

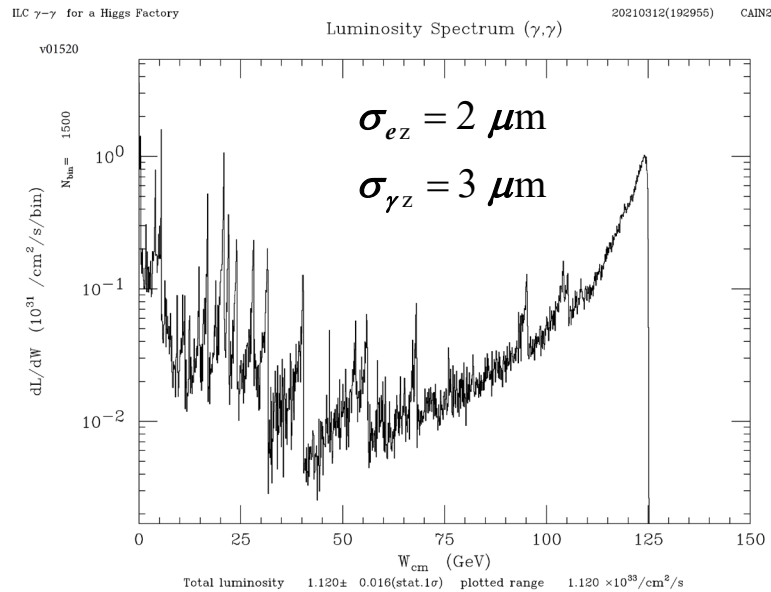
XCC Small Crossing Angle

Tim Barklow
XFEL $\gamma\gamma$ Collider Meeting
Apr 21, 2021

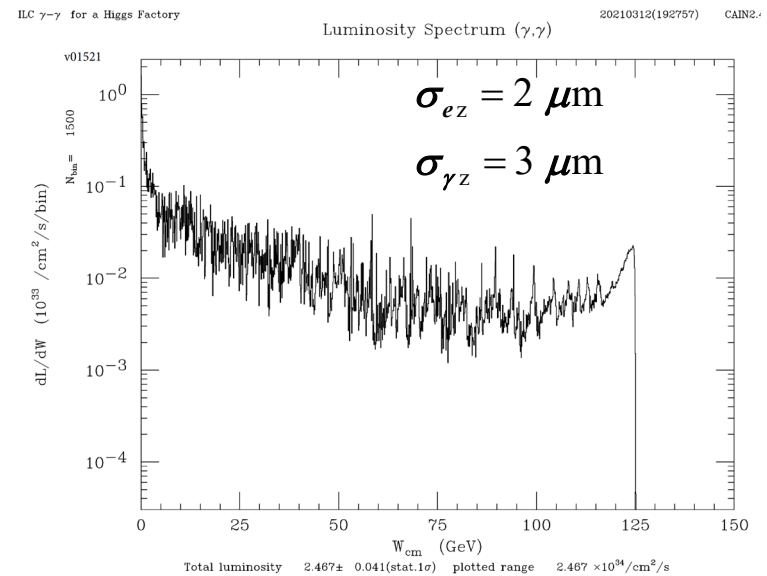
For configs with few microns rms bunch length for both 62.5 GeV and 30 GeV e- beams, the beamstrahlung luminosity is not so bad at 0 crossing angle. Perhaps then we don't need deflector beams in such cases.

However, there is a significant increase in beamstrahlung lumi with these configs when going to a finite crossing angle

0 mrad crossing angle

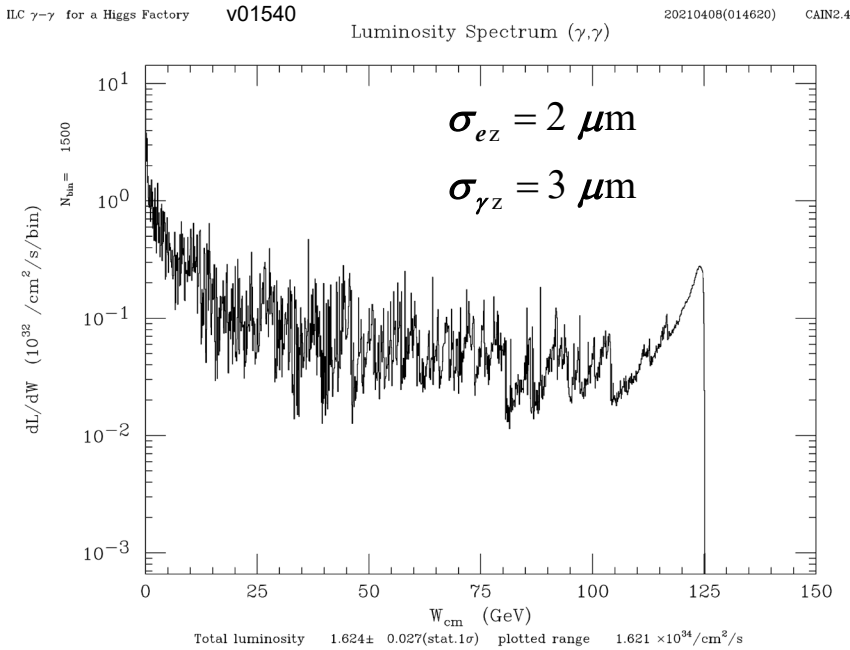


14 mrad crossing angle

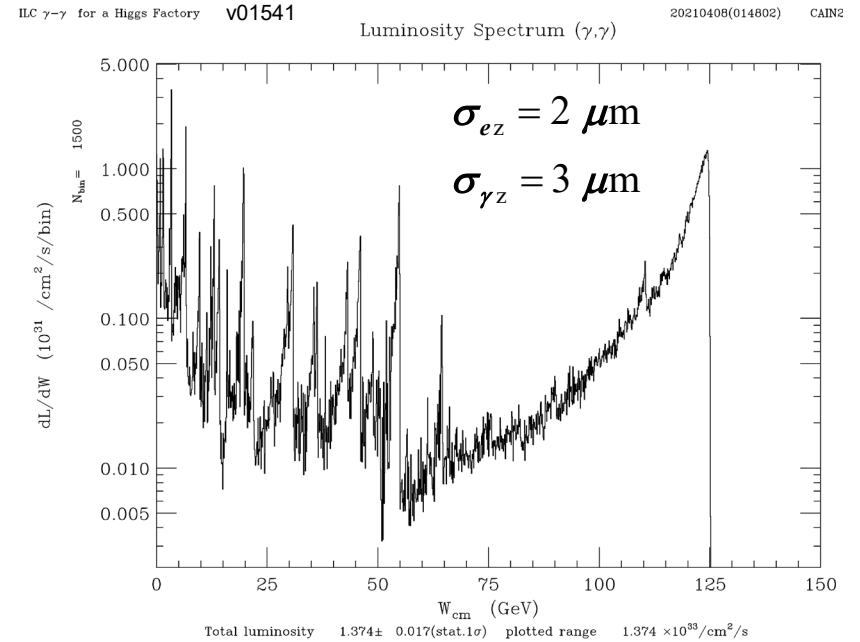


This problem persists down to a crossing angle of about 0.1 mrad

0.5 mrad crossing angle



0.1 mrad crossing angle



The high beamstrahlung lumi is due to the reduction in Compton conversion probability for finite crossing angles

