



Proposal to modify the polarimeter chicane in the ILC 14 mrad extraction line

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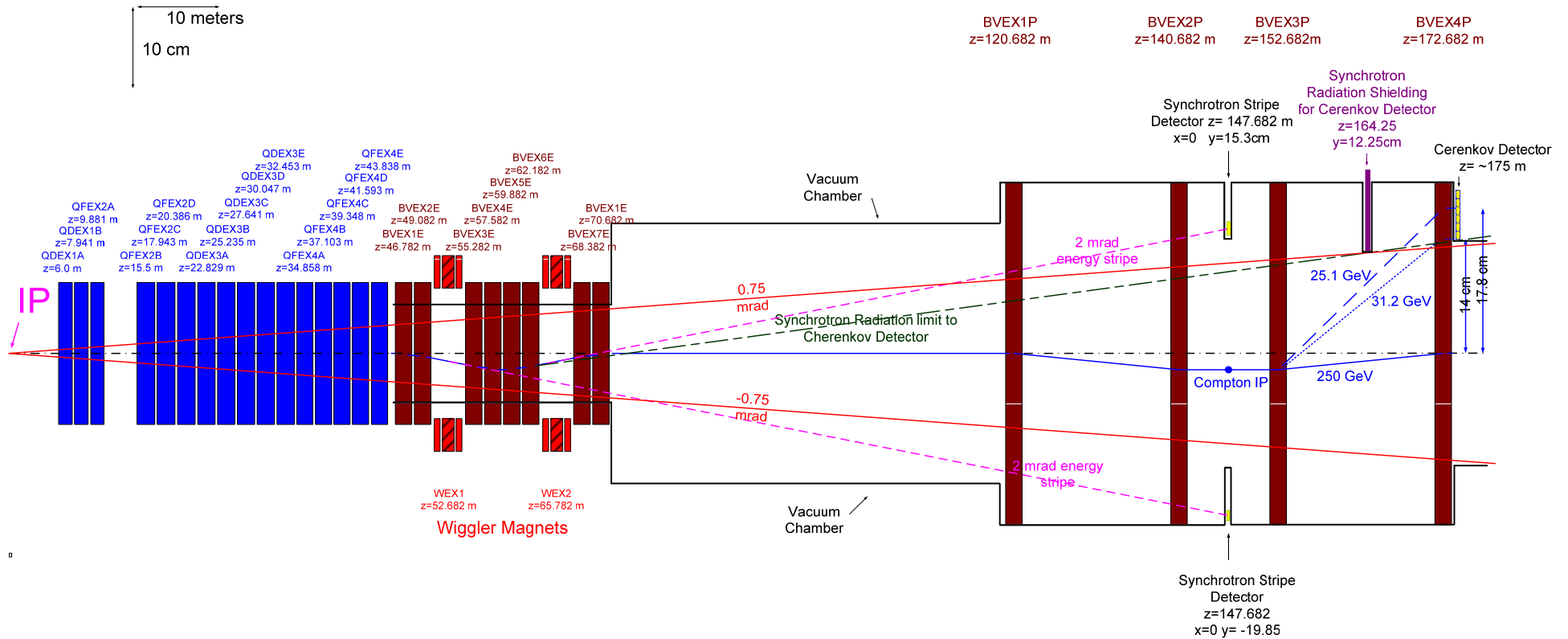
*presenting talk



