Beam background for Super B-factory

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(Super B Factory Workshop – Hawaii – Jan 21, 2004)

OUTLINE

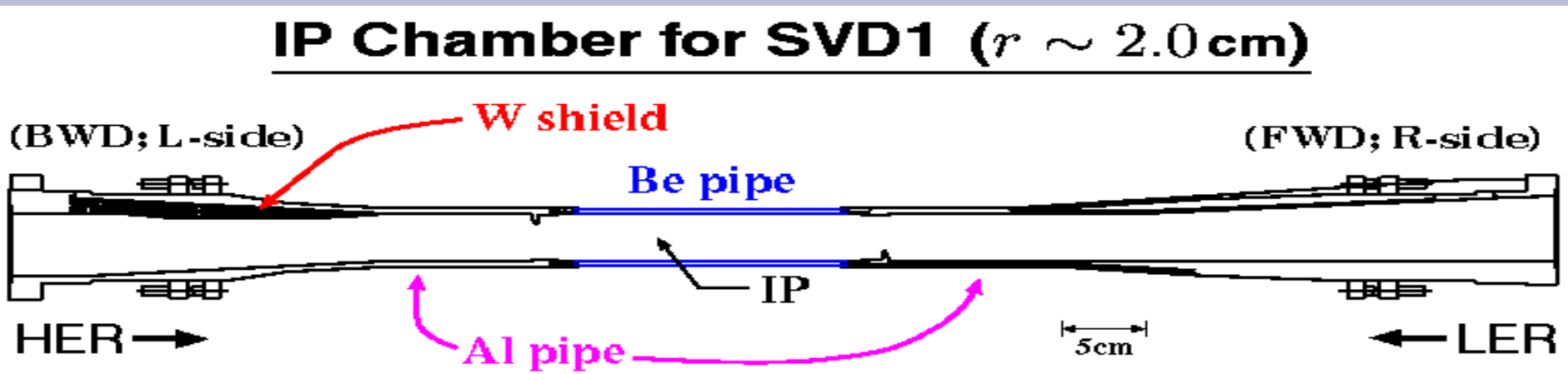
- from SVD1 to SVD2 : heavy masks with a smaller radius
- very preliminary results on super kekb case

At the beginning...

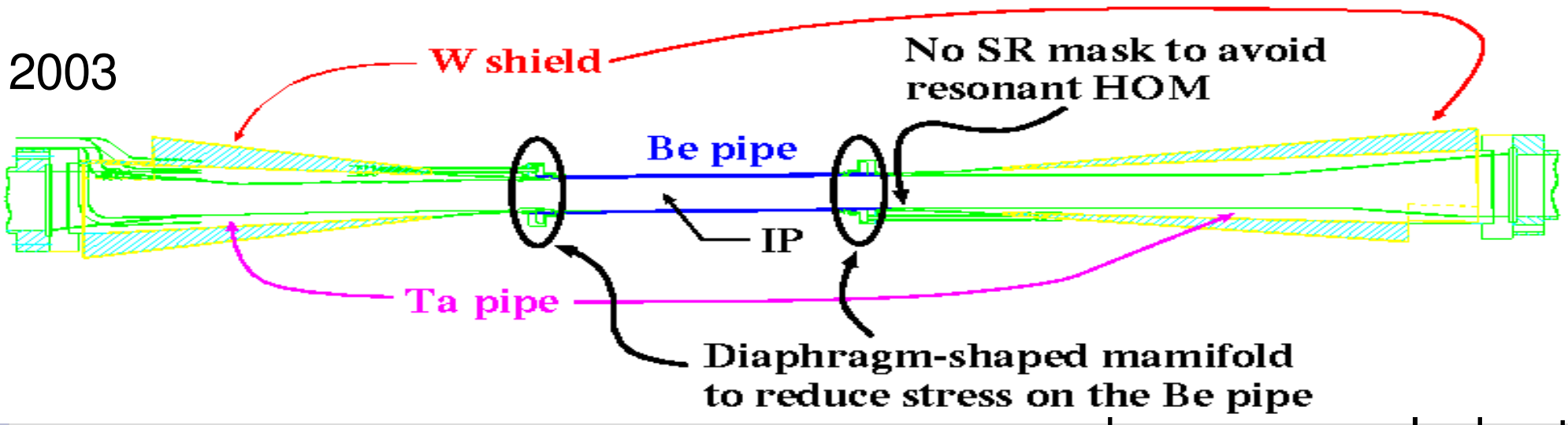
Energy-weighted distribution of z-origin of photons has several peaks, which exactly correspond to the positions of heavy materials like flanges, masks and tapers along the beam-pipe in the interaction region. Such materials behave as “photon amplifiers” to backgrounds. Hence one must try to reduce the amount of heavy materials around the beam-pipe as much as possible

(Proceedings of the Second WS on backgrounds at the machine detector interface...)
1997