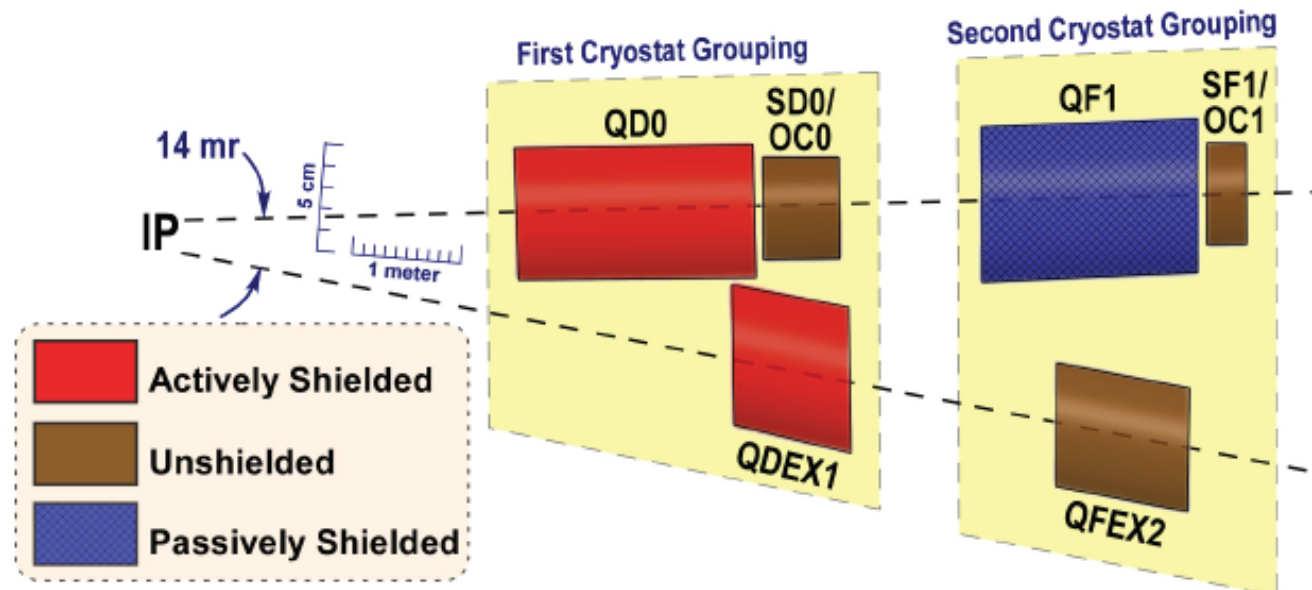
crossing angle (mrad) e^- conversion eff.

0.0	0.93
0.1	0.92
0.5	0.62
14.0	0.38

Putting aside the beamstrahlung luminosity issue, will a finite crossing angle work?

ILC:

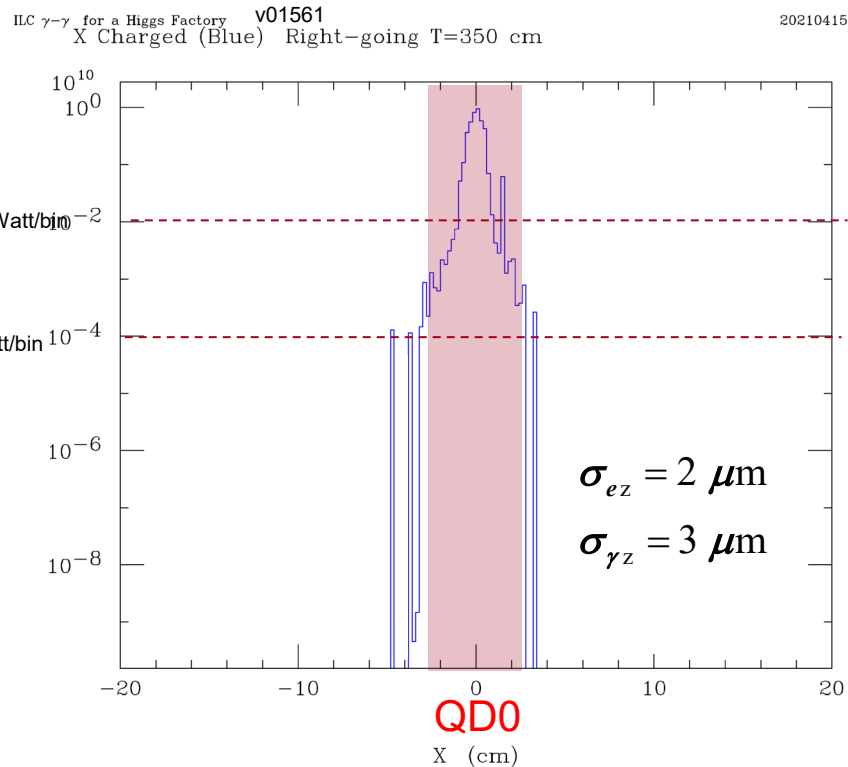
Figure 8.7
Schematic layout of
magnets in the IR.



Energy absorbed by SC QD0

0 mrad crossing angle, no deflector beams

XCC



QD0 = final quad for 62.6 GeV beam

e- Energy vs X at QD0 faces (350 cm from IP)

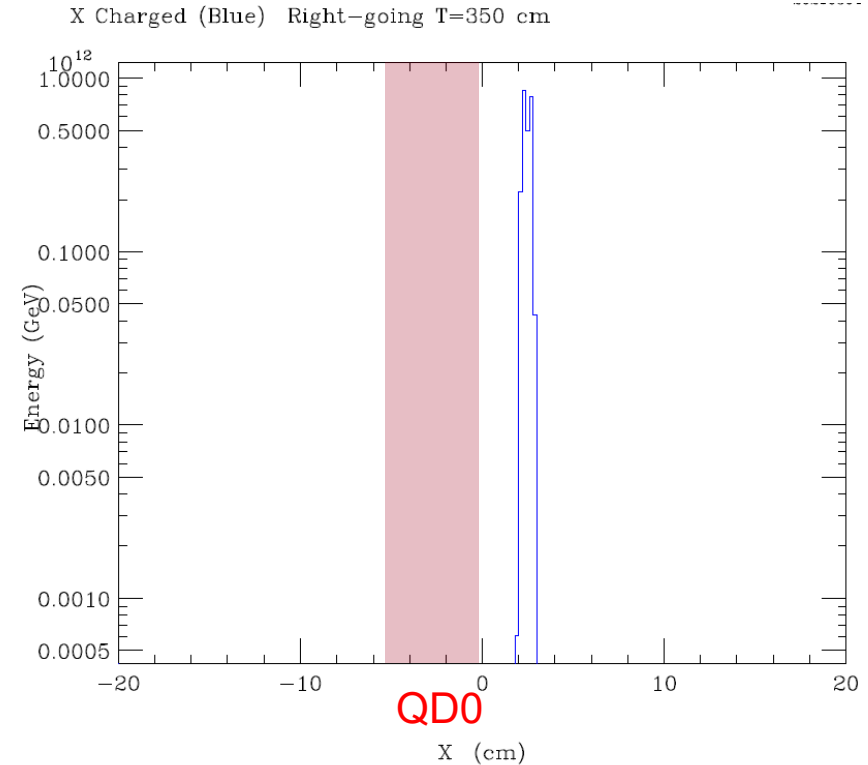
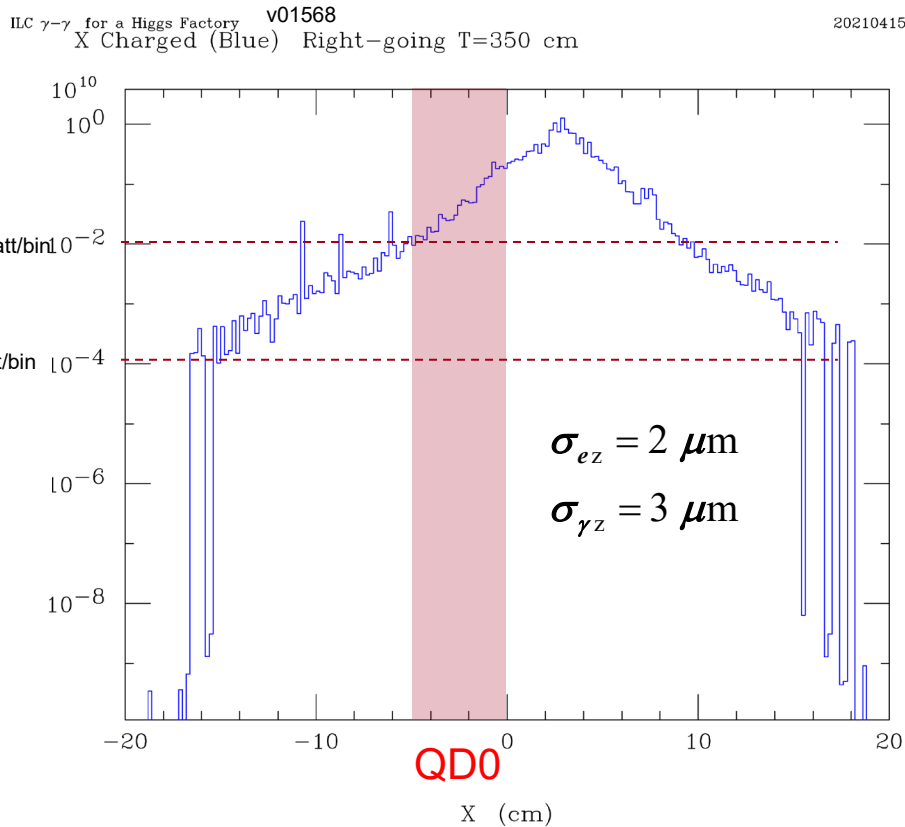
From this plot it looks like a 14 mrad cross angle should be sufficient to avoid QD0 (shift beam to the right and QD0 to the left by $0.007 \times 350 \text{ cm} = 2.45 \text{ cm}$)

