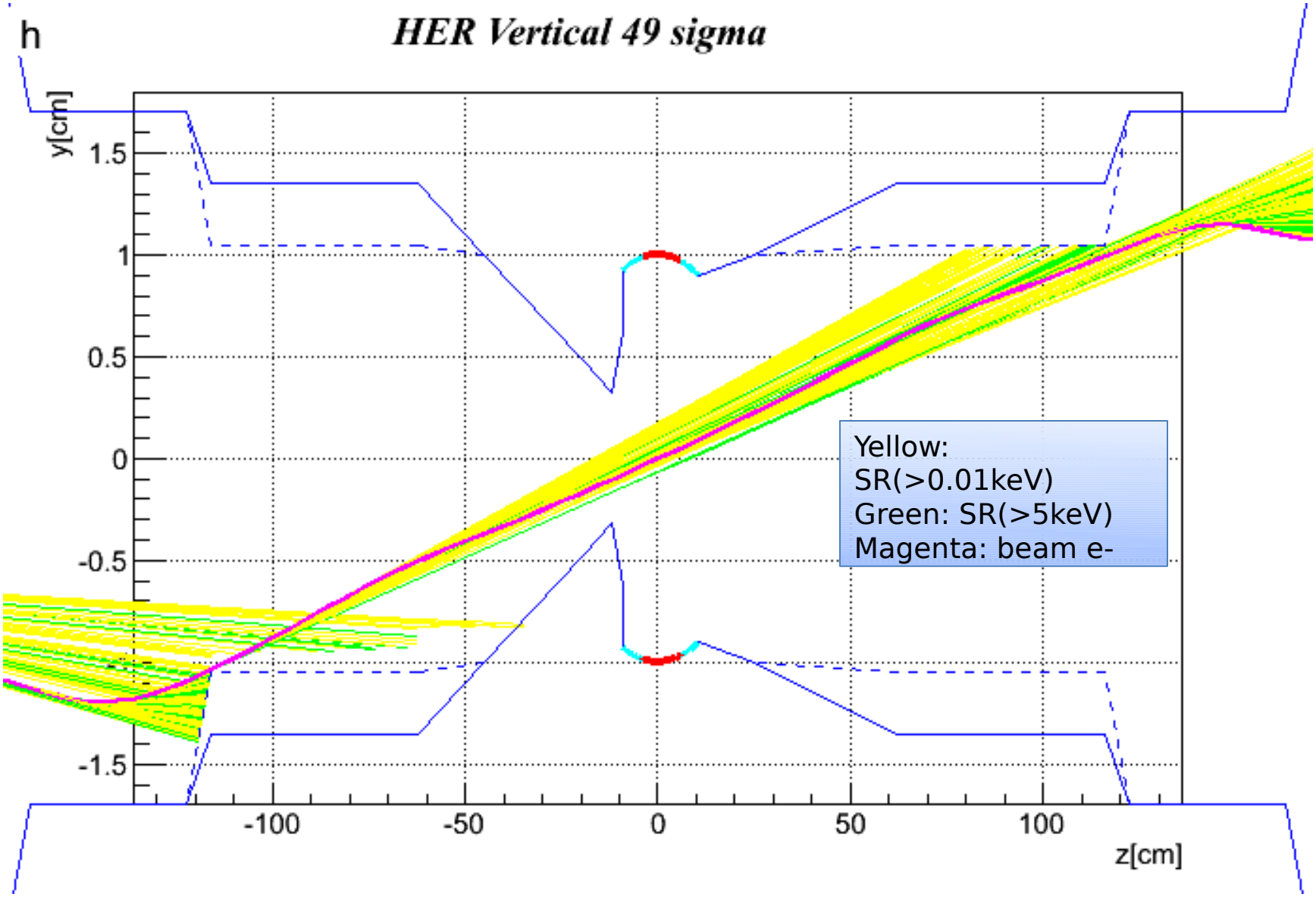
H. Nakayama
Y. Soloviev

Orbit with 2D solenoid field
X and Y planes



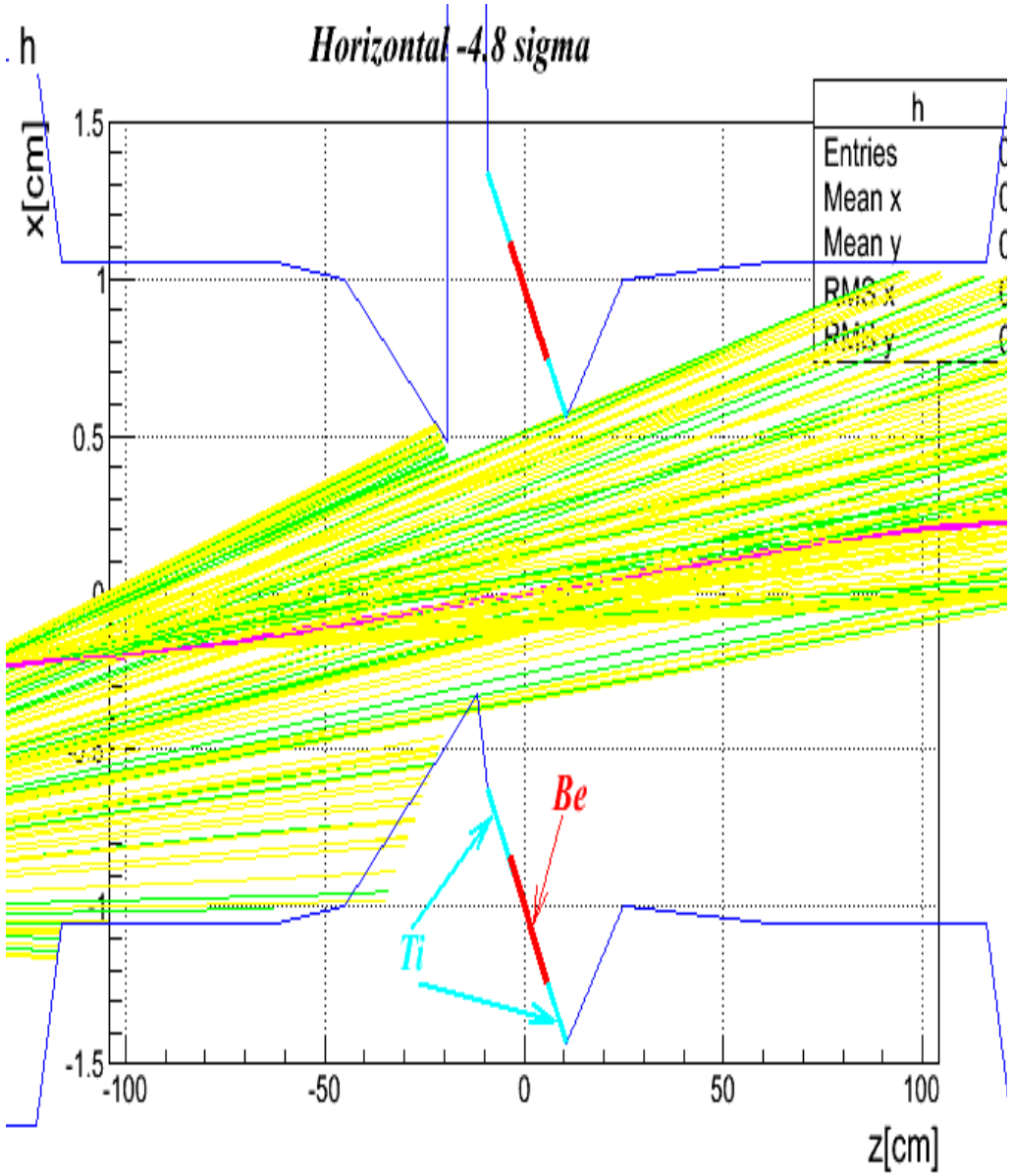
SR must not hit Be part.
SR is desired not to hit Ti part.