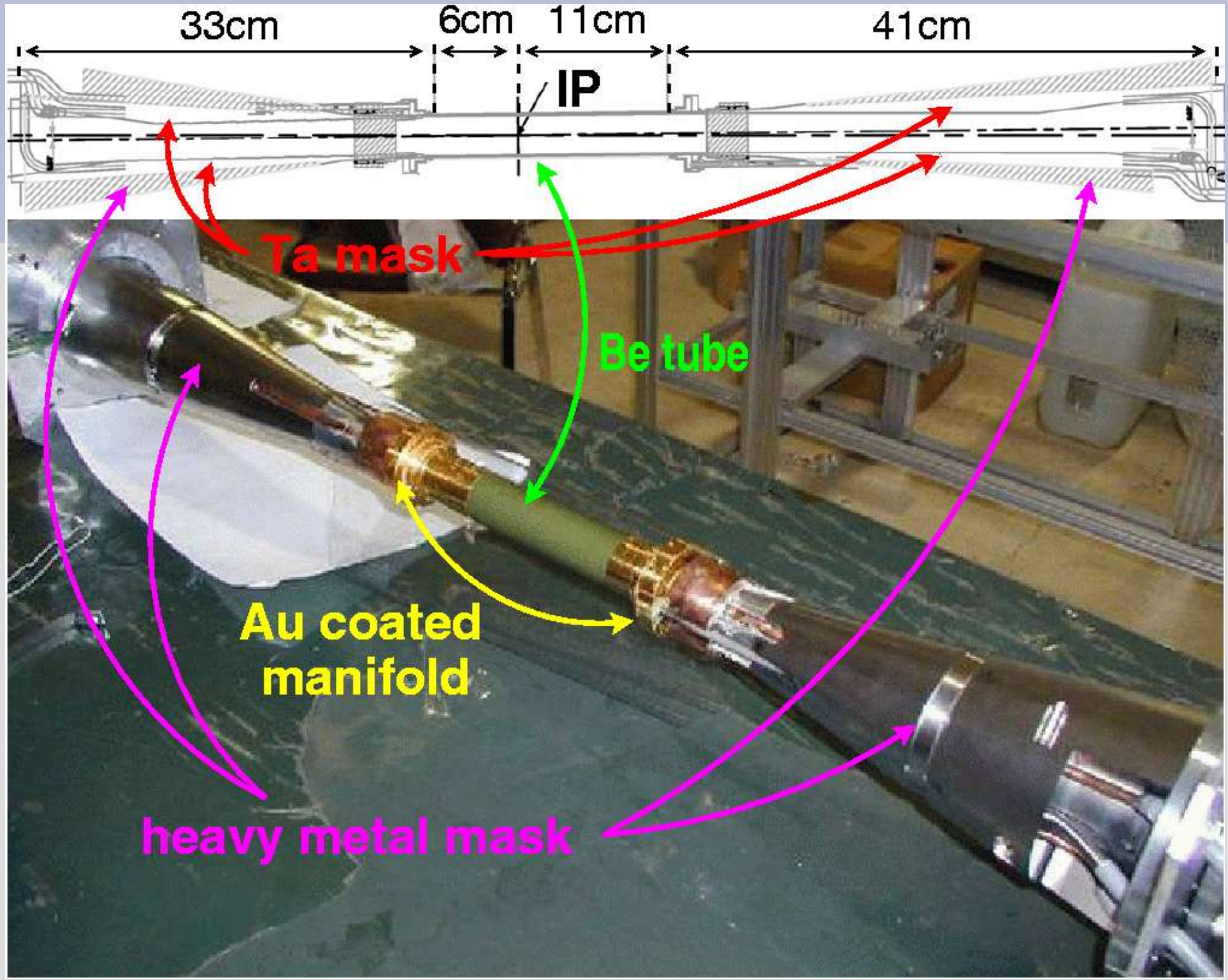
many svds and beam-pipes...



(remember 2cm -> 1.5cm !)



as heavy as an elephant...


33cm
6cm
11cm
41cm
IP
Ta mask
Be tube
Au coated
manifold
heavy metal mask

O.Tajima

Radiation Dose at SVD 1st layer

At Maximum Currents: HER 1.1A, LER 1.6A

(…) is simulation @ 1nTorr pressure

	Outer-direction ~ 0 degree	**Inner-direction ~ 180 degree**
Particle-BG (LER)	22 (18) kRad/yr	14 (11) kRad/yr
Particle-BG (HER)	44 (53) kRad/yr	29 (33) kRad/yr
SR-BG	17 (8) kRad/yr	33 (29) kRad/yr
Total	**83 (79)** kRad/yr	**76 (73)** kRad/yr

Touschek contribution is reduced based on measurement

Data and simulation is consistent

信じられない。

lighter version ?

The heavy material masks were necessary ? I think so...

See comparison with the simulation for a lighter version of the beam pipe :

	Layer 1	Layer 2	Layer 3	Layer 4
e^- Brem	21 ± 4	8 ± 1	2 ± 0.2	1 ± 0.1
e^- Coulomb	32 ± 10	9 ± 2	3 ± 0.5	1.5 ± 0.5
e^- Brem	73 ± 13	31 ± 5	8 ± 1	3 ± 0.5
e^- Coulomb	101 ± 50	54 ± 28	12 ± 4	5 ± 2

x 3-4

see Senyo's talk for degradation under higher bckg

Simulation description

These simulated beam particles are then swum through a modified version of the program DECAY TURTLE (Trace Unlimited Rays Through Lumped Elements) from Brown and Iselin until a point where the particle interacts with a residual gaz molecule. The interaction maybe of first order (Coulomb scattering) or second order (Bremsstrahlung) in alpha. The particle with altered momentum then continues its journey through the beam line with the help of DECAY TURTLE until it reaches the Belle detector.

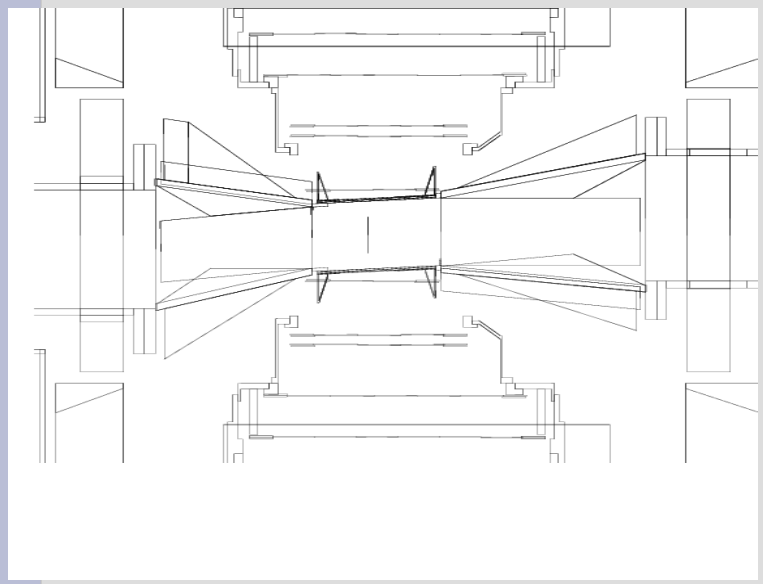
TURTLE can handle horizontal, vertical and elliptical masks : for SVD2, the whole rings (3km) were simulated (stopped most of the contribution of Coulomb above 100 meters...). Today, assuming that the far away contribution can be stopped simulate the last 150 meters...