Energy absorbed by SC QD0

14 mrad crossing angle, no deflector beams

XCC

ILC



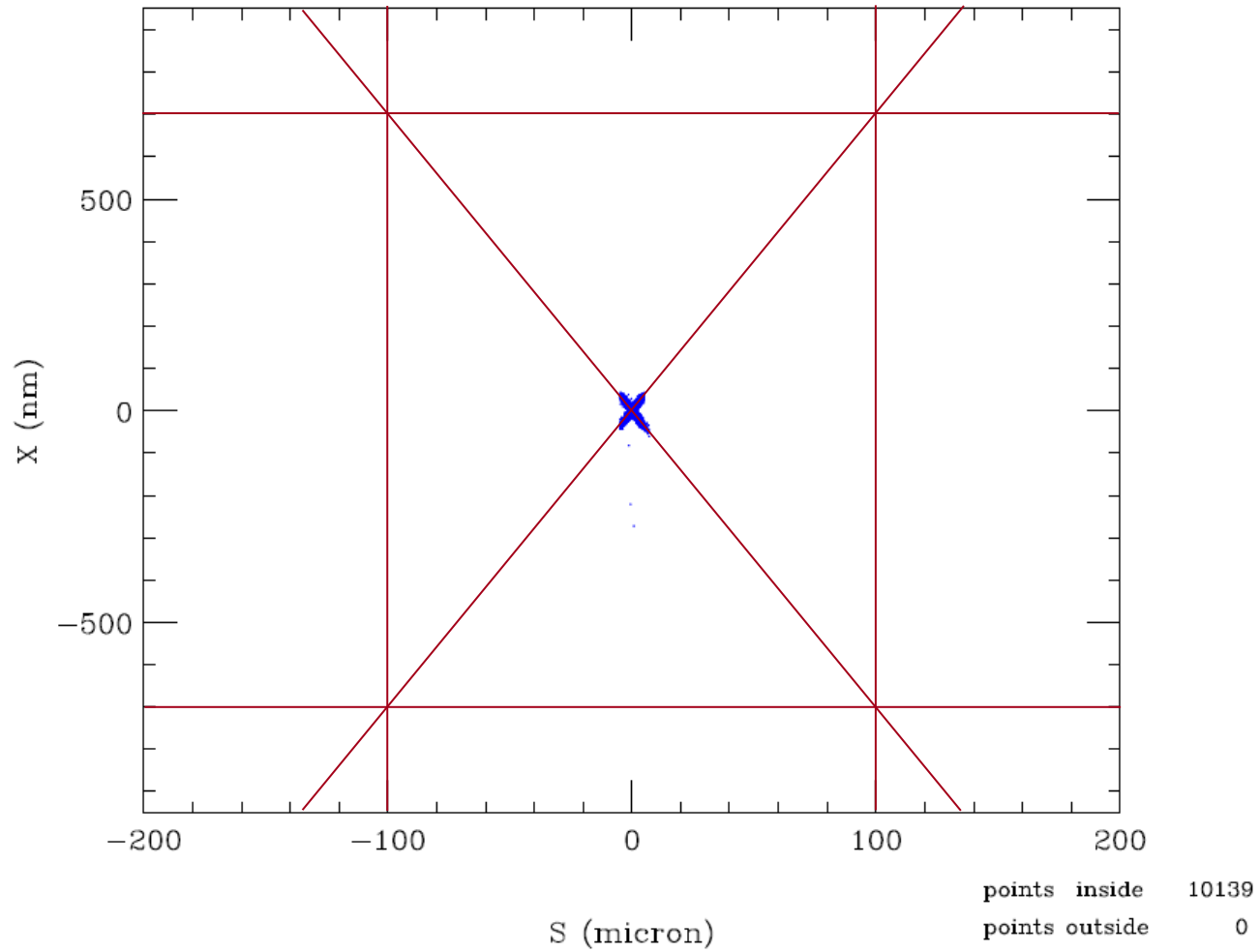
Electrons are spread out over a much wider range of angles once the crossing angle is introduced, due to the fact that e- Compton conversion efficiency $\ll 0.9$ for 14 mrad angle

QD0 = final quad for 62.6 GeV beam

e- Energy vs X at QD0 faces (350 cm from IP)