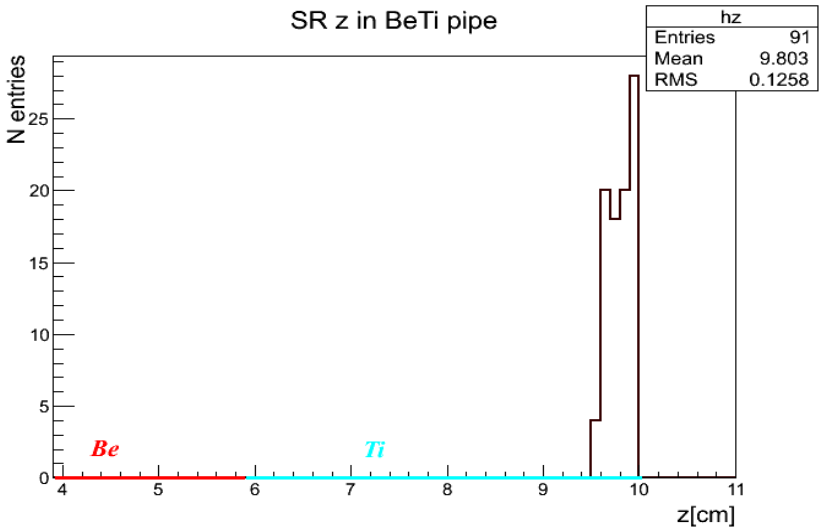
Collimator stops direct SR hit on Ti part for SR which is parallel to the beam.

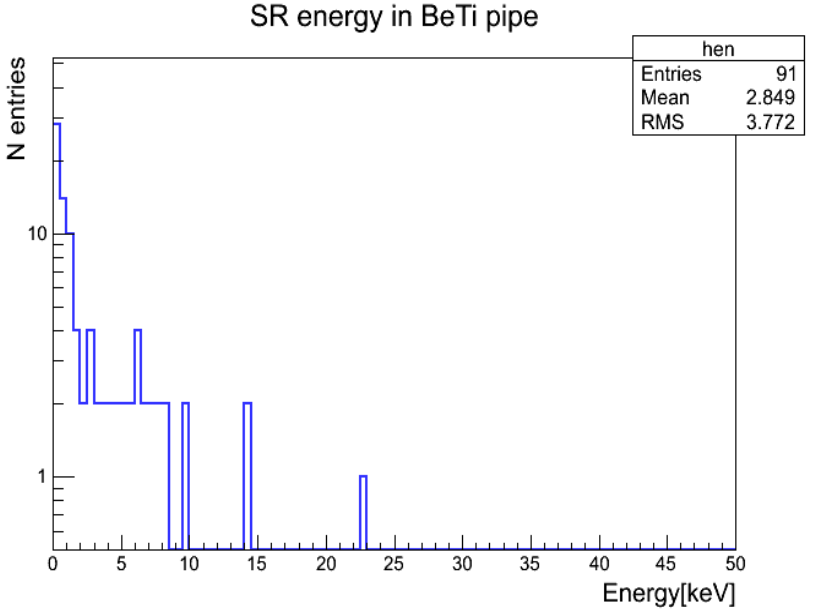


Orbit entering IP with θy/σy = 0, +-3,+-6, +-9, +-12, +-15, +-18, +-20, +-25, +-30, +-35, +-40, +-45, +-49, σy = 200μrad