14 mrad Extraction Line Existing Version

Energy Chicane

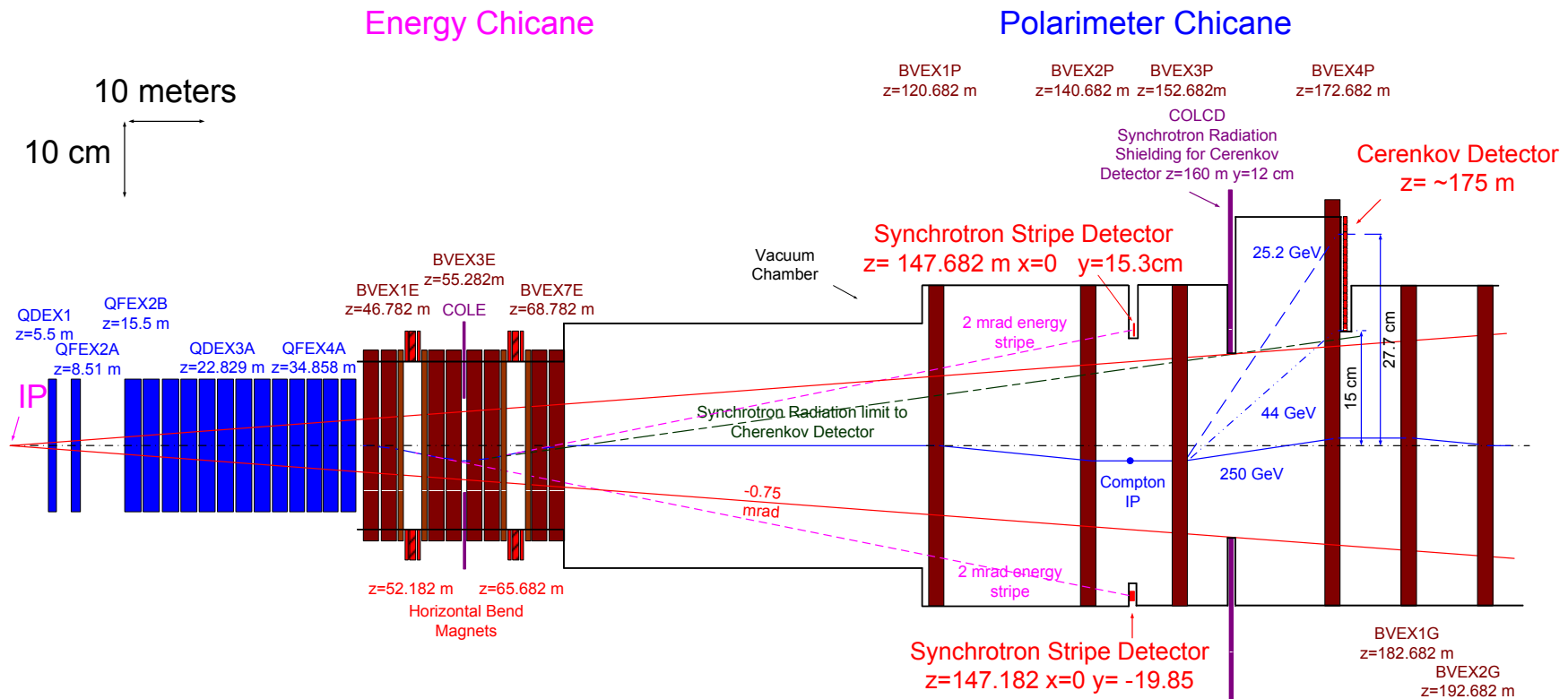
Polarimeter Chicane





14 mrad extraction line new proposal*

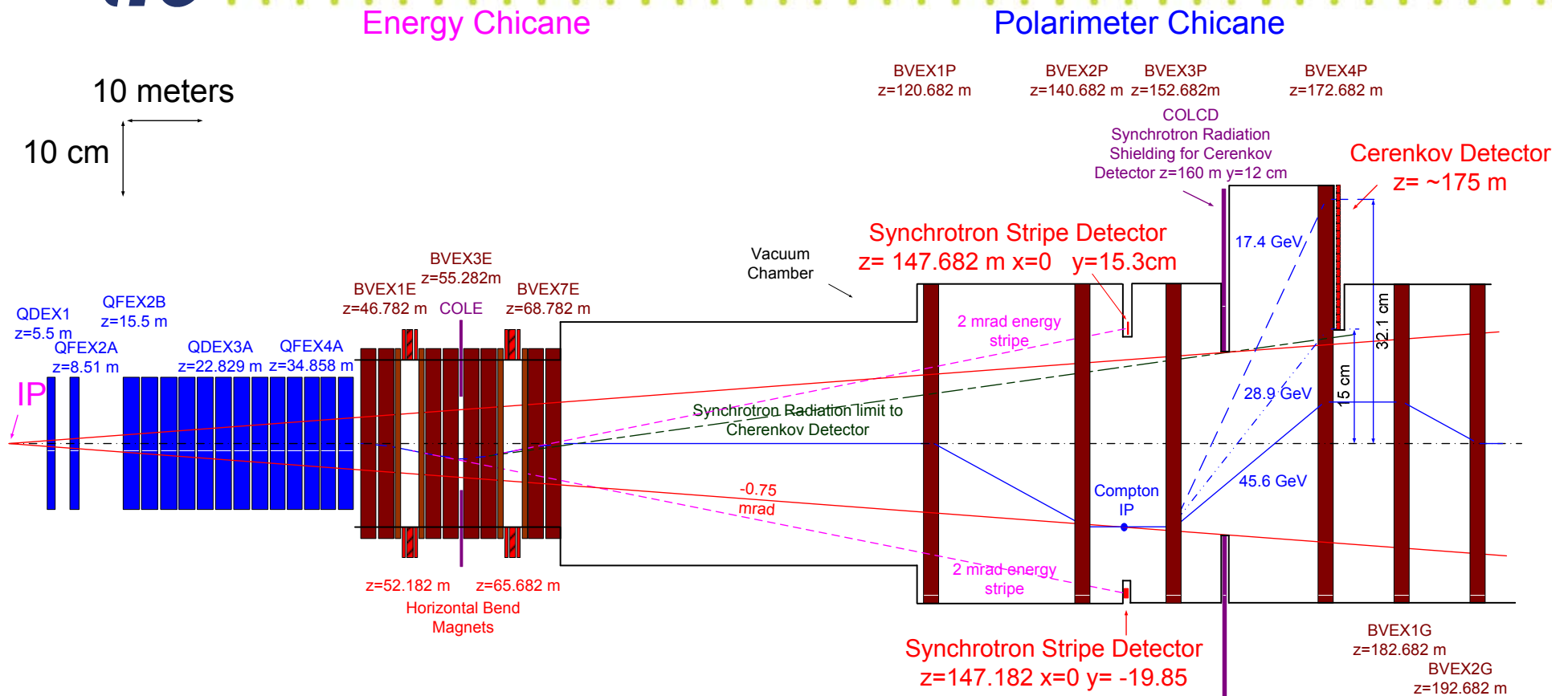
*includes recent updates for IR quad configuration to accommodate push-pull (see MDI/BDS talk by Y. Nosochkov)