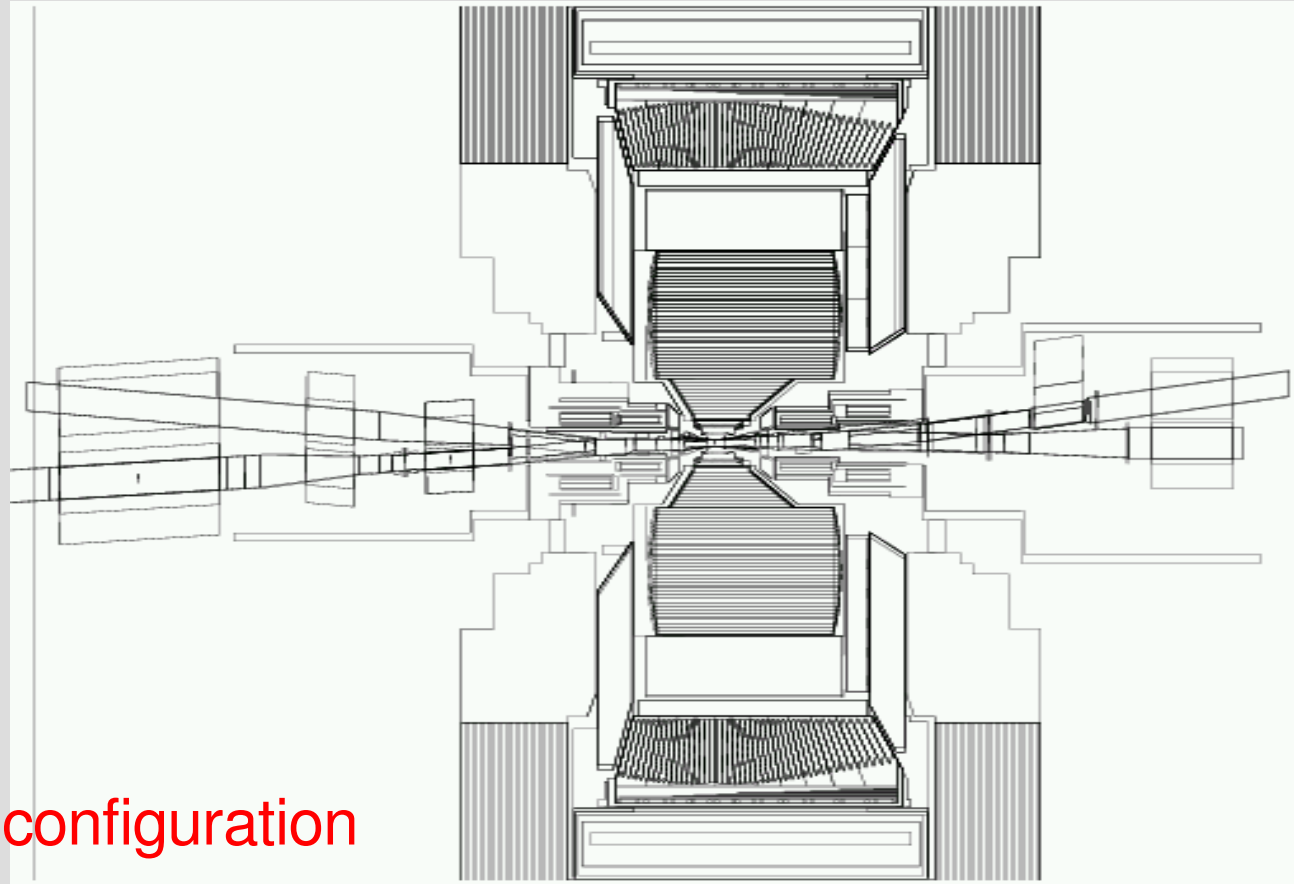
Assume uniform pressure : 1nTorr of CO....

Simulation description

At some point, the position and 4-vector information is introduced to the BELLE Geant simulation (Geant 3.0) for a complete evaluation of the effects of the background in the detector

- entrance at LER : +6m
- entrance at HER : -7.2m





we will consider only 1.5 cm configuration

Charge collected by Si

If an electron hits the beam pipe after being transferred to the GEANT section of the simulation, the energy collected in each layer is recorded, then :

$$\mathrm{Dose}(kRad/yr) = \frac{E}{A}\,\frac{\mathcal{R} \times 10^6 \times 10^7}{4.39 \times 10^9}$$

$\mathcal{R}$: rate of the process (Coulomb, Bremsstralhung...)

E is the energy deposited per beam particle in MeV

-> Radiation dose for each layer of SVD (4 layers)