ILC $\gamma\text{-}\gamma$ for a Higgs Factory 3
t= 0.00000mm

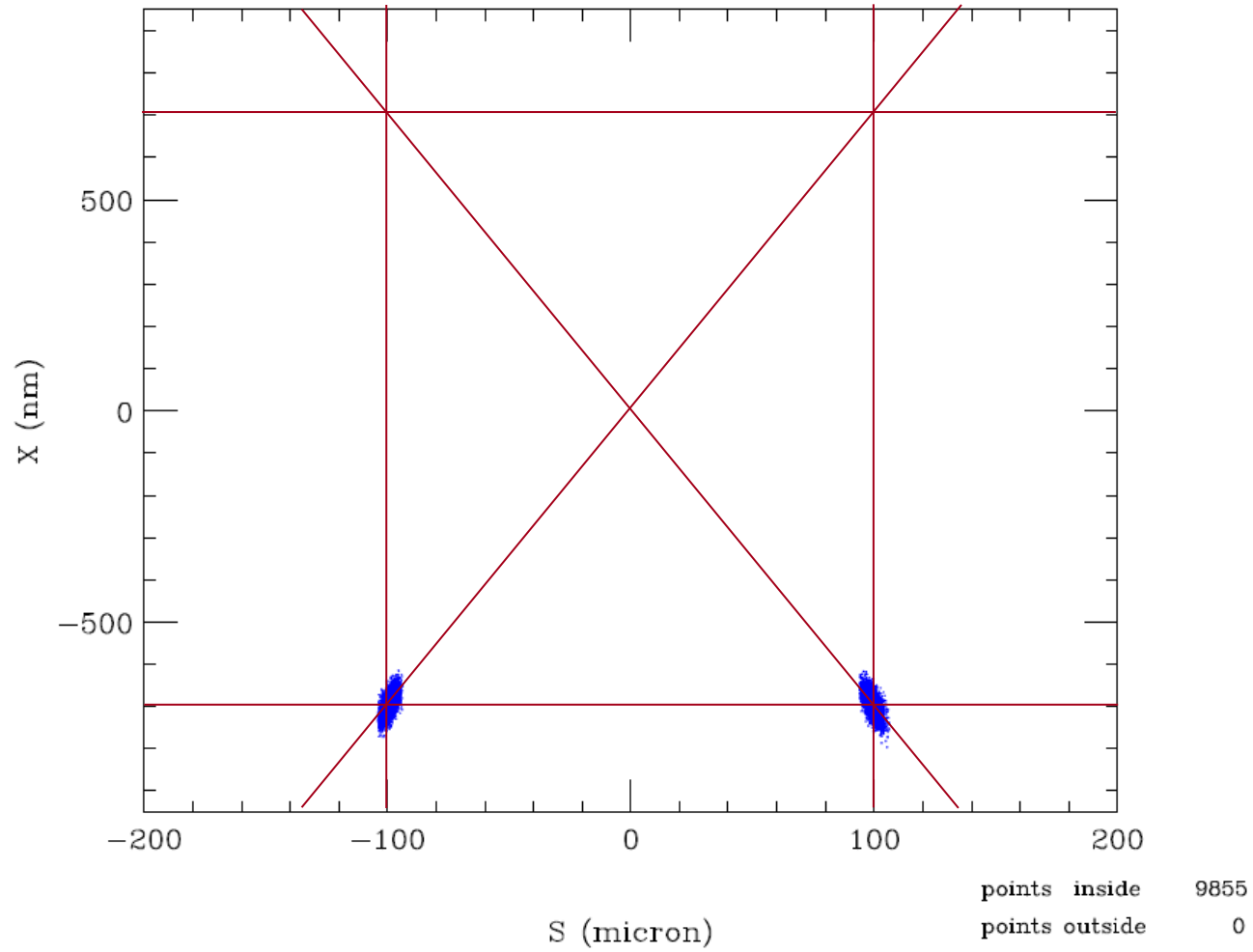
20210421(031444) CAIN2.42



ILC $\gamma\text{-}\gamma$ for a Higgs Factory 3
 $t = -0.09903\text{mm}$

20210421(031444)

CAIN2.42



A 2 mrad crossing angle was once considered for ILC

SLAC-PUB-11613

January 2006

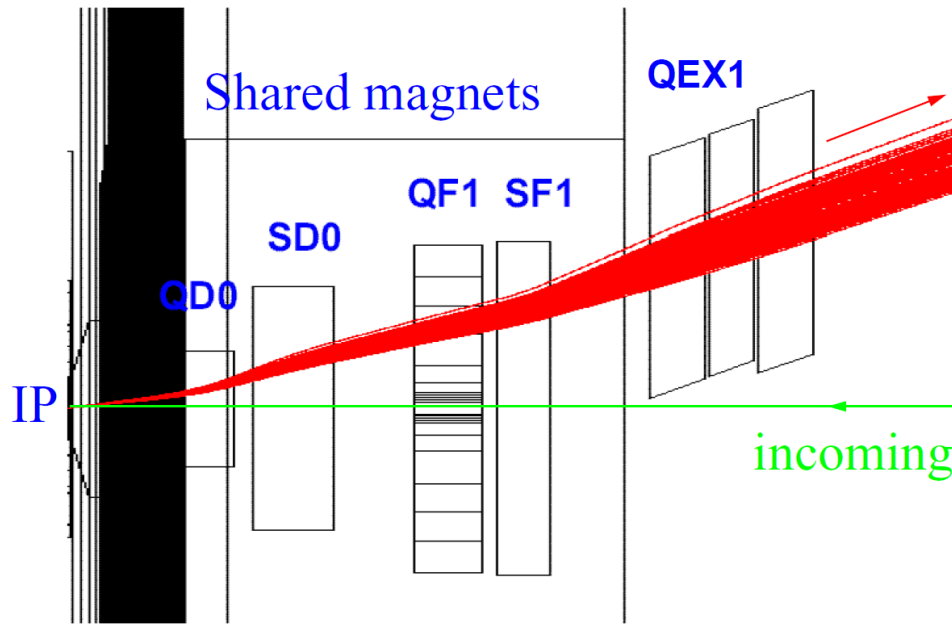
2005 ALCPG & ILC Workshops - Snowmass, U.S.A.