→ Magnets 3 and 4 of Polarimeter Chicane have 1.5x Bdl of first two magnets



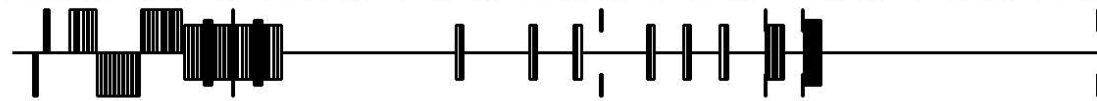
Proposed Chicane at 45.6 GeV



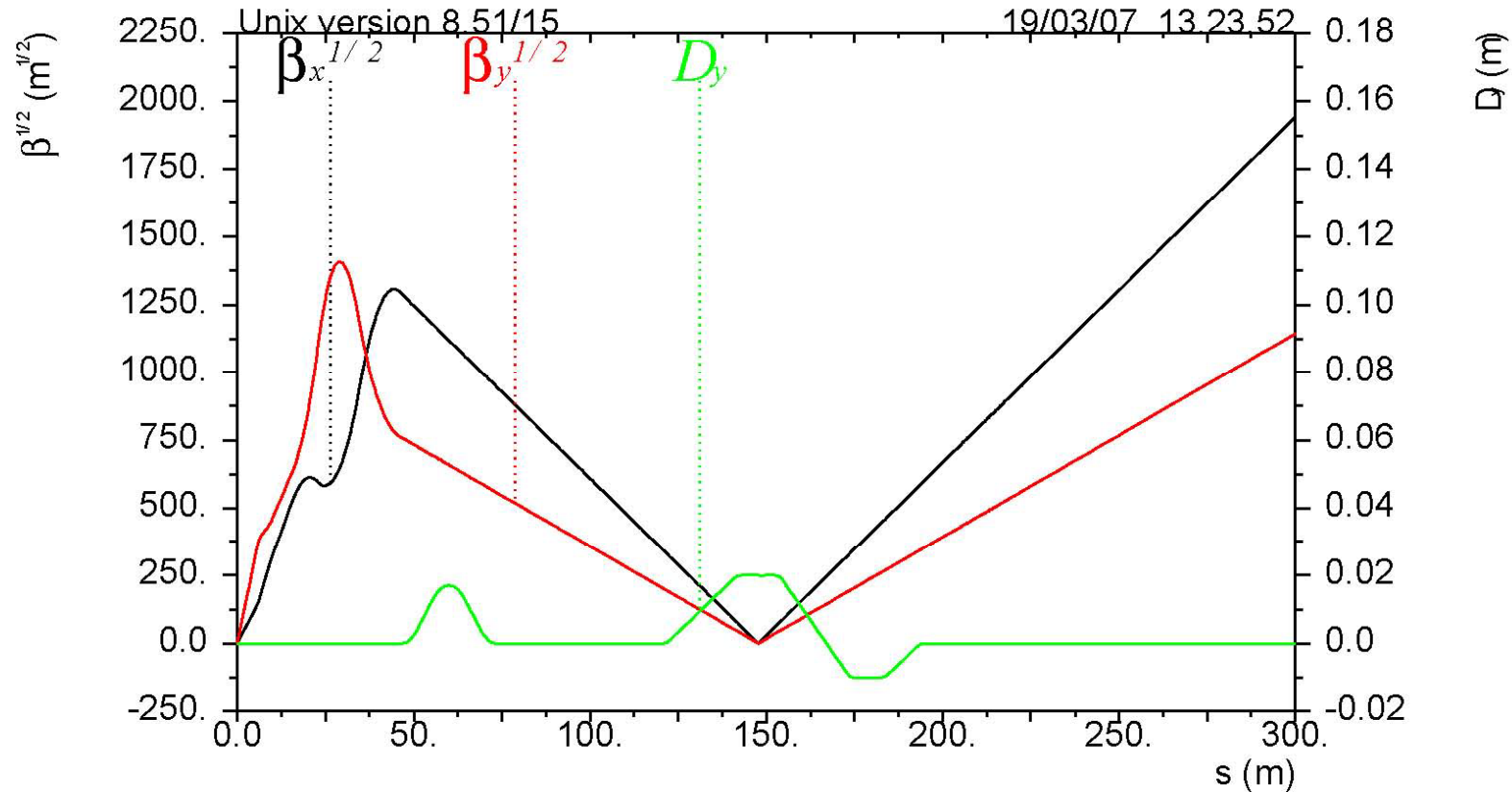
Since magnets 3 and 4 of the polarimeter chicane have 1.5 times Bdl of magnets 1 and 2, the position of the Compton edge in the Cerenkov detector will be at a different y position than for 250 GeV case (32.1cm rather than 27.7cm).