Horizontal 4.8 sigma

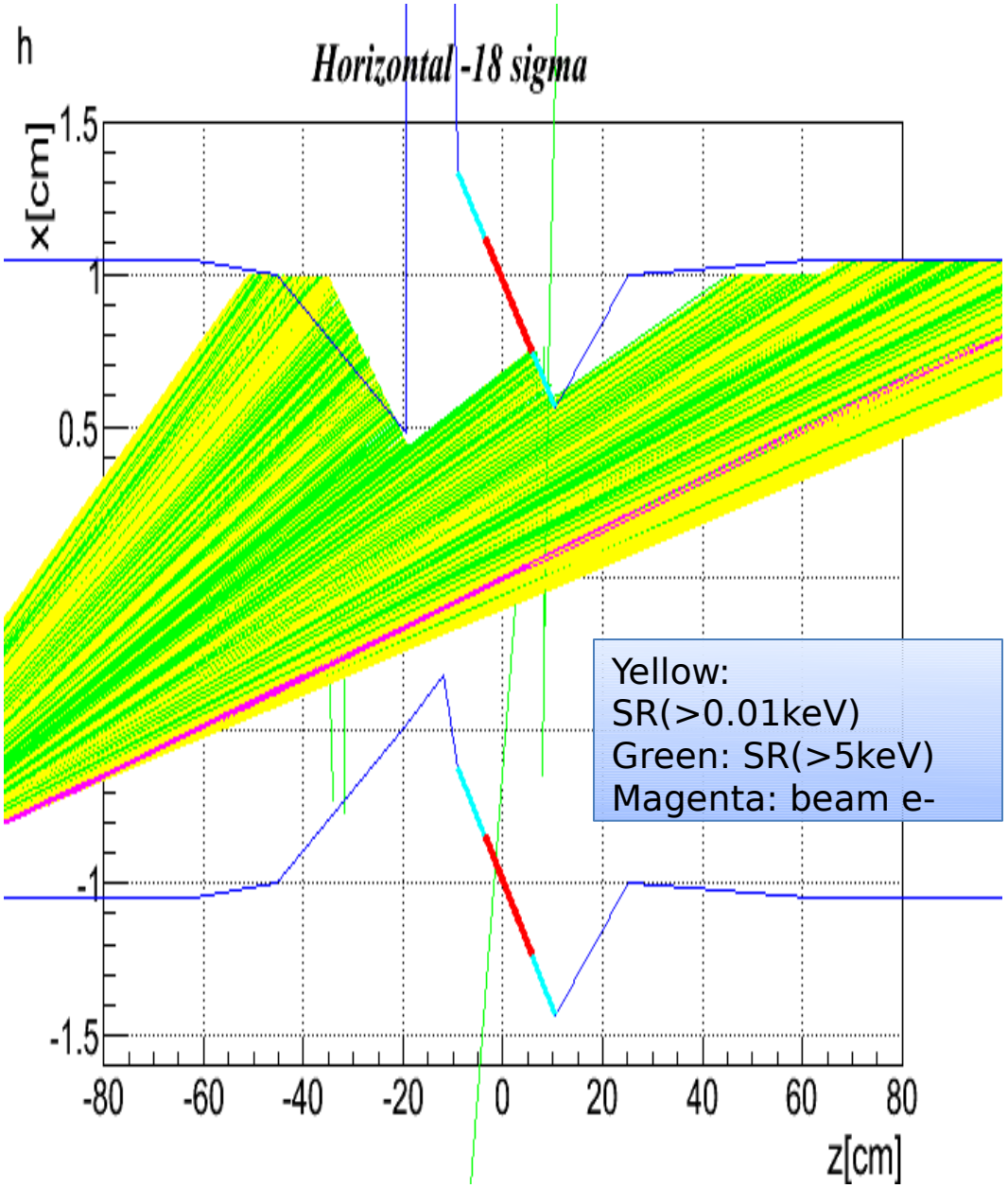


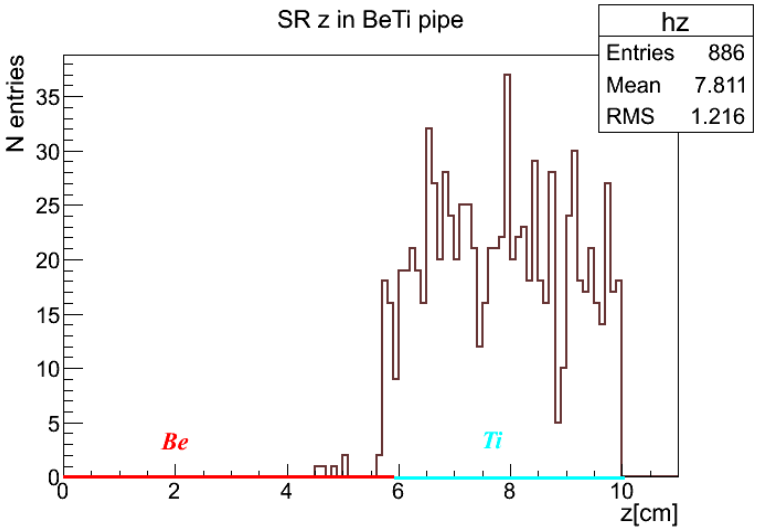


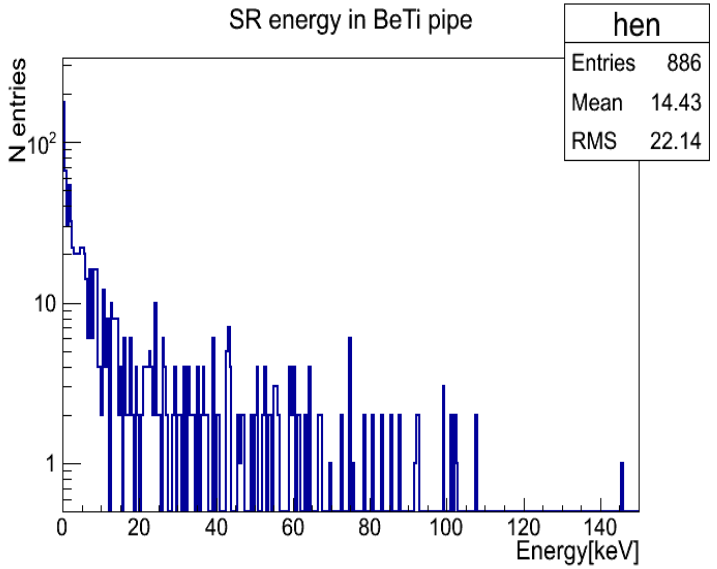


Orbit entering IP with θx/σx = 0, +-3,+-6, +-9, +-12, +-15, +-18,σx=429μrad

Horizontal -18 sigma







Assuming gaussian shape of beam angular distribution in X-plane, beam life time = 10min, and uniformly distributed halo electrons one can estimate number of direct hits of SR photons (>5keV) in Be -Ti beam pipe in case of gaussian beam core on top of uniformly distributed beam halo.

The number of electrons per bunch 6*10e+10.

The fraction of hits in Be part is about 1e-2 of that in Be-Ti one (for sigma values 12 and larger).

Sigma interval	Nsrph > 5keV per 2000 electrons (simulated)	Tail probability	Number of e- in tail including halo electrons	Nsrph >5keV per bunch (hits per sec)
-4.7 – -4.9	23	5.1e-7	3.3e+4	380 (9.5e+10)
-4.9 – -5.5	40	2.9e-7	1.9e+4	380 (9.5e+10)
-5.5 – -7.5	66	1e-9	140	5 (1.2e+9)
-7.5 – -10.5	167	1.1e-19	75	6 (1.5e+9)
-10.5 – -13.5	277	7.2e-34	75	10 (2.5e+9)
-13.5 – -16.5	308	2.5e-51	75	12 (3e+9)
-16.5 – -19.5	430	4e-73	75	16 (4e+9)

Conclusions

- No direct hits in Beryllium-Titanium beam pipe in vertical plane of aperture and for positive sigma in horizontal plane was found. Hits of scattered photons are possible,needs more statistics to investigate.
- There are direct hits of synchrotron radiation in Be-Ti beam pipe in the horizontal plane of aperture for negative sigma values. There are direct hits in Beryllium part of beam pipe ! (for beam divergence over 12 sigma). That may not be negligible in presence of beam halo.
- Scattered (re-emitted) photons may enter Be-Ti pipe at steeper angles, diminishing the stopping power and may go through. If we have ~5 scattered SR(>5keV) photon in 2000 events at large sigma samples then the expected rate of such a SR photons ~ 5e+7Hz . Needs more statistics.
- The geometry in Geant4 (BASF2) is obsolete therefore needs to be updated to simulate more real picture with SR background in beam pipe. With existing geometry in BASF2 frame the SR background is underestimated.
- 3D solenoid field would give more realistic picture.