Optics of the ILC Extraction Line for 2 mrad Crossing Angle

Y. Nosochkov, K. Moffeit, A. Seryi, C. Spencer, M. Woods
Stanford Linear Accelerator Center, Menlo Park, CA 94025, USA

D. Angal-Kalinin, R. Appleby
ASTeC, Daresbury Laboratory, Warrington, WA4 4AD, England

B. Parker
Brookhaven National Laboratory, Upton, NY 11973, USA



$L^* = 450$ cm

QD0 inner radius = 3.5 cm

2 mrad crossing angle - right-going beams at QD0 face

XCC

no deflector beams

$B_{\text{solenoid}} = 10 \text{ Tesla}$

$\sigma_{ez} = 2 \mu\text{m}$

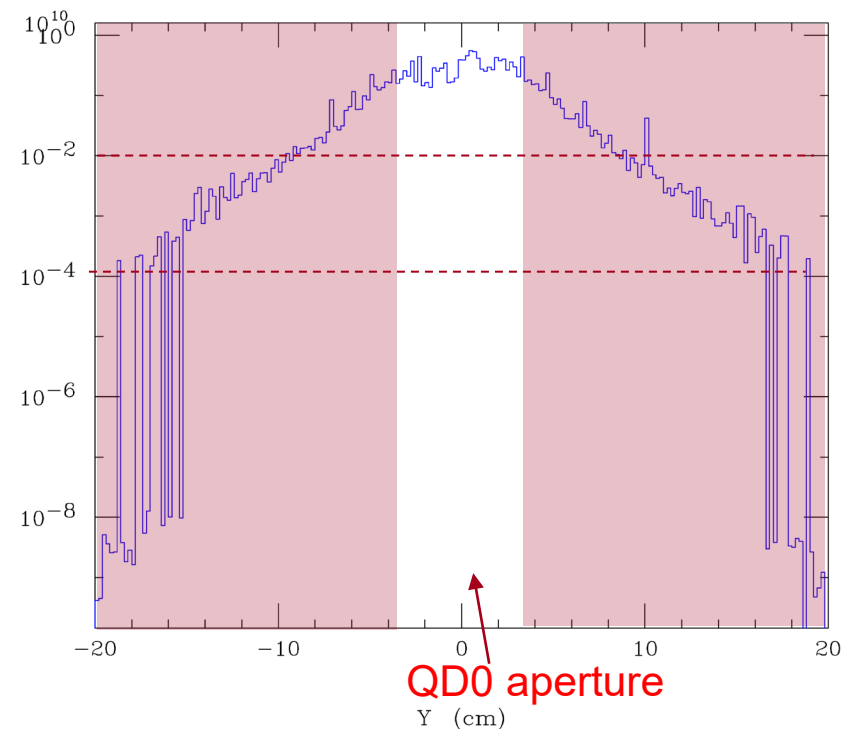
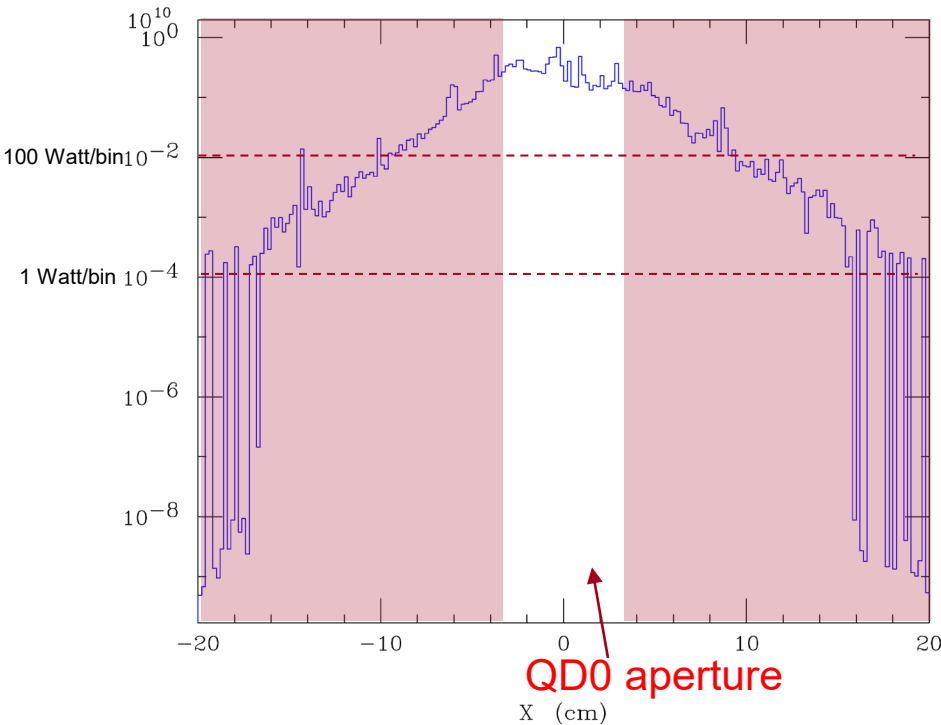
$\sigma_{\gamma z} = 3 \mu\text{m}$

ILC $\gamma\text{-}\gamma$ for a Higgs Factory v01560
X Charged (Blue) Right-going T=450 cm

20210414

ILC $\gamma\text{-}\gamma$ for a Higgs Factory v01560
Y Charged (Blue) Right-going T=450 cm

20210414



QD0 = final quad for 62.6 GeV beam assuming same aperture as ILC 2mrad design

e- Energy vs X or Y at QD0 faces (450 cm from IP)

Electrons are spread out over a wide range of angles, due to the fact that e- Compton conversion efficiency < 0.9 for 2 mrad crossing angle

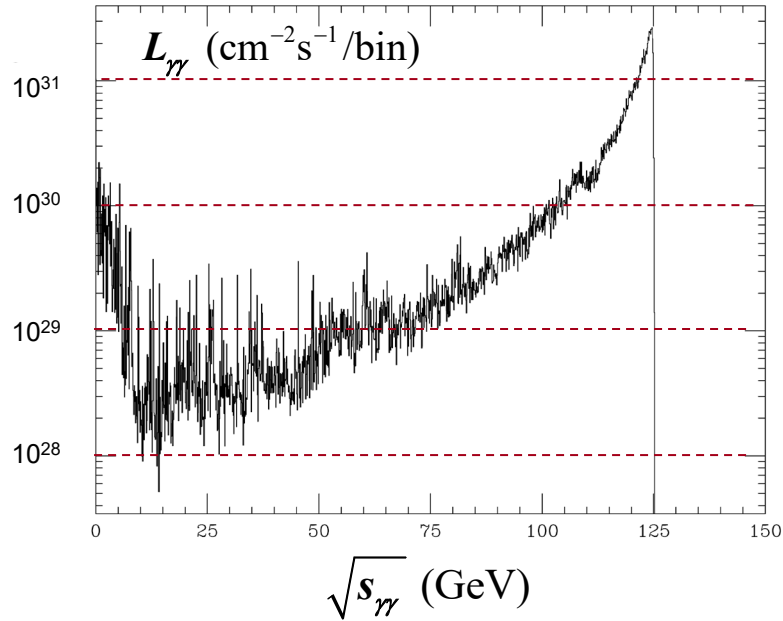
Return to configs with deflector beams.

2 mrad crossing angle

ILC $\gamma\text{-}\gamma$ for a Higgs Factory v01557

Luminosity Spectrum (γ,γ)

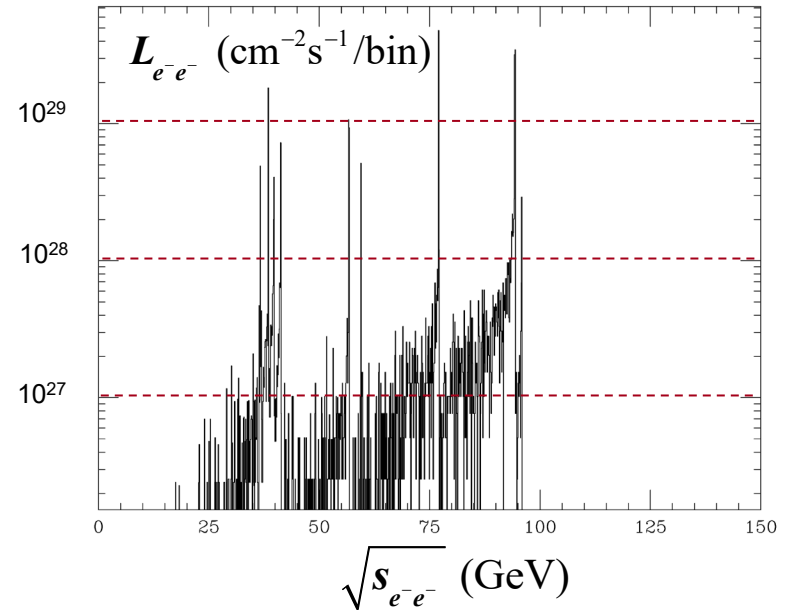
20210415(030335) CAIN2.