Machine parameters of KEKB and Super-KEKB

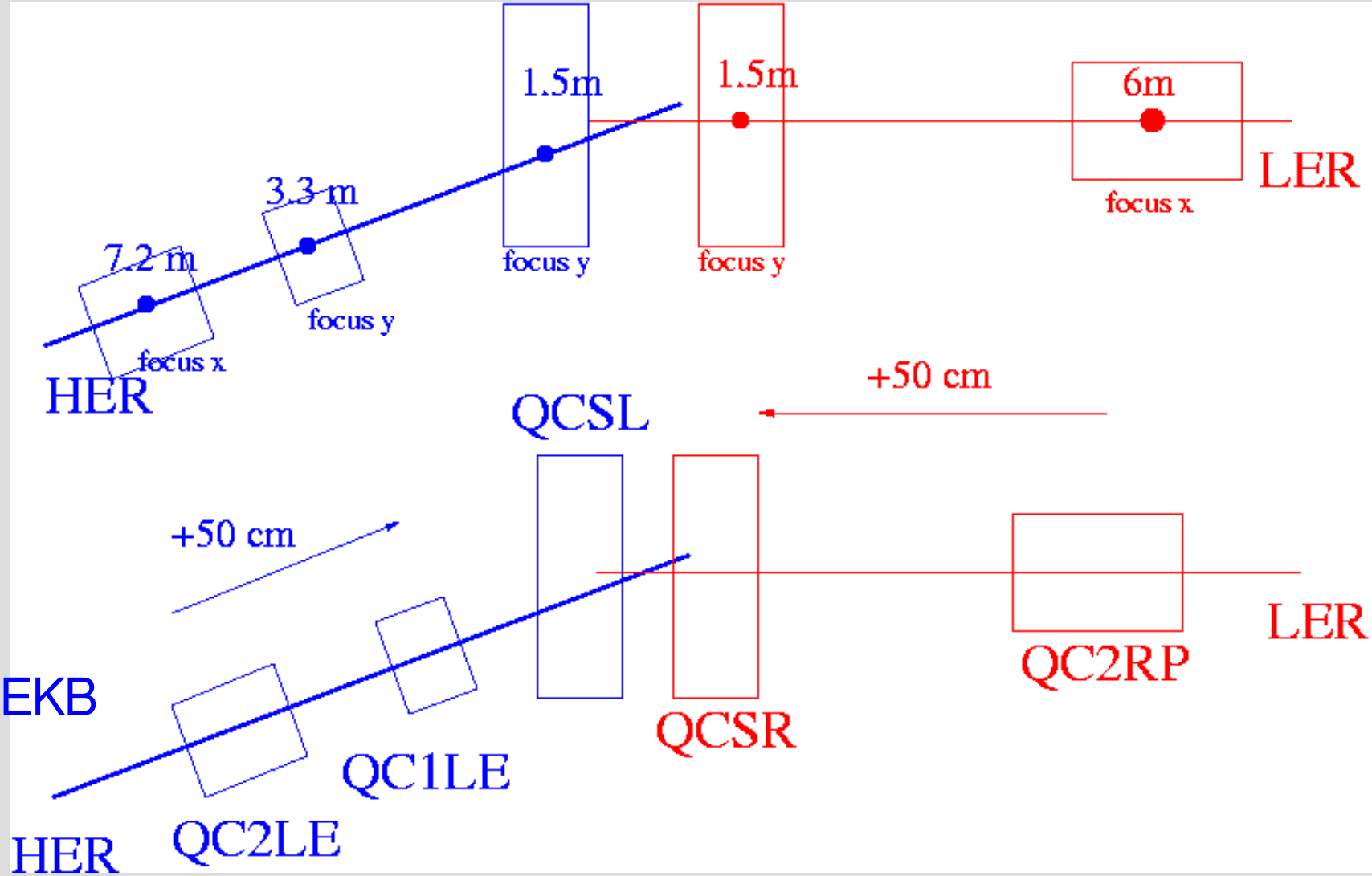
	KEKB LER$^+$/HER$^-$	Super-KEKB LER$^+$/HER$^-$
energy (GeV)	3.5/8	3.5/8
nbunch	1223/1223	5018/5018
I_{beam} (A)	1.4/1.1	9.4/4.1
I_{bunch} (A)	1.14/0.86	1.87/0.82
ϵ_x (nm)	18/24	33/33
ϵ_y/ϵ_x	0.055/0.041	0.06/0.06
β_x^* (cm)	59/63	20/20
β_y^* (mm)	6/7	3/3
xing (mRad)	22	30
$\mathcal{L}$ (10^{33}/cm^2/s)	11	500

in sim, still 22 mrad...