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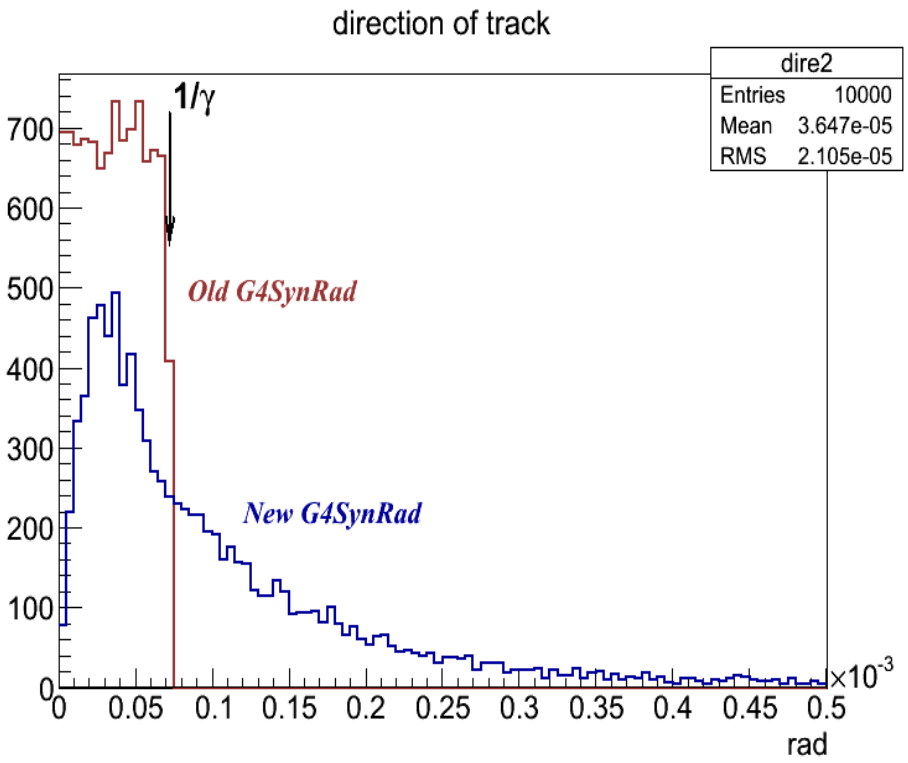
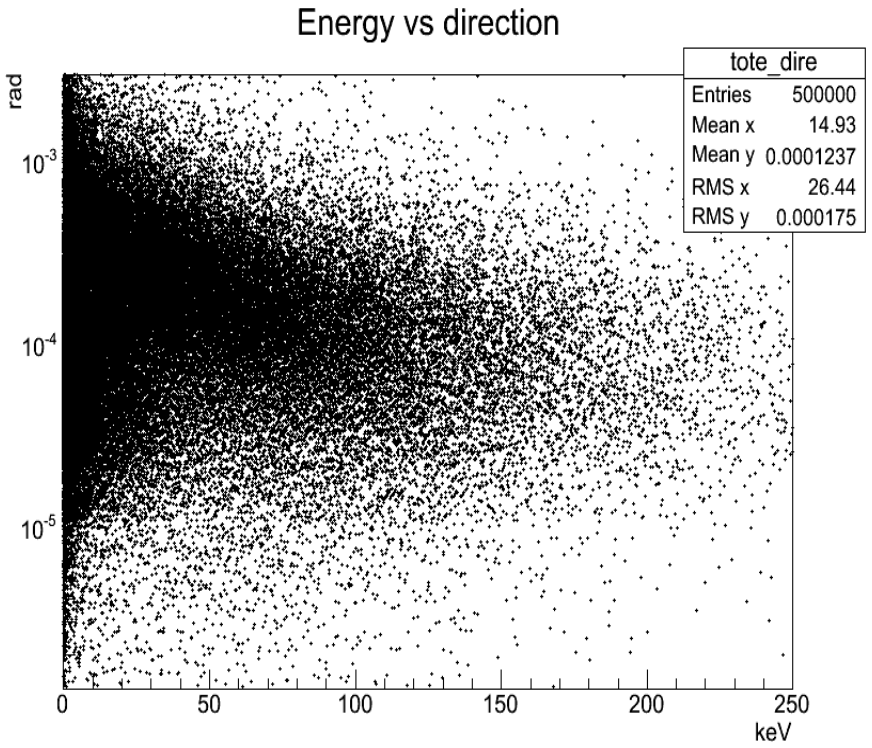
Validation of GEANT4 SR model
Angular distribution

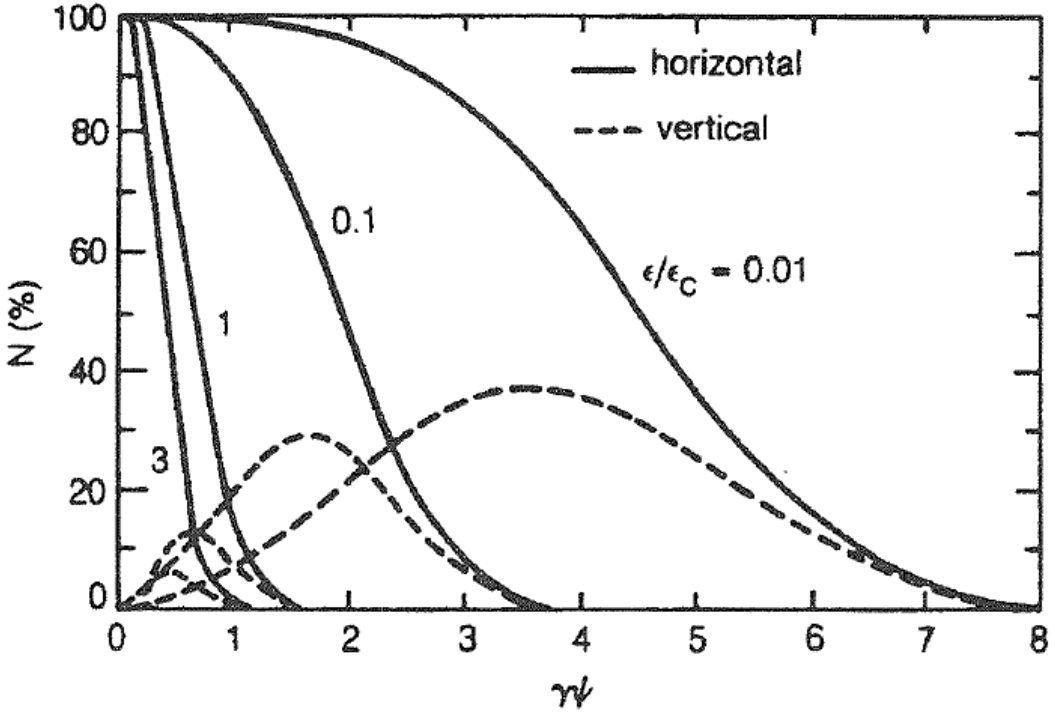
G4SynRad New VS G4SynRad Old





- Angular distribution with new SynRad code is closer to real one.
- Still there is no energy dependence of irradiated photon with respect to initial electron. Slices of scattered plot were done for different values of Ec/E, no dependence on photon energy seen.

Angular distribution vs. photon energy



7GeV, 1.5T , Ec= 50keV
7GeV, 0.1T , Ec = 3keV

To do

- Simulate SR with 2D field for different beam offset in IP .
- Include bunch lateral shapes and angular divergence in X and Y to estimate fraction of SR hitting the beam pipe.
- Update with 3D solenoid field.
- Discuss with G4 developers further improvements in angular distribution of SR model.
- Validate G4 SR model to simulate scattering and absorption on Au plated surface.
- Tip scattering on ridge structure.
- ....