New Extraction Line Optics



Disrupted beta and dispersion in the extraction line.



Optical β functions and vertical momentum dispersion D_y in the 14 mrad extraction line from IP to the dump, shown for the 250 GeV nominal disrupted beam.



Parameters of the extraction quadrupoles at 250 GeV

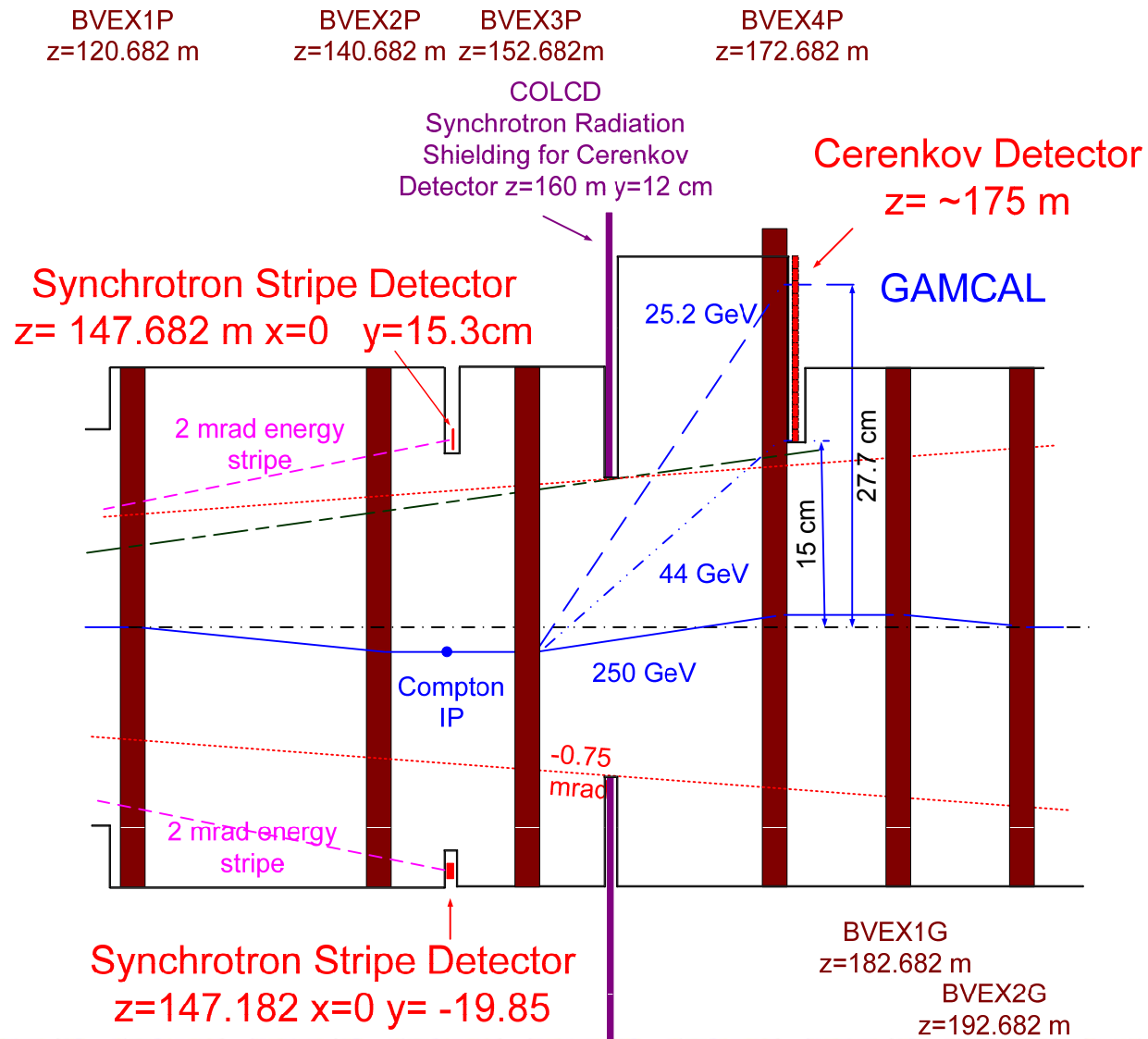
Quad name	Qty	L (m)	G (T/m)	R (mm)
QDEX1 (SC)	1	1.060	100.00	15
QFEX2A (SC)	1	1.200	23.08	26
QFEX2B,C,D	3	2.143	11.19	42
QDEX3A,B	2	2.106	11.93	42
QDEX3C	1	2.106	10.89	46
QDEX3D	1	2.106	9.63	52
QDEX3E	1	2.106	8.08	62
QFEX4A	1	1.945	7.11	71
QFEX4B,C,D,E	4	1.945	5.94	85