Many thanks to Koiso-san for providing latest LER/HER configurations

Changes around the IP

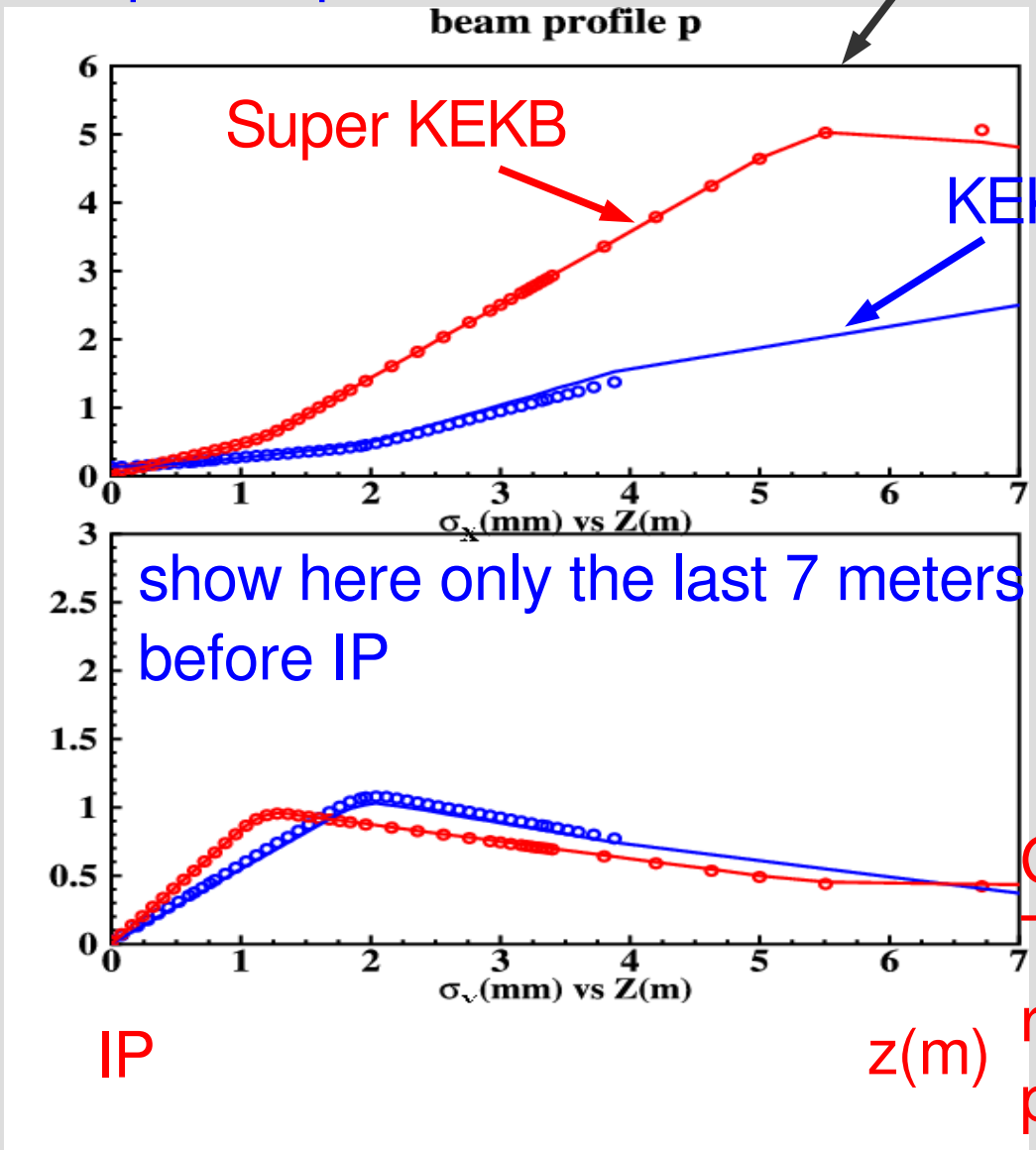
KEKB

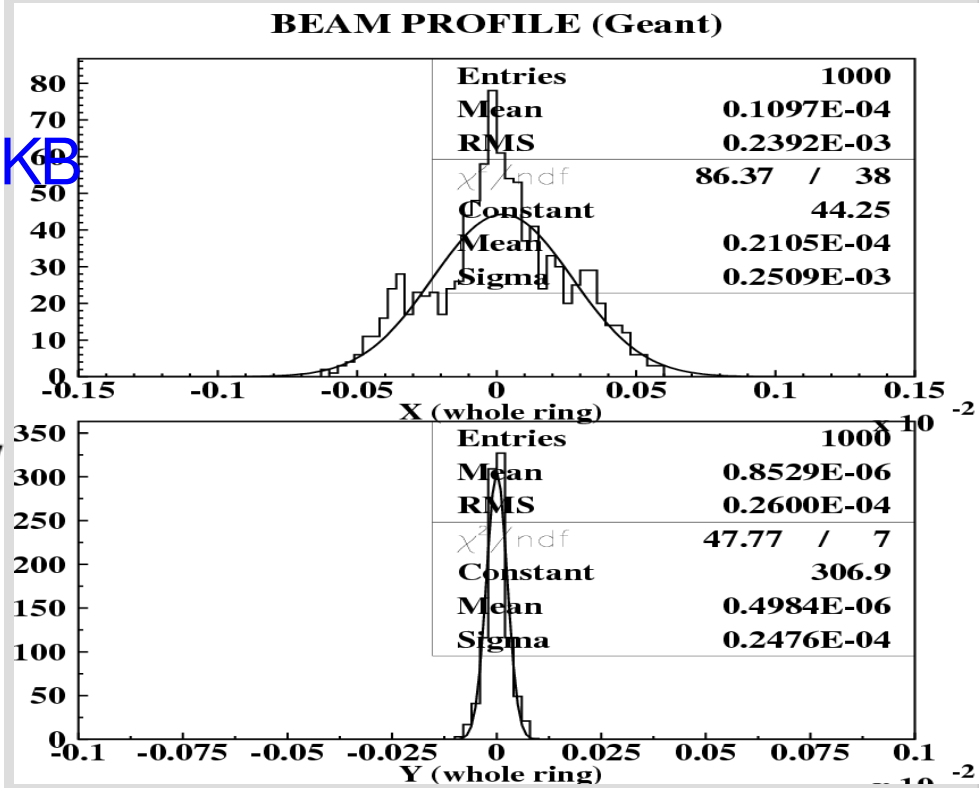


Super KEKB

trajectory in Turtle and Geant

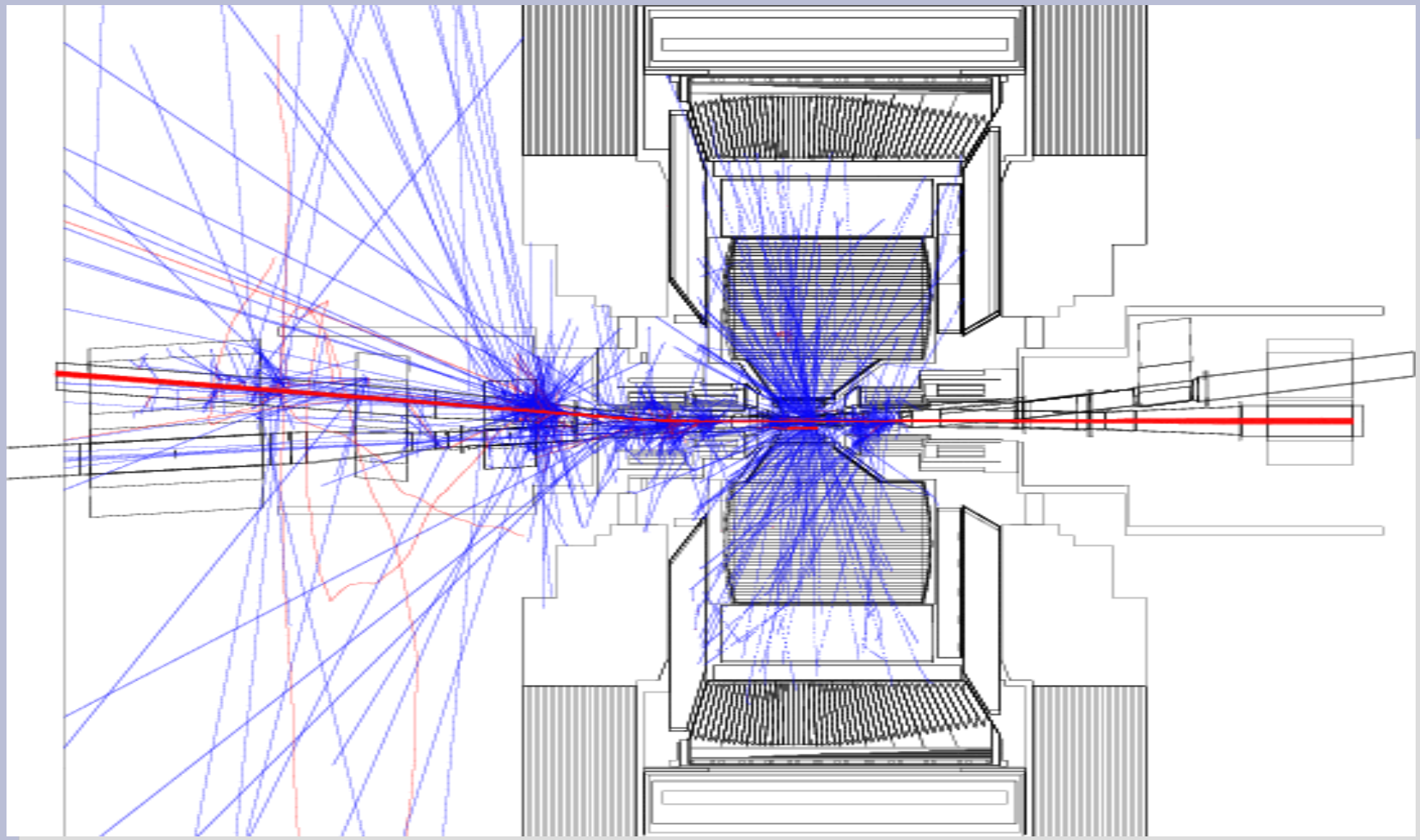
example for positron





Given the initial beam profile, the TURTLE (and GEANT) optics reproduce the beam shapes as prescribed in the accelerator design

previous LER file...