BACKUP

Ver. 20111205

Aperture Data for SAD simulation

LER

s[mm	r[mm
-3640	40
-2725	40
-2675	35
-1750	35
-1630	23
-1590	22
-1252	22
-1172	14
-1092	10.5
-	10.5
-452	10
-	4.226
-	2.822
-	5.827
89.99	6.272
250	10
620.5	10.5
1092	10.5
1172	14
1252	22
1590	22
1630	23
1750	35
2350	35
2400	40
3315	40

For -191mm~250mm, symmetric aperture which is narrower than real aperture

HER

s[mm]	r[mm]
-3315	40
-2400	40
-2350	35
-1811	35
-1631	17
-1225	17
-1160	10.5
-620.5	10.5
-452	10
-	4.783
-	3.197
-90.66	6.182
99.98	5.794
250	10
620.5	10.5
1160	10.5
1225	17
1631	17
1811	35
2675	35
2725	40
3640	40

For -194mm~250mm, symmetric aperture which is narrower than real aperture

Ver. 20120201

Aperture Data for SAD simulation

QC1 を 10.5mm→13.5mm に拡げた場合

LER

s[mm]	r[mm]
-3640	40
-2725	40
-2675	35
-1750	35
-1630	23
-1590	22
-1252	22
-1172	14
-1092	***13.5***
-	***13.5***
-452	10
-	4.226
-	2.822
-	5.827
89.99	6.272
250	10
620.5	***13.5***
1092	***13.5***
1172	14
1252	22
1590	22
1630	23
1750	35
2350	35
2400	40
3315	40

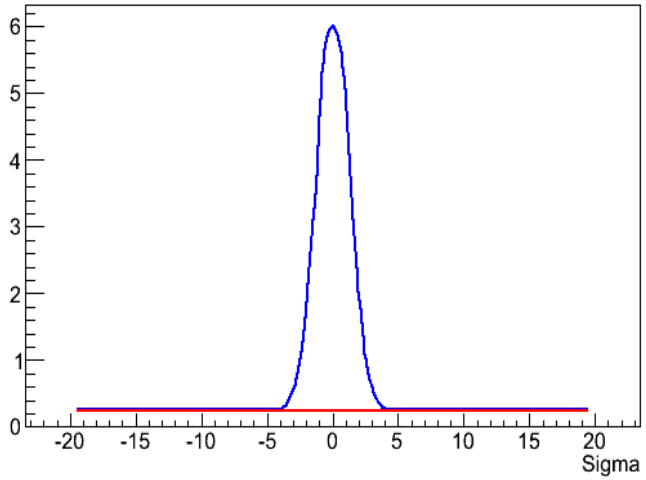
For -191mm~250mm, symmetric aperture which is narrower than real aperture

HER

s[mm]	r[mm]
-3315	40
-2400	40
-2350	35
-1811	35
-1631	17
-1225	17
-1160	***13.5***
-620.5	***13.5***
-452	10
-	4.783
-	3.197
-90.66	6.182
99.98	5.794
250	10
620.5	***13.5***
1160	***13.5***
1225	17
1631	17
1811	35
2675	35
2725	40
3640	40

For -194mm~250mm, symmetric aperture which is narrower than real aperture

Estimation of halo



Ne - number of electrons per bunch

f – revolution frequency

τ – life time

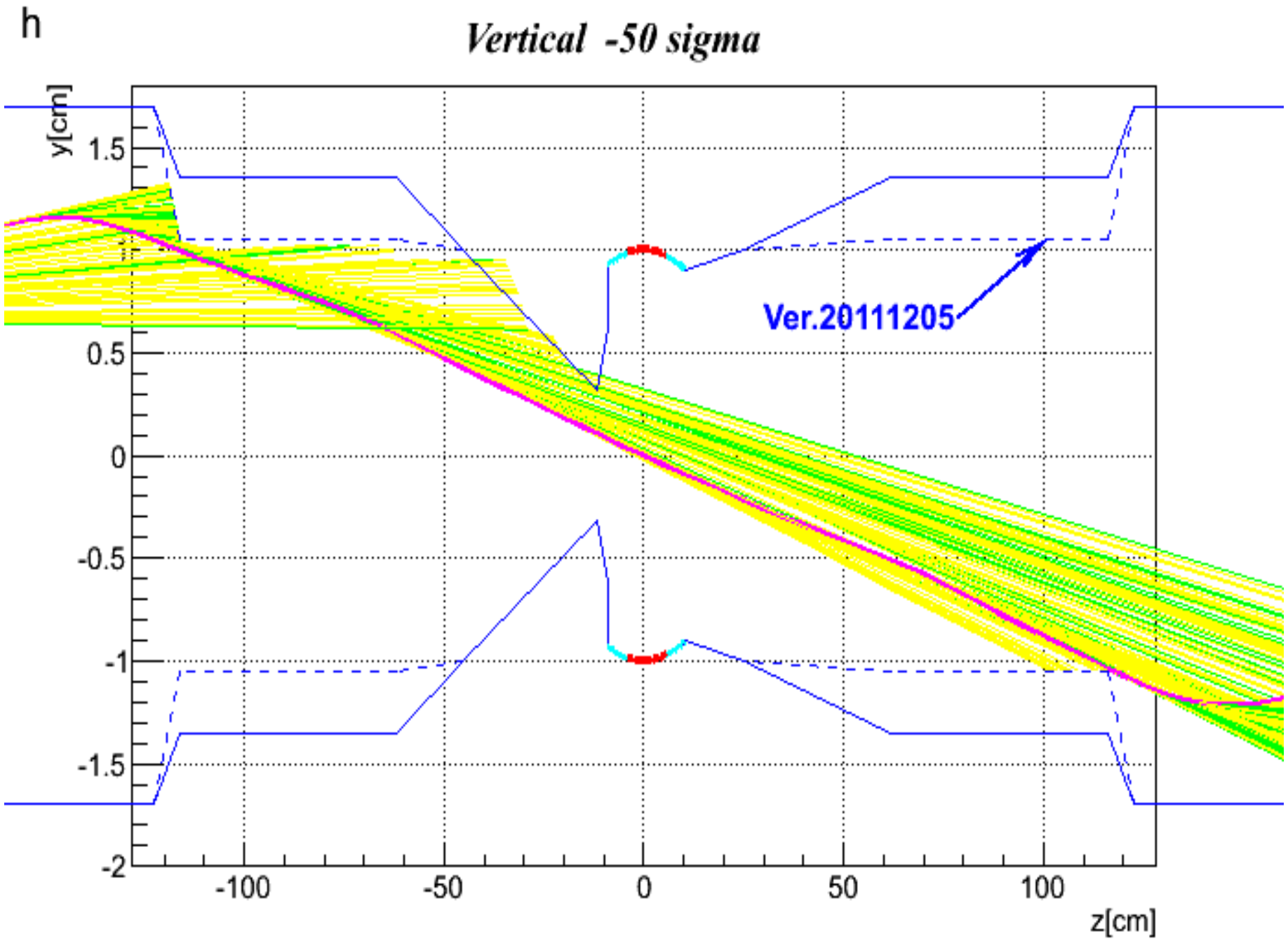
Ne=6.5e+10, f = 1e+5 , τ = 600 sec number of bins in sigma = 37