Parameters of the existing and proposed chicane bends at 250 GeV

Bend name	Qty	L (m)	B (T)	Half-gap (mm)	Diagnostics
BVEX1E,2E,...,8E	8	2.0	0.4170	85	Energy
BVEX1P,2P	2	2.0	0.4170	117	Polarimeter
BVEX3P	1	2.0	0.6254	117	
BVEX4P	1	2.0	0.6254	132	
BVEX1G,2G	2	2.0	0.4170	147	GAMCAL



Polarimeter Chicane

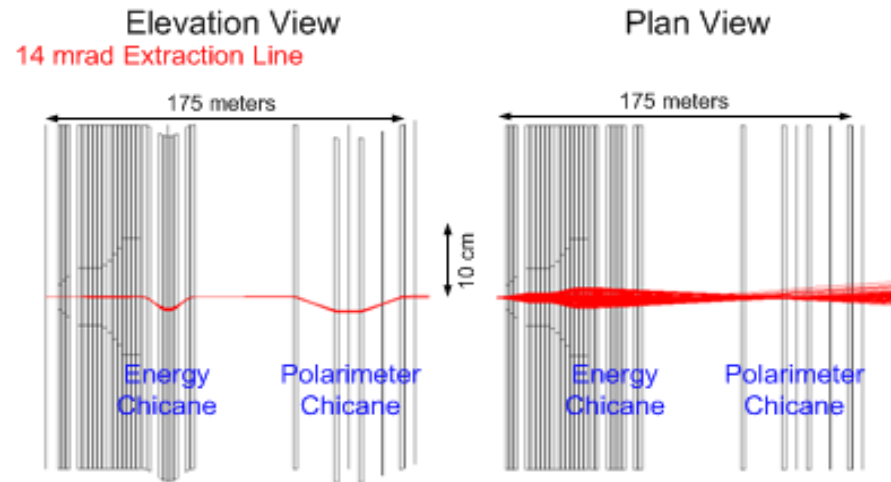




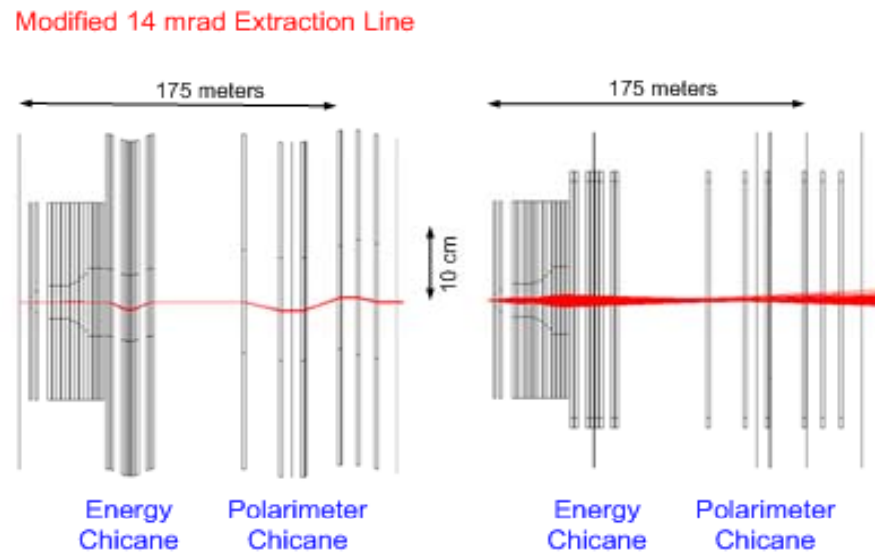
Ray Trace for 100 Beam Tracks

0.5 TeV CMS

Existing Optics

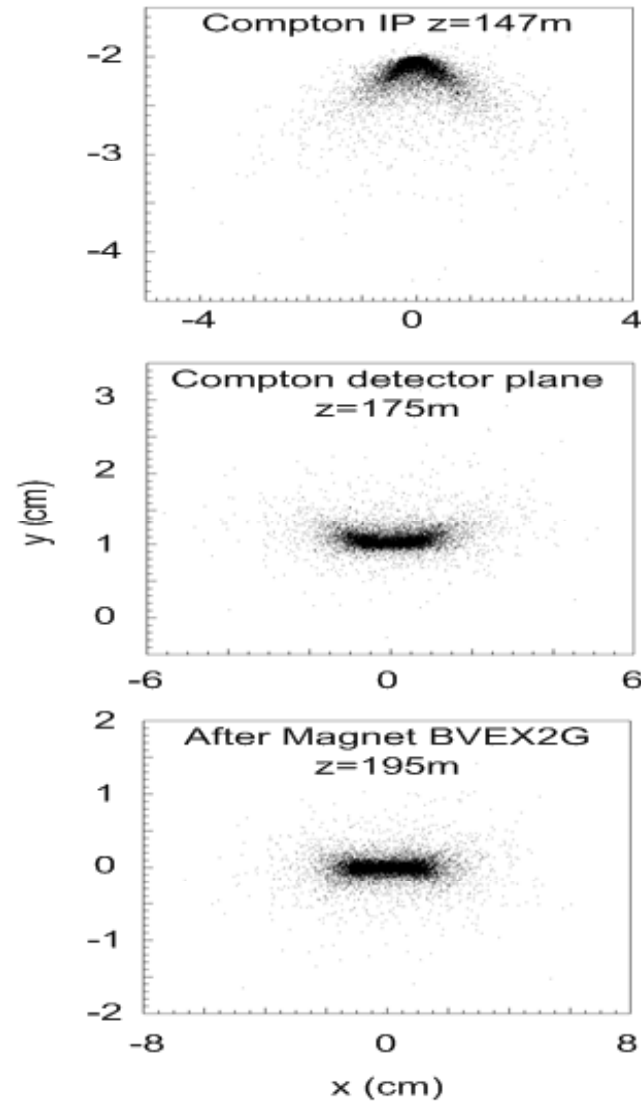


New Optics