in previous version, y more defocussed created big showers around 1m
-> 1-2 Mrad/yr for Coulomb

Results (unit kRad/yr)

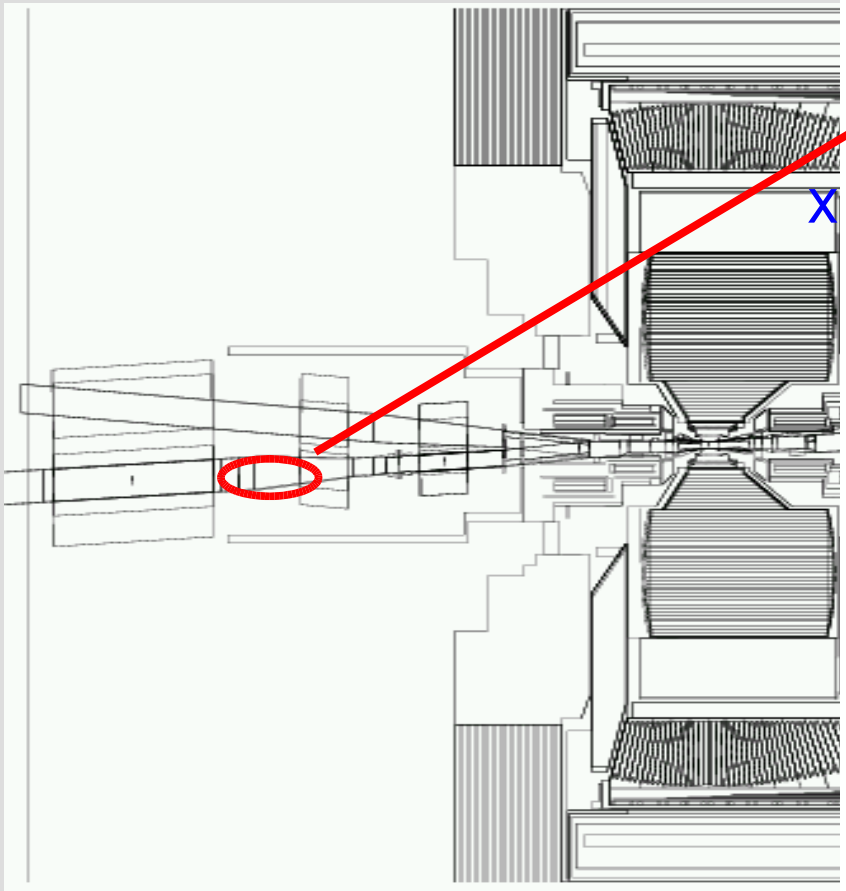
very preliminary results for Super KEKB

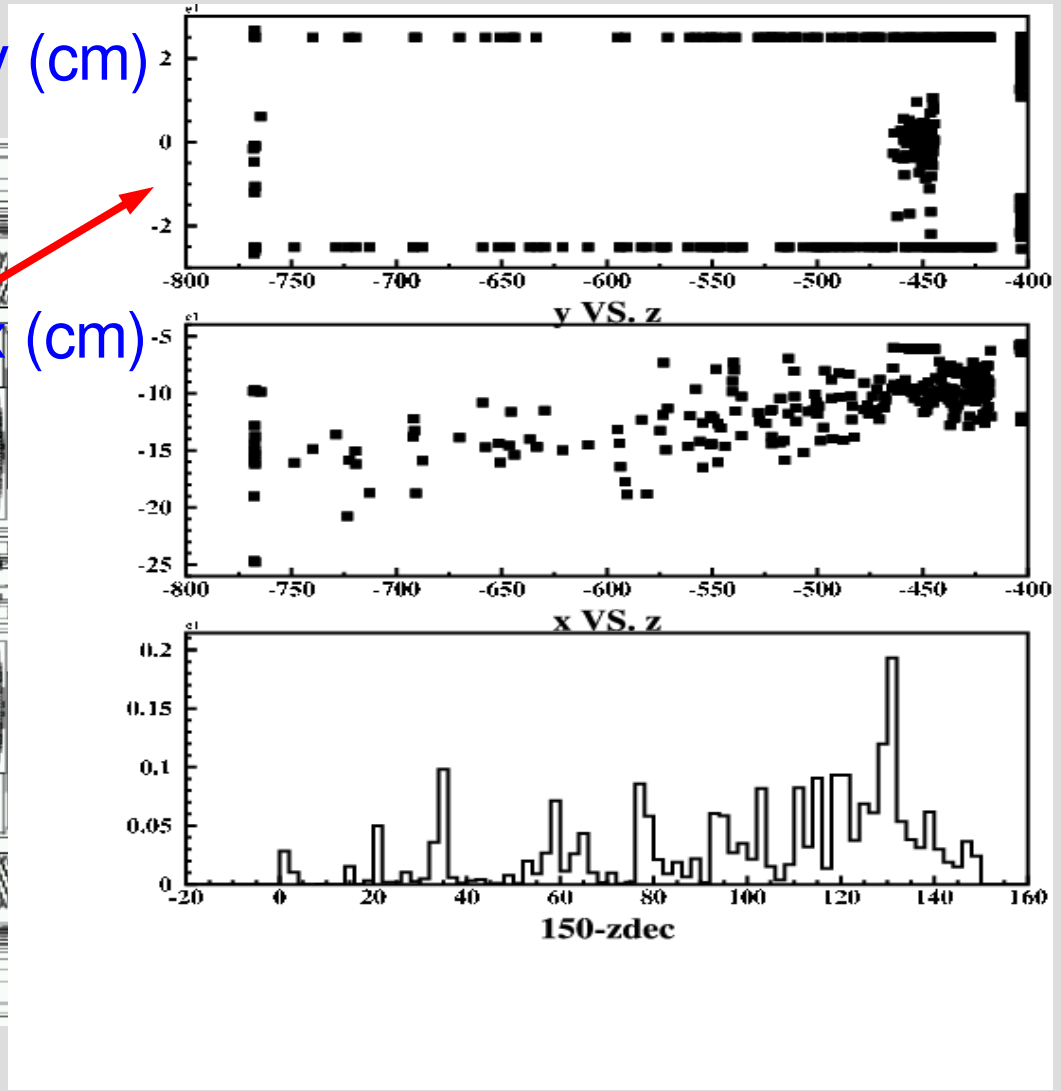
	Layer 1	Layer 2	Layer 3	Layer 4
e^- Brem	16.4 ± 3.7	3.1 ± 0.8	1.6 ± 0.3	0.6 ± 0.1
e^- Coulomb	595 ± 68	239 ± 24	97 ± 7	40 ± 3
e^+ Brem	120 ± 10	39 ± 3	42 ± 3	19 ± 1
e^+ Coulomb	22 ± 6	30 ± 11	7 ± 2	6 ± 2
e^+ Touschek	183 ± 12	68 ± 4	65 ± 3	30 ± 1