Ne/(τ * f) – lost in one turn =~1000

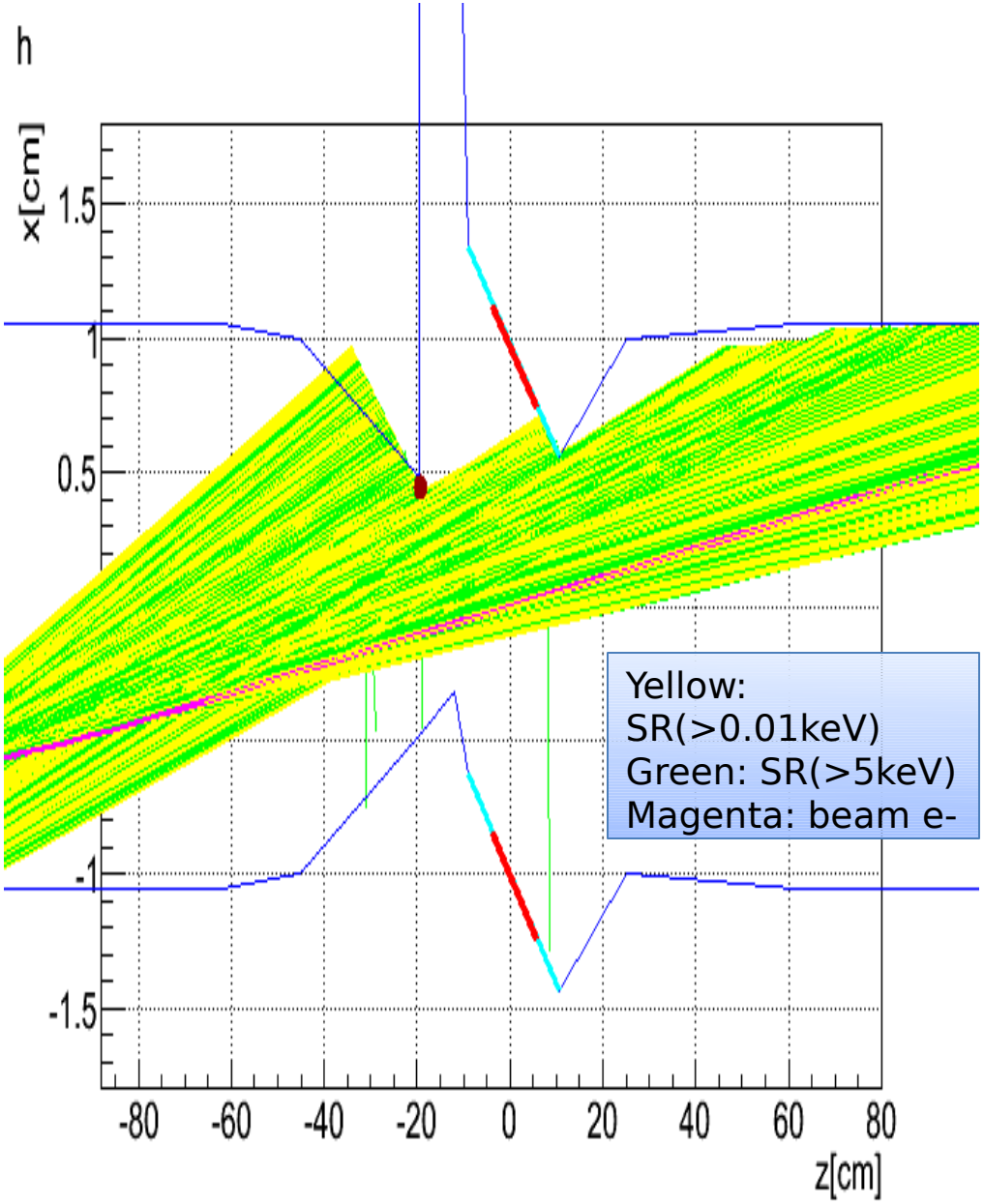
number of halo electrons per 1 sigma bin ~25

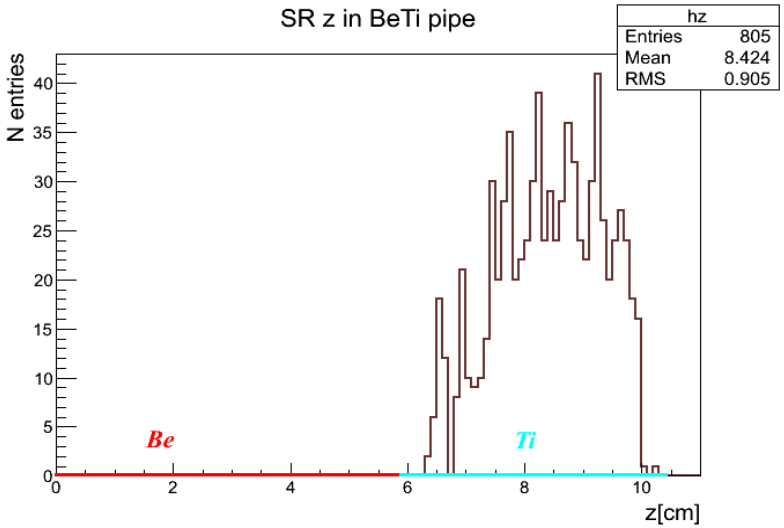
Assuming gaussian shape of beam angular distribution in X-plane ,i.e. only beam core without beam halo,is possible to estimate the number of direct hits of SR photons with energy over 5keV in Be-Ti beam pipe per bunch for this ideal case. The number of electrons per bunch was estimated as 6.5*10e+10.

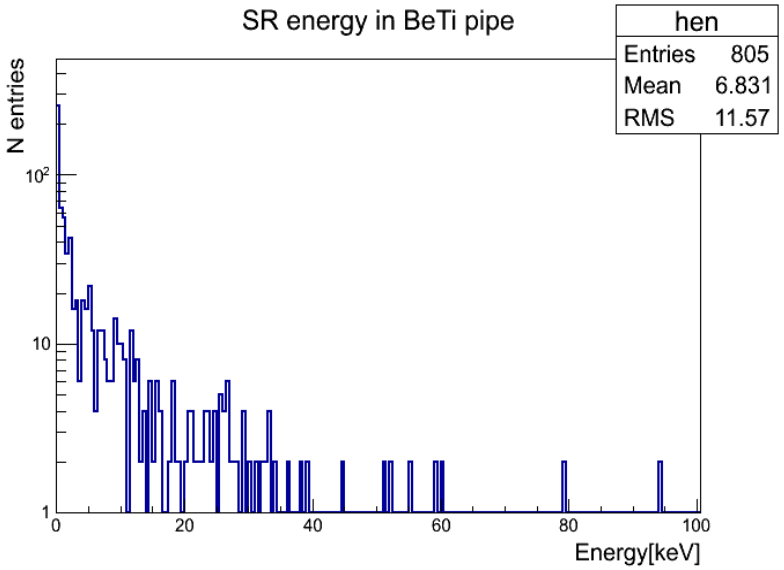
Sigma	Nsrph > 5keV per 2000 electrons (simulated)	Tail probability	Number of e- in tail	Nsrph >5keV per bunch
-4.8	23	5.1e-7	3.3e+4	380
-5.0	40	2.9e-7	1.9e+4	380
-6.0	66	1e-9	65	2
-9.0	167	1.1e-19	7.5e-9	6.3e-10
-12.0	277	7.2e-34	5e-23	7e-24


h
Vertical -50 sigma
y[cm]
1.5
0.5
0
-0.5
-1
-1.5
-2
-100
-50
0
50
100
z[cm]
Ver.20111205