x-y Distributions of Beam Electrons





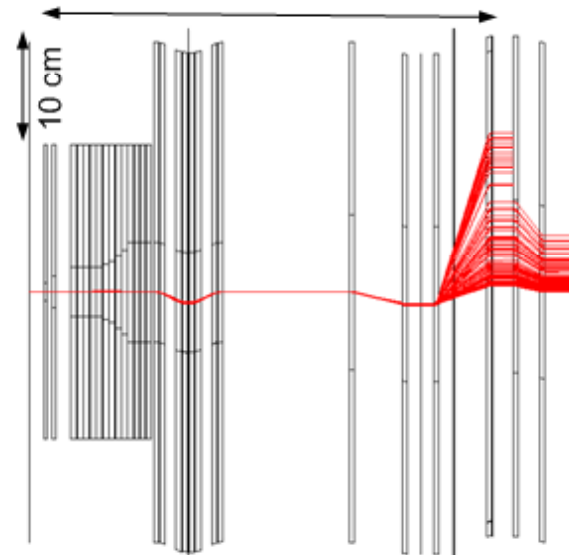
Ray Trace for 100 Compton Electrons

Modified 14 mrad Extraction Line

0.5 TeV CMS

Elevation View

175 meters



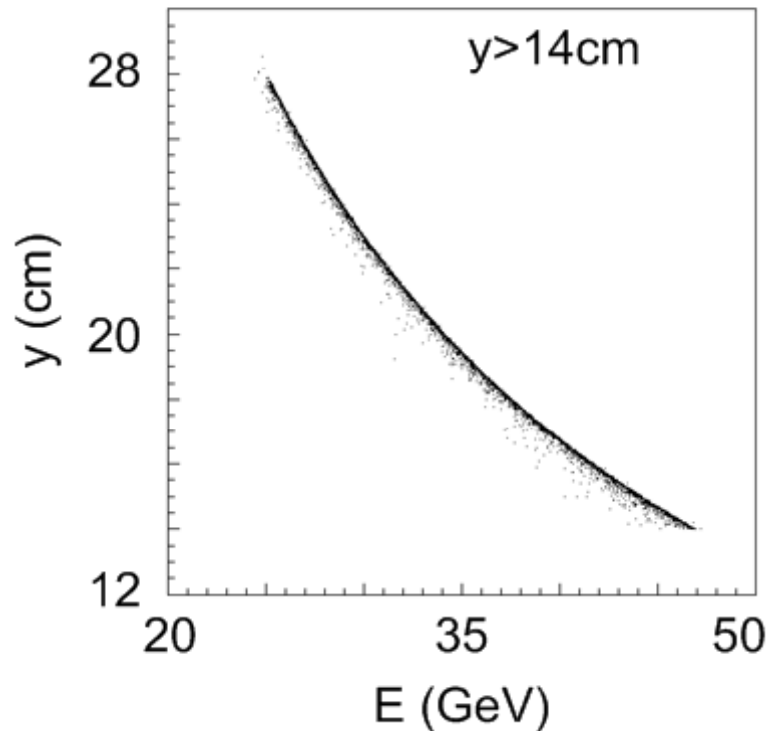
Energy Chicane Polarimeter Chicane

- At the Compton IP each beam track is changed into a Compton-scattered electron.
- Compton-scattered electrons with low enough energy to exit the beam pipe are detected in the Compton Cherenkov detector located at $z = 175$ m.