reference simulation for KEKB

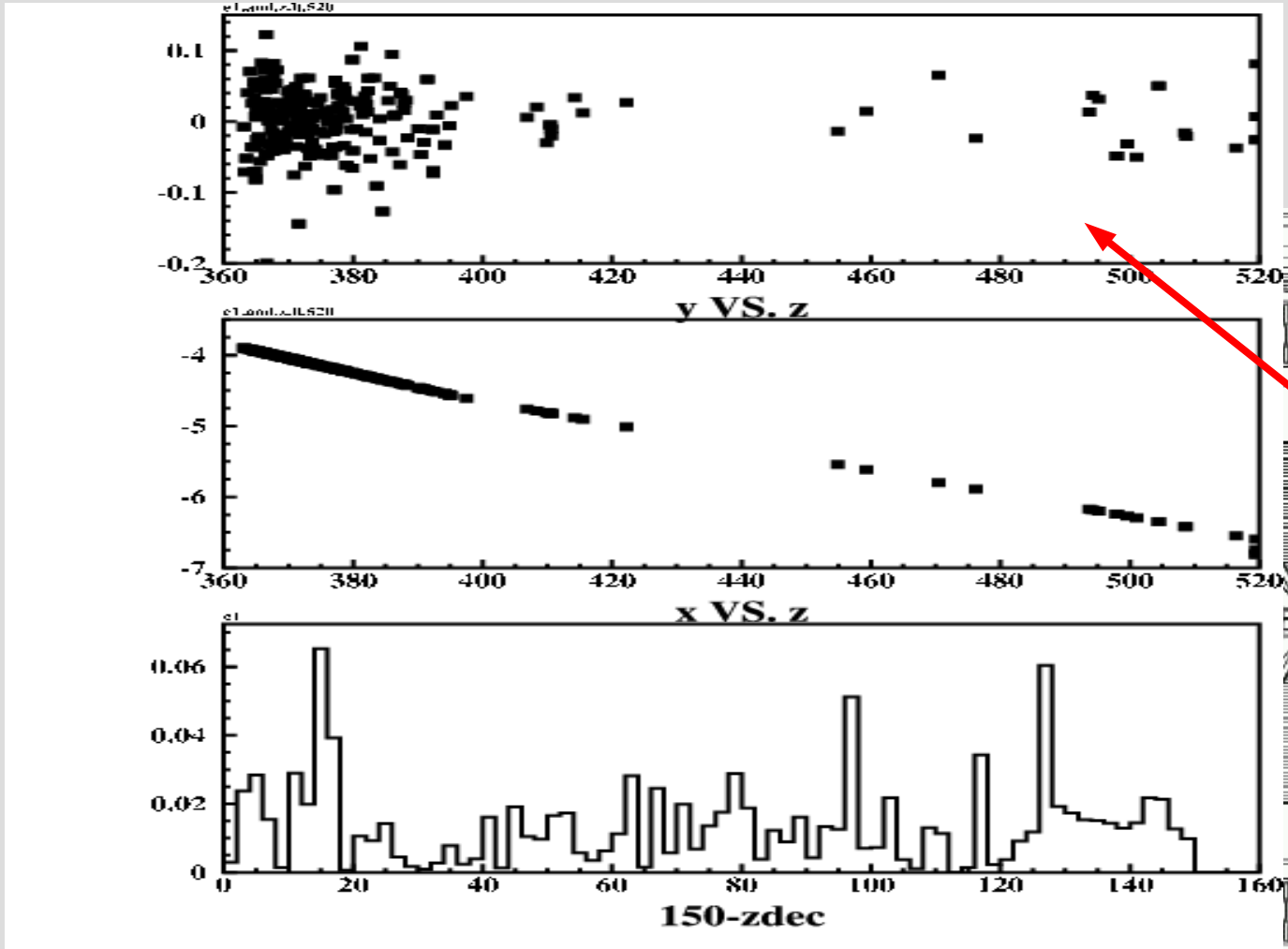
	Layer 1	Layer 2	Layer 3	Layer 4
e^- Brem	21 ± 4	8 ± 1	2 ± 0.2	1 ± 0.1
e^- Coulomb	32 ± 10	9 ± 2	3 ± 0.5	1.5 ± 0.5
e^+ Brem	18 ± 3	6.5 ± 1	2.2 ± 0.3	1.4 ± 0.2
e^+ Coulomb	11 ± 2	2.2 ± 0.3	0.9 ± 0.1	0.35 ± 0.05
e^+ Touschek	17 ± 8	6 ± 3	0.5 ± 0.2	3 ± 0.5