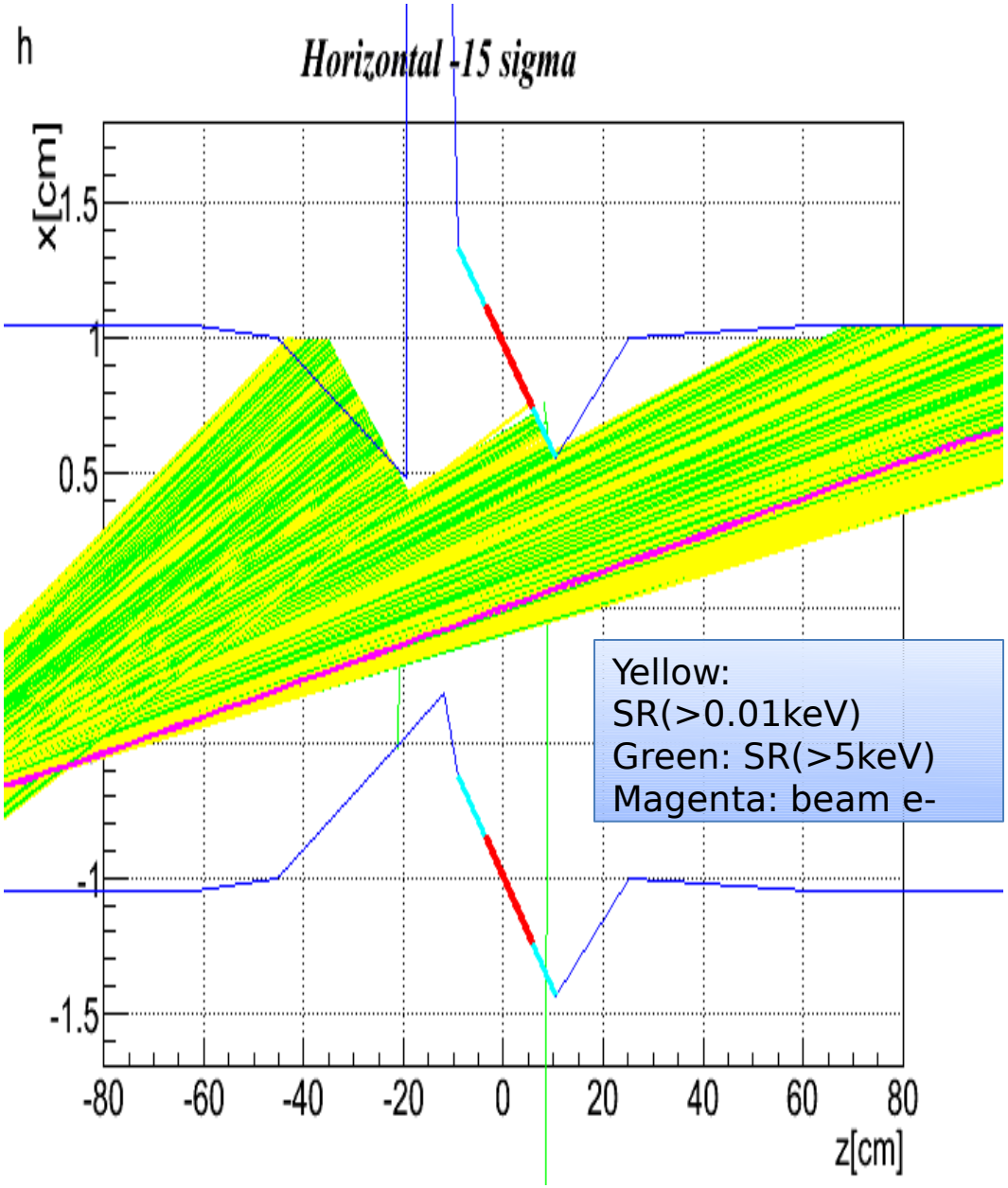
Horizontal -12 sigma

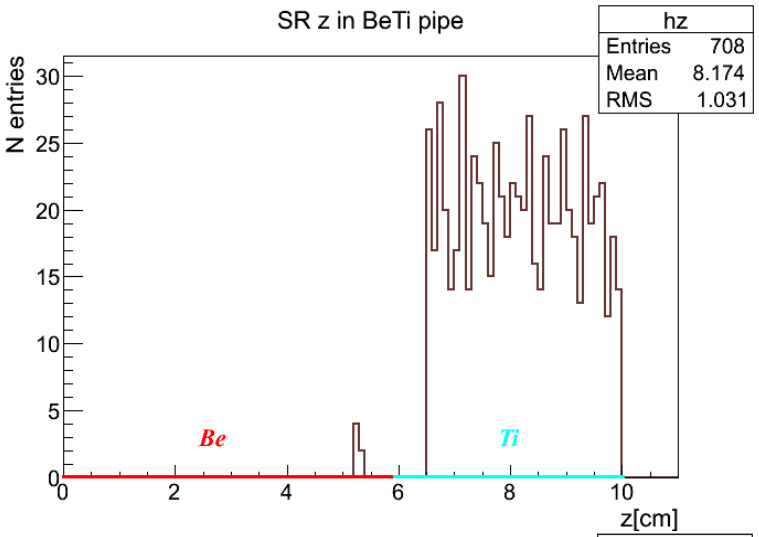


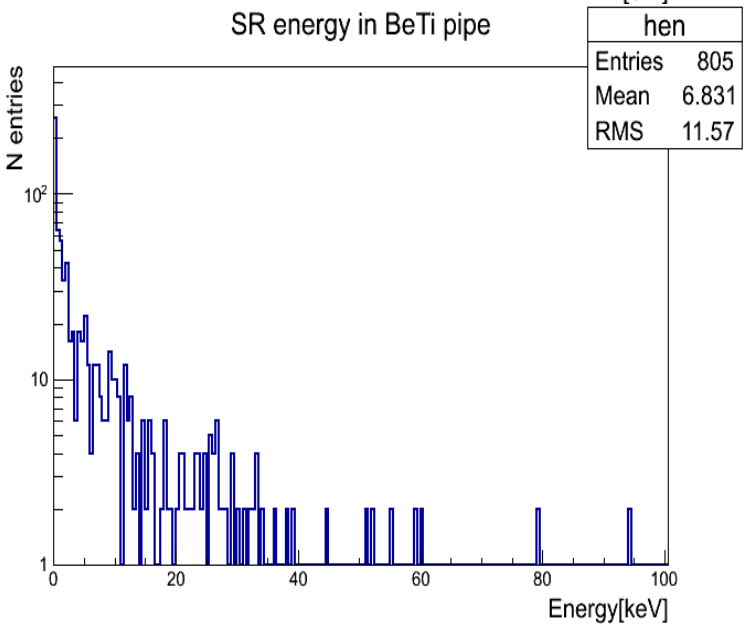




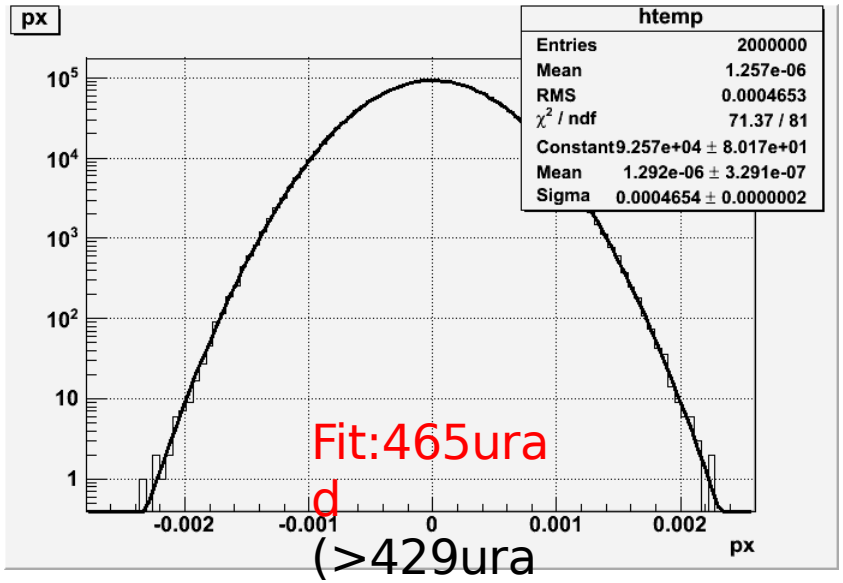
Horizontal -15 sigma