ILC $\gamma\text{-}\gamma$ for a Higgs Factory v01559

Luminosity Spectrum (e^-,e^-)

20210415(030415) CAIN2.4



$$\sigma_{ez} = 6 \mu\text{m}$$

$$\sigma_{\gamma z} = 6 \mu\text{m}$$

e^-e^- luminosity is completely negligible

e^- conversion eff. = 0.38 $\ll$ 0.9 but it doesn't matter because the e^- beams are deflected away from each other

Energy vs angle

with deflector beams

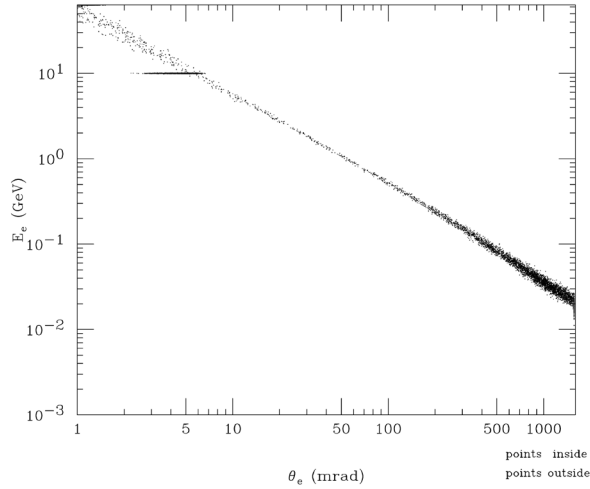
$$\sigma_{ez} = 6 \mu\text{m}$$

$$\sigma_{\gamma z} = 6 \mu\text{m}$$

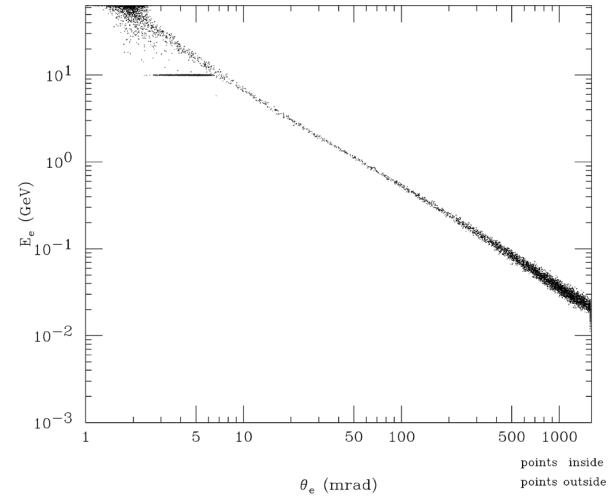
after Compton

after Primary IP

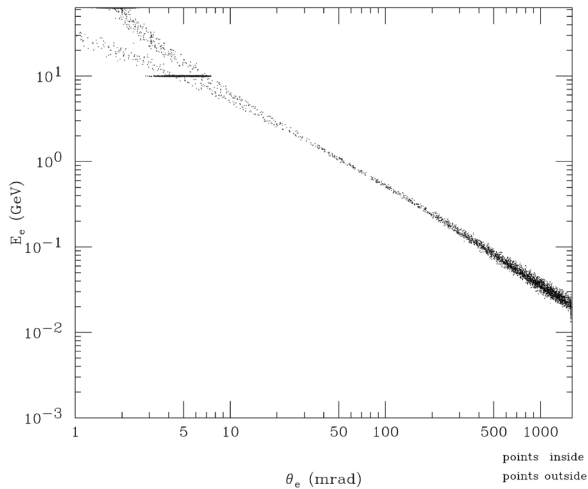
ILC $\gamma\gamma$ for a Higgs Factory 3 v01553
Electron Energy vs. Angle after Compton IP 20210413(03)



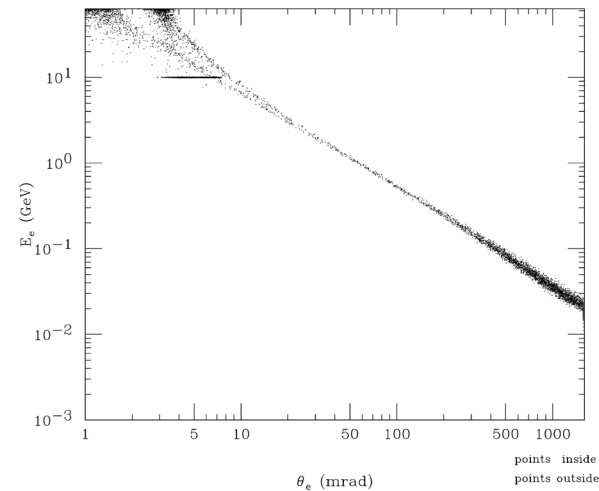
ILC $\gamma\gamma$ for a Higgs Factory
T=0.5 cm Electron Energy vs. Angle after IP 20210413(0)



ILC $\gamma\gamma$ for a Higgs Factory 3 v01557
Electron Energy vs. Angle after Compton IP 20210415(0)



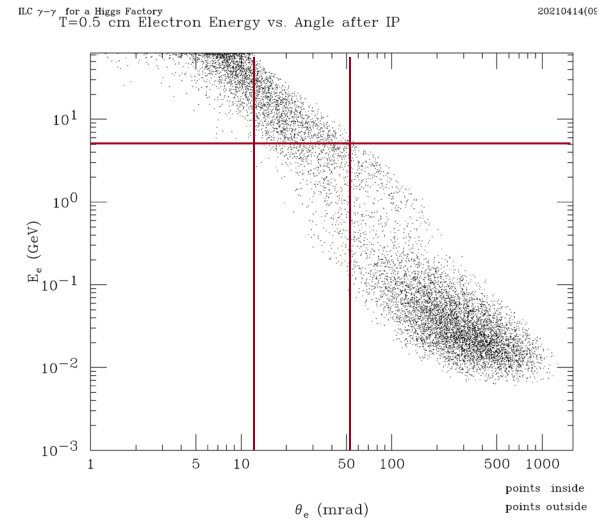
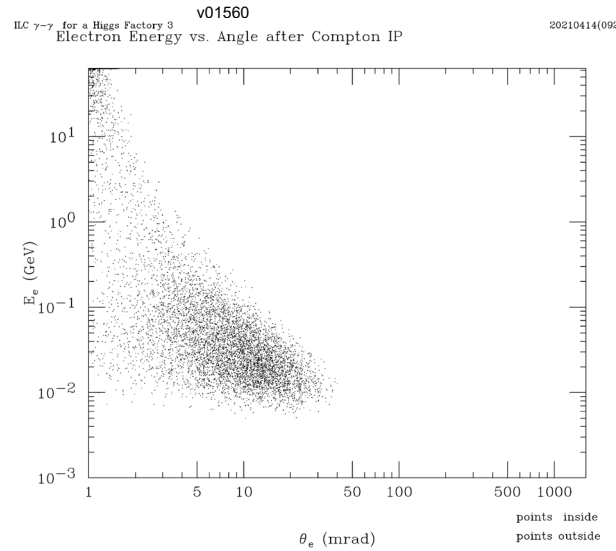
ILC $\gamma\gamma$ for a Higgs Factory
T=0.5 cm Electron Energy vs. Angle after IP 20210415(0)



Energy vs angle

after Compton

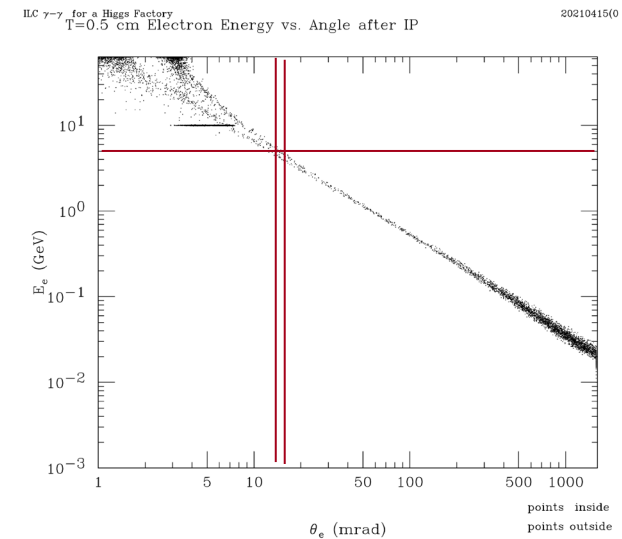
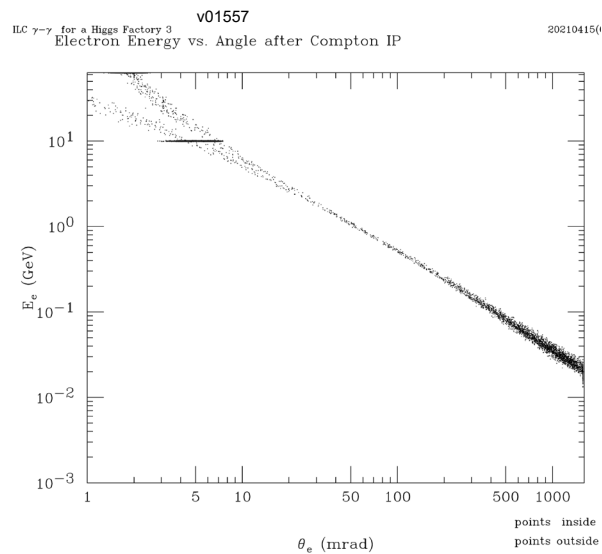
after Primary IP