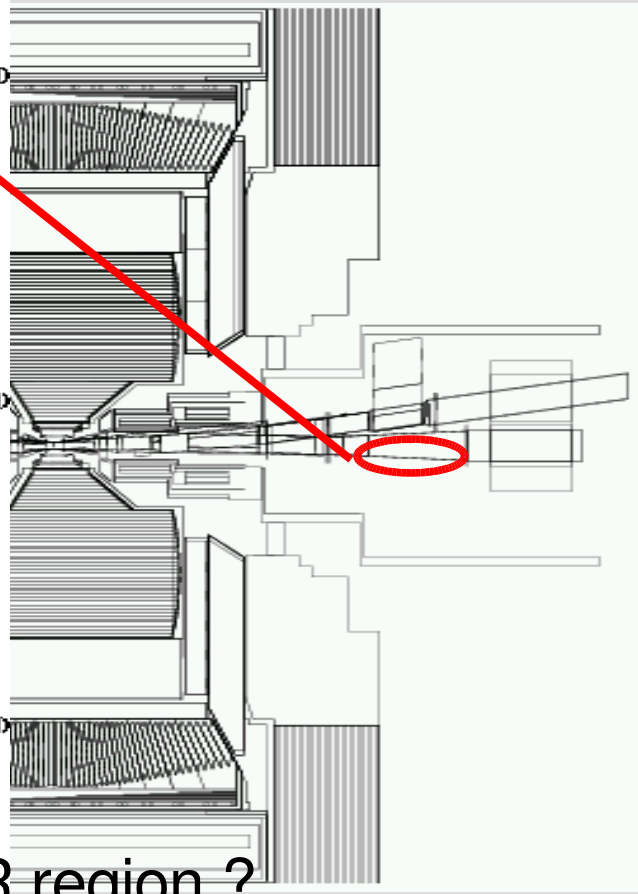
e- Coulomb contribution





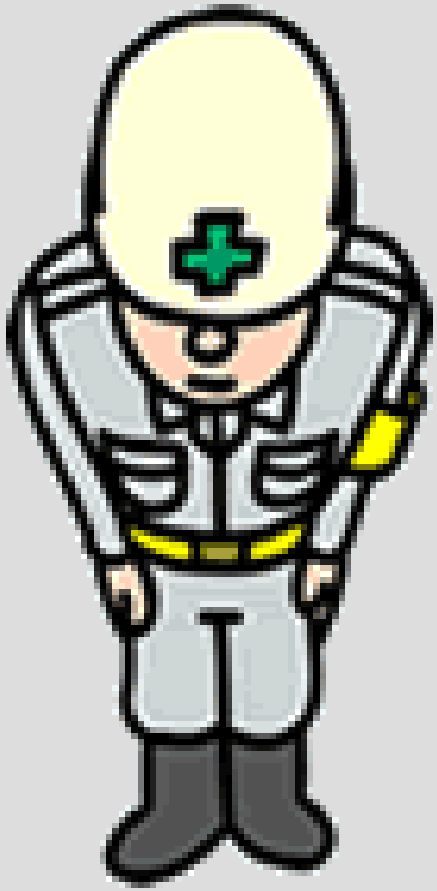
e+ Brem contribution





could these distributions disappear with modified IR region ?

Under construction...



現在調整中です

公開まで今しばらく
お待ちください

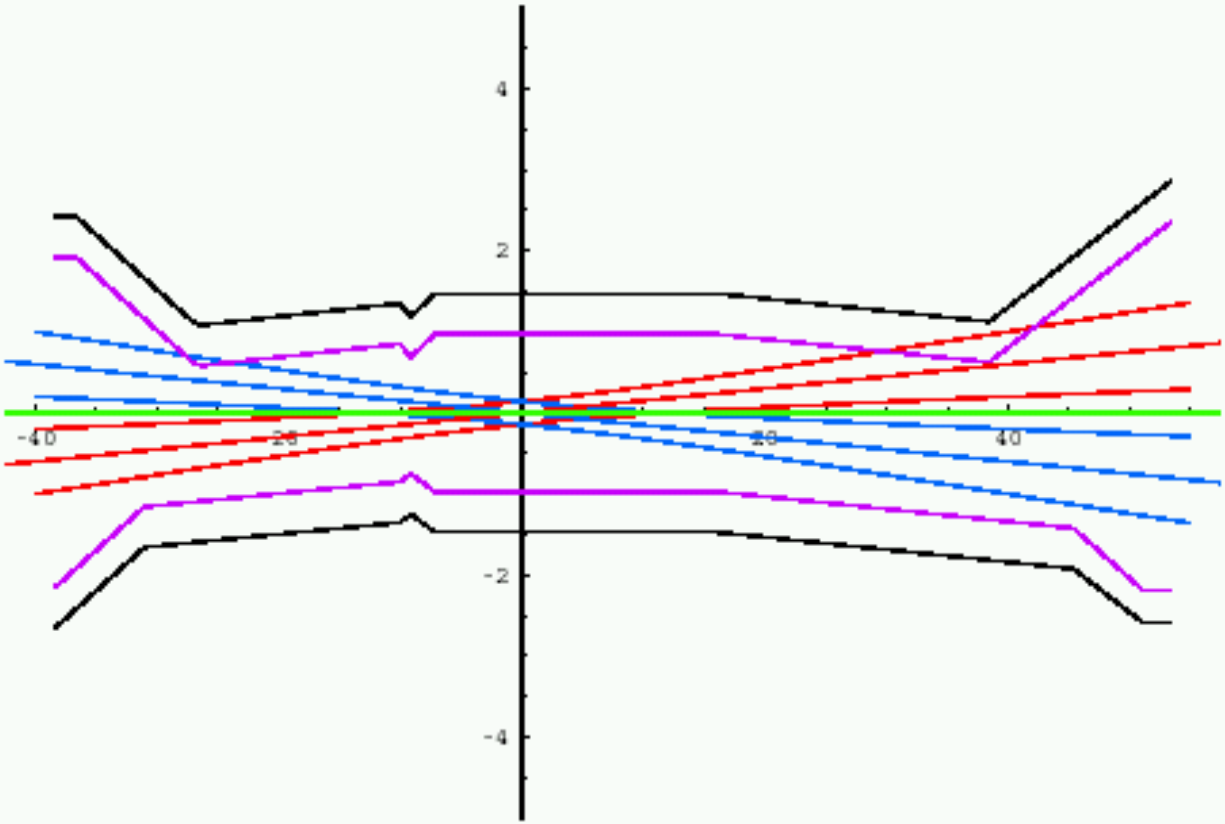
Also...

H.Yamamoto

Effect of 30mrad crossing angle

Simulation was for 22mrad crossing angle.

Super-KEKB $r_{\text{beampipe}} = 1.5\text{cm}$, 1cm
Horizontal beam-stay-clear (20σ)



Larger cuts may be needed at the mask corners.
(redesign of mask → reevaluation of bkg)

Conclusions

- very preliminary results for SuperKEKB : need more study for masks, beam pipe shape, LER 8mrad rotation, SVD 1cm, improve Touschek simulation...
- what about other components ? term % luminosity seen by BaBar (Bhabha ? due to bending magnet) : does simulation reproduce such contribution ?
- big jump between actual situation and Super B Factory....