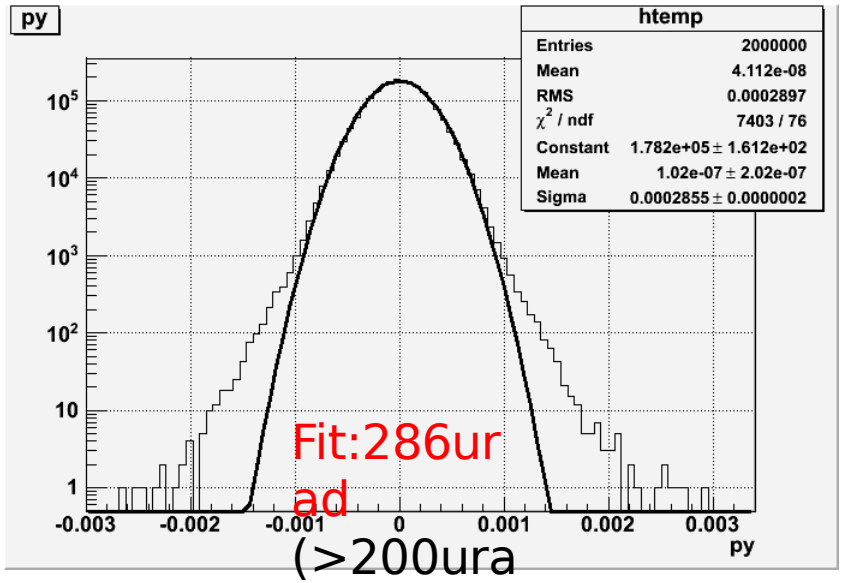




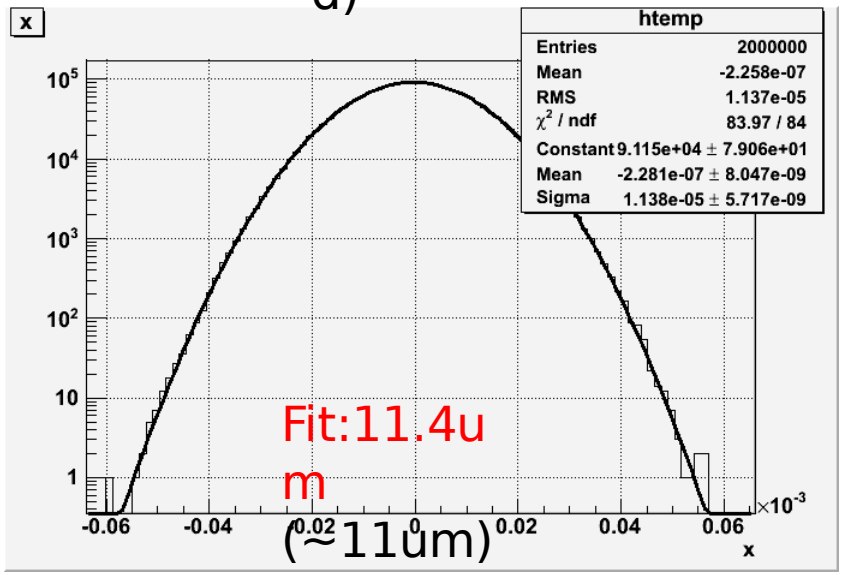
HER



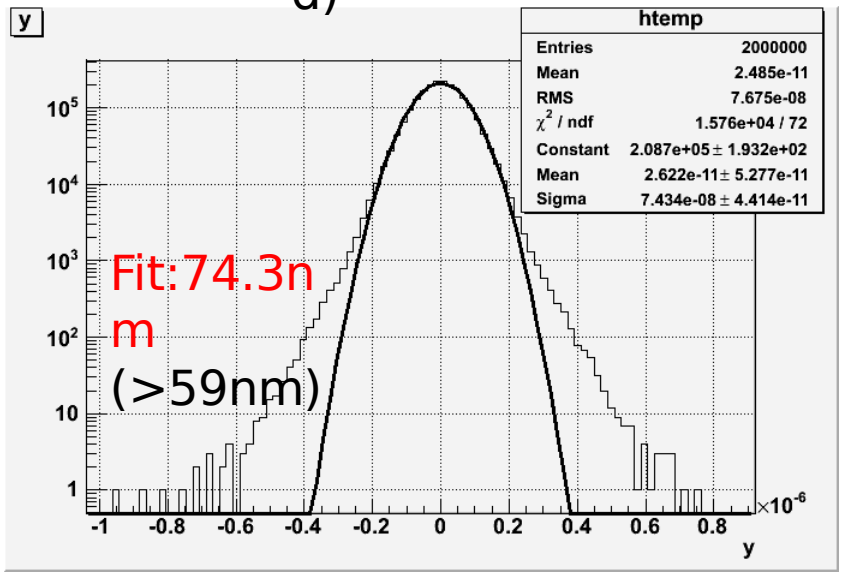
Fit:465urad
(>429urad)



Fit:286urad
(>200urad)



Fit:11.4um
(≃11um)



Fit:74.3nm
(>59nm)