no deflector beams

$$\sigma_{ez} = 2 \mu\text{m}$$

$$\sigma_{\gamma z} = 3 \mu\text{m}$$

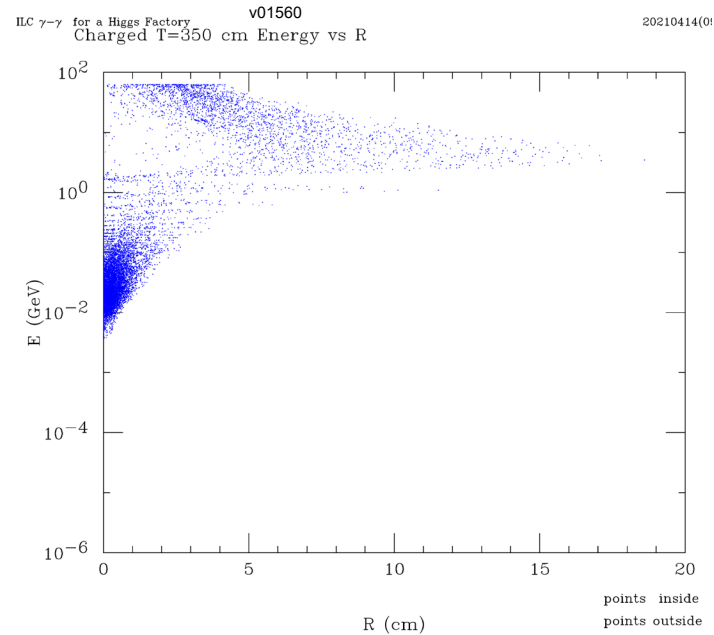


with deflector beams

$$\sigma_{ez} = 6 \mu\text{m}$$

$$\sigma_{\gamma z} = 6 \mu\text{m}$$

Energy vs radial distance from beamline at Z=350 cm.

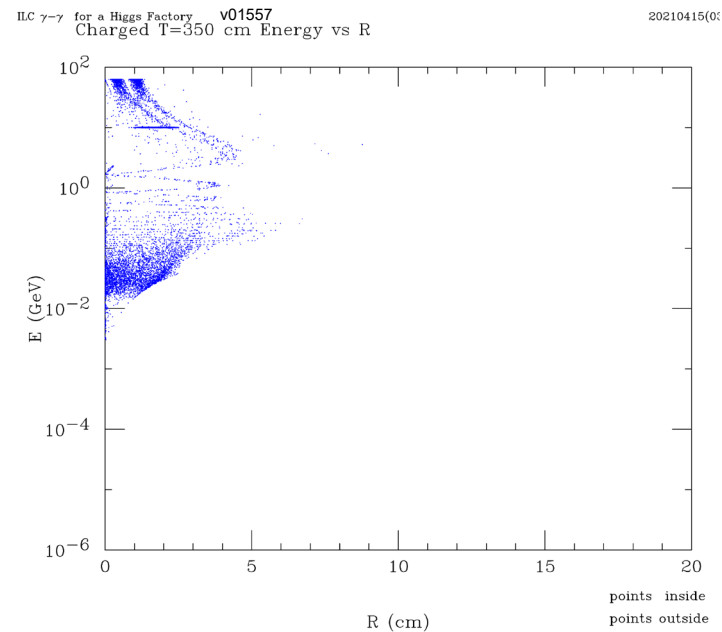


no deflector beams

$$B_{\text{solenoid}} = 10 \text{ Tesla}$$

$$\sigma_{ez} = 2 \text{ } \mu\text{m}$$

$$\sigma_{\gamma z} = 3 \text{ } \mu\text{m}$$



with deflector beams

$$B_{\text{solenoid}} = 10 \text{ Tesla}$$

$$\sigma_{ez} = 6 \text{ } \mu\text{m}$$

$$\sigma_{\gamma z} = 6 \text{ } \mu\text{m}$$

2 mrad crossing angle - right-going beams at QD0 face

XCC

with deflector beams

$B_{\text{solenoid}} = 10 \text{ Tesla}$

$\sigma_{ez} = 6 \mu\text{m}$

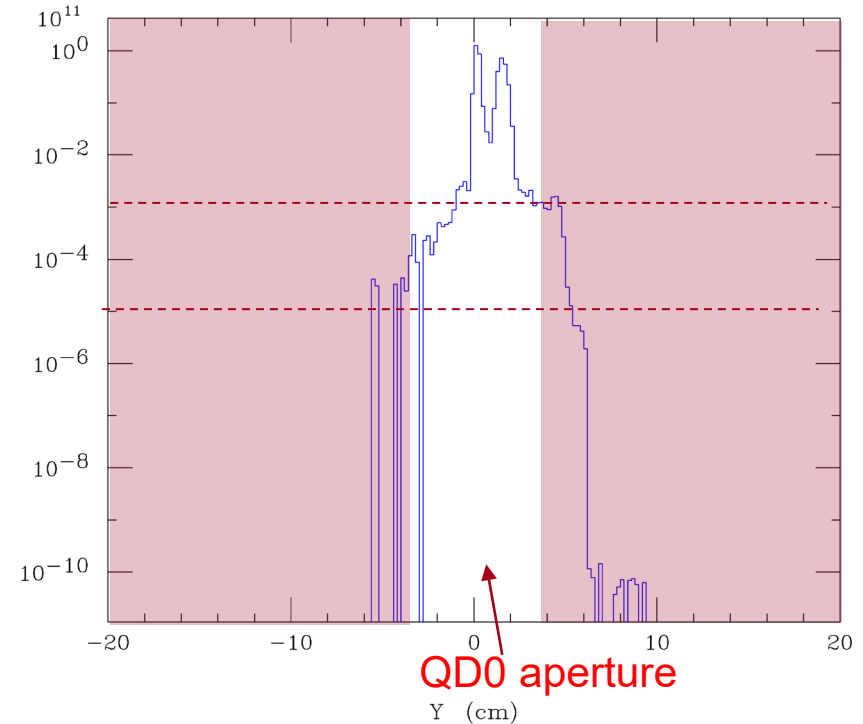
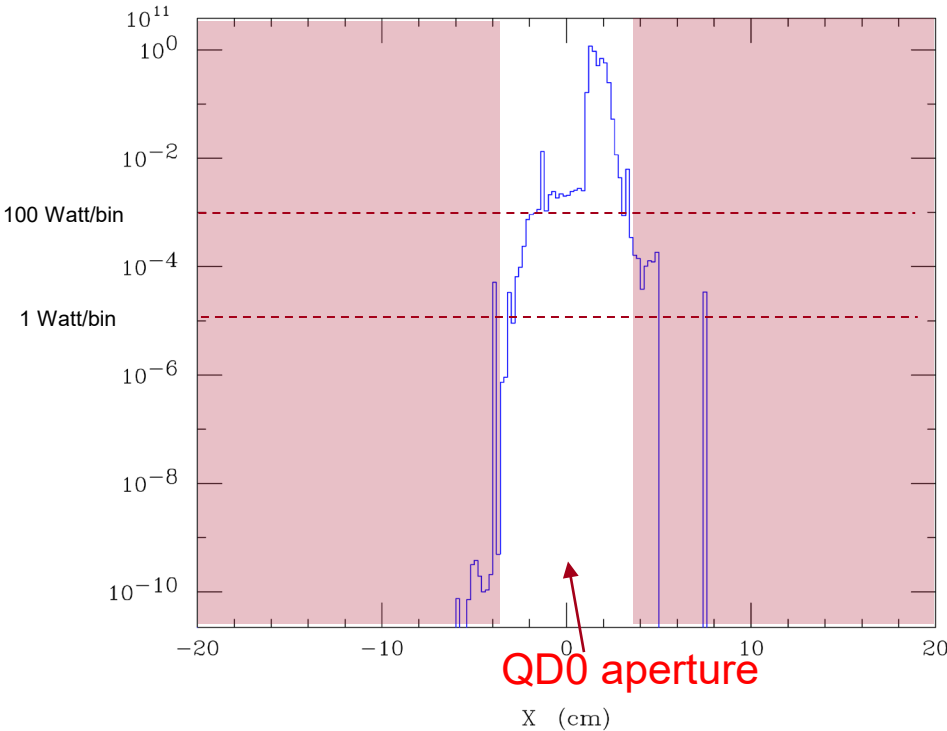
$\sigma_{\gamma z} = 6 \mu\text{m}$

ILC $\gamma\text{-}\gamma$ for a Higgs Factory v01557
X Charged (Blue) Right-going T=450 cm

20210414

ILC $\gamma\text{-}\gamma$ for a Higgs Factory v01557
Y Charged (Blue) Right-going T=450 cm

20210414



QD0 = final quad for 62.6 GeV beam assuming same aperture as ILC 2mrad design

e- Energy vs X or Y at QD0 faces (450 cm from IP)

Although e^- conversion eff. = $0.38 \ll 0.9$, the electron angular spread is limited to that due to the Compton collision because the e^- beams have been deflected away from each other

2 mrad crossing angle - right-going beams at QD0 face

XCC

with deflector beams

$B_{\text{solenoid}} = 20 \text{ Tesla}$

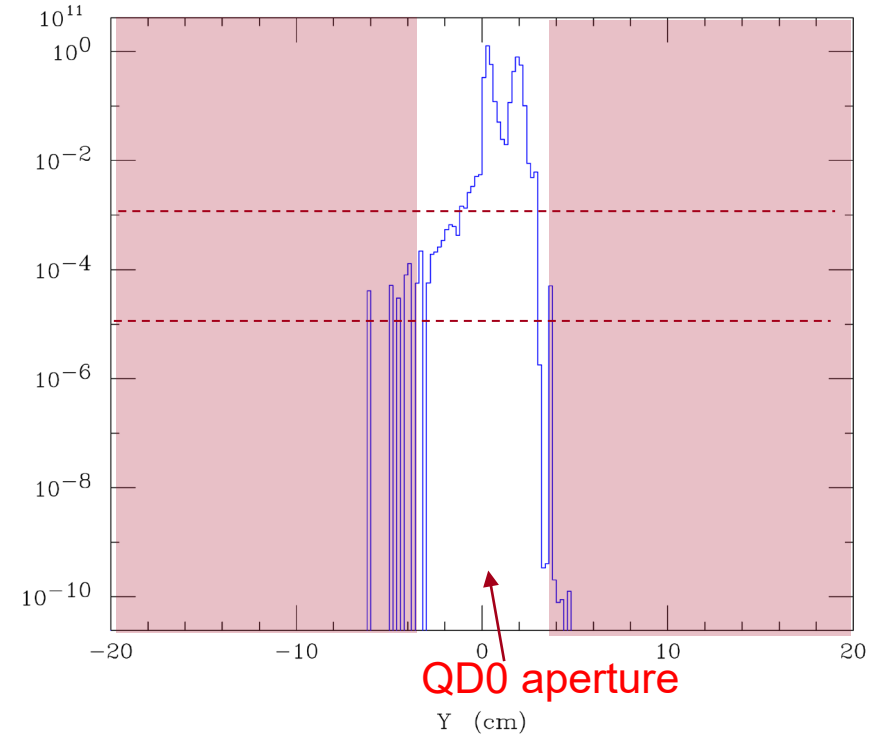
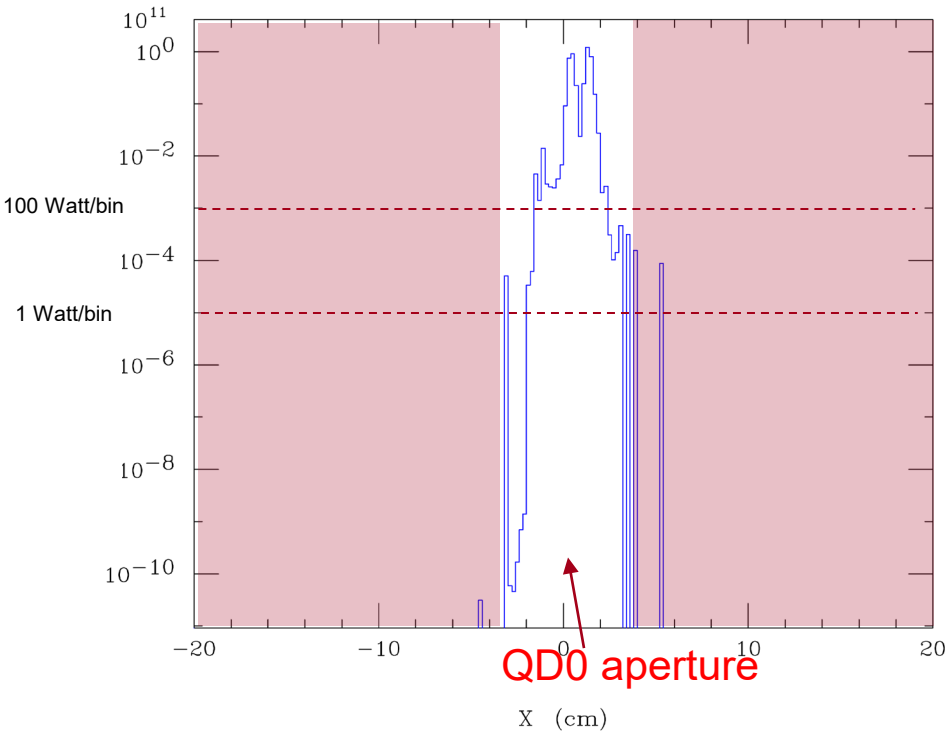
$\sigma_{ez} = 6 \mu\text{m}$

$\sigma_{\gamma z} = 6 \mu\text{m}$

ILC $\gamma\text{-}\gamma$ for a Higgs Factory v01558
X Charged (Blue) Right-going T=450 cm

20210414 ILC $\gamma\text{-}\gamma$ for a Higgs Factory v01558
Y Charged (Blue) Right-going T=450 cm

20210414



QD0 = final quad for 62.6 GeV beam assuming same aperture as ILC 2mrad design

e- Energy vs X or Y at QD0 faces (450 cm from IP)

Although e^- conversion eff. = $0.38 \ll 0.9$, the electron angular spread is limited to that due to the Compton collision because the e^- beams have been deflected away from each other