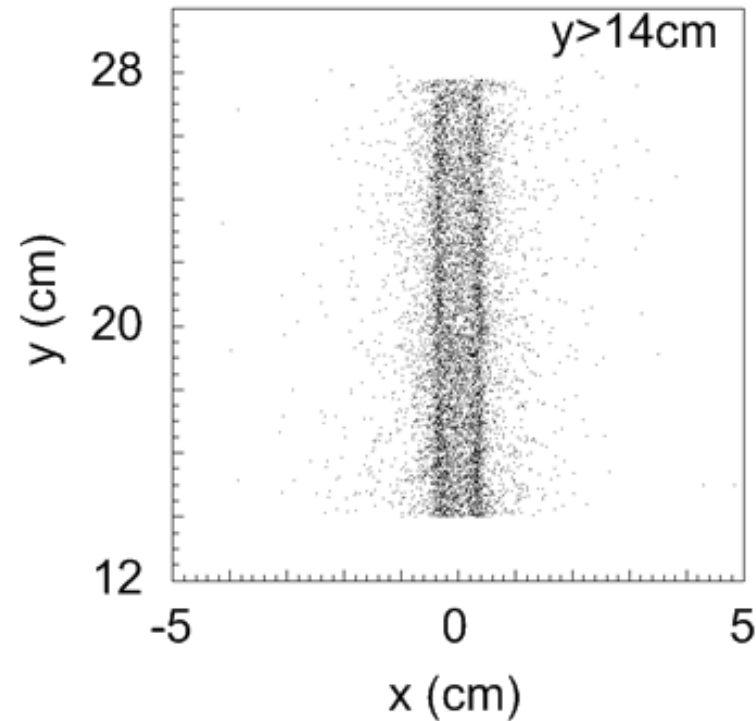


E-y and x-y Distributions of Compton Electrons at Detector Plane

Compton scattered electrons at the
Compton detector plane
 $z=175\text{m}$



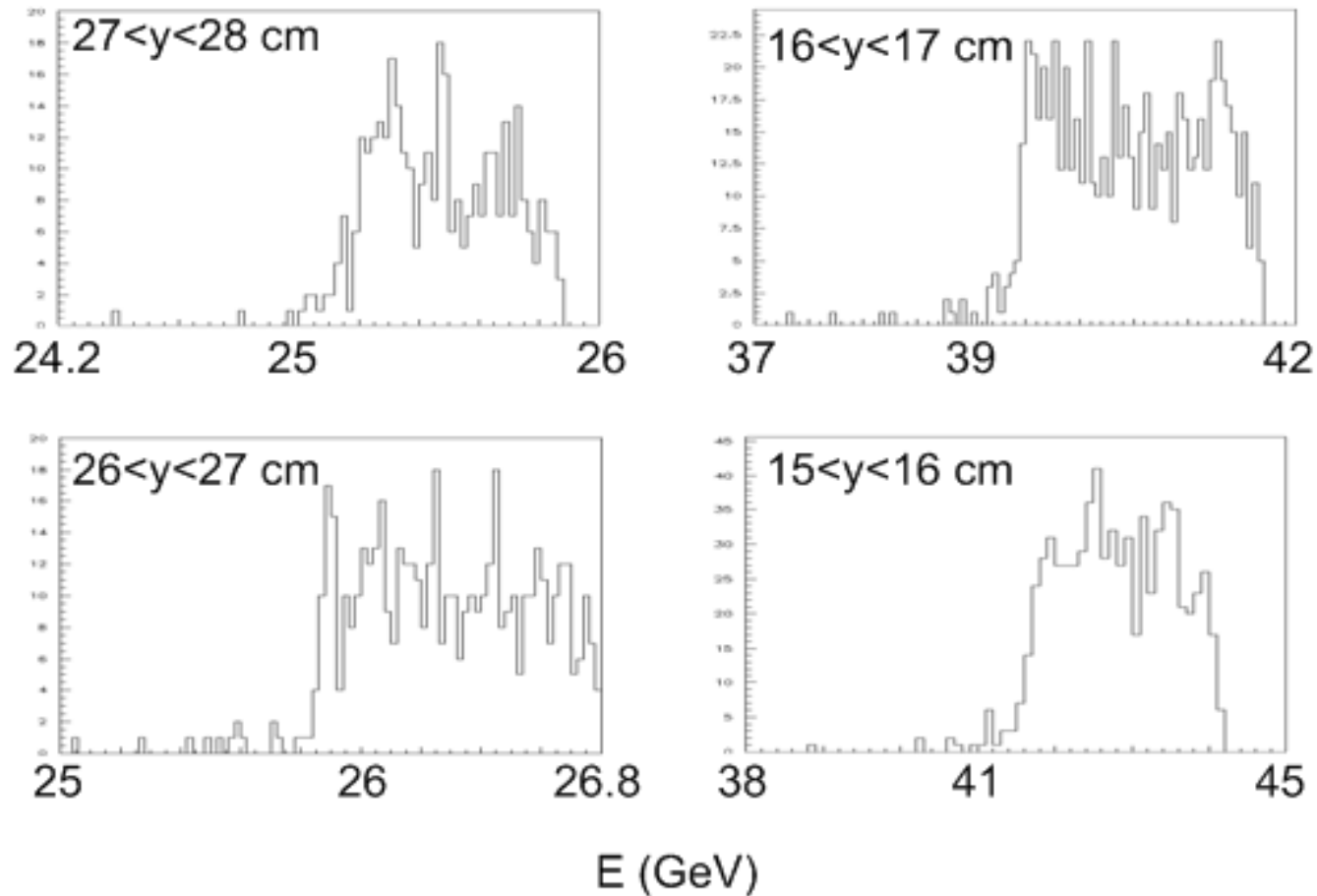
Compton scattered electrons at the
Compton detector plane
 $z=175\text{m}$





Energy Distributions in Different Detector cells

Compton scattered electrons at the
Compton detector plane
 $z=175\text{m}$





Nominal beam option cs11

For 34,883 beam particles tracked through extraction line,

- No particles are lost between the e+e- interaction point and the end of the six-magnet polarimeter chicane at $z = 195$ m
- There are no background particles above $y = 4$ cm. The first cell of the Compton Cherenkov detector begins at $y = 15$ cm.

For 17.6 million beam particles w/ $E < 162.5$ GeV or x-y angles $> 500 \mu\text{rad}$,

- No particles are lost between the e+e- interaction point and the end of the six-magnet polarimeter chicane at $z = 195$ m

The proposed modified six-magnet chicane transports the nominal ILC beam as efficient as the original design.



Low power option cs14

For 17.45 million beam particles w/ $E < 162.5 \text{ GeV}$ or x-y angles $> 500 \mu\text{rad}$,

- there are 0.0096% lost particles between the e+e- IP and the Compton detector plane (an additional 0.00005% are lost between the Compton detector plane and $z = 195\text{m}$)

→ lost particles produce backgrounds at the Compton detector of photons and charged particles

Extrapolating to a beam of $2 \cdot 10^{10}$ particles

- the backgrounds would be ~ 1650 per centimeter squared (the area of a Cherenkov cell). Background is mostly photons; only a small portion will convert to e+e- pairs in material before the Cherenkov detector. In addition, 56% of the background particles are photons with $E < 15 \text{ MeV}$ and will not give Cherenkov light.

The backscattered electron counting rate is high for the proposed Compton Polarimeter with about 650 Compton electrons per GeV at the endpoint energy of 25.2 GeV.

→ **Backgrounds from secondary interactions should be small compared to the signal even for Low Power beam parameter running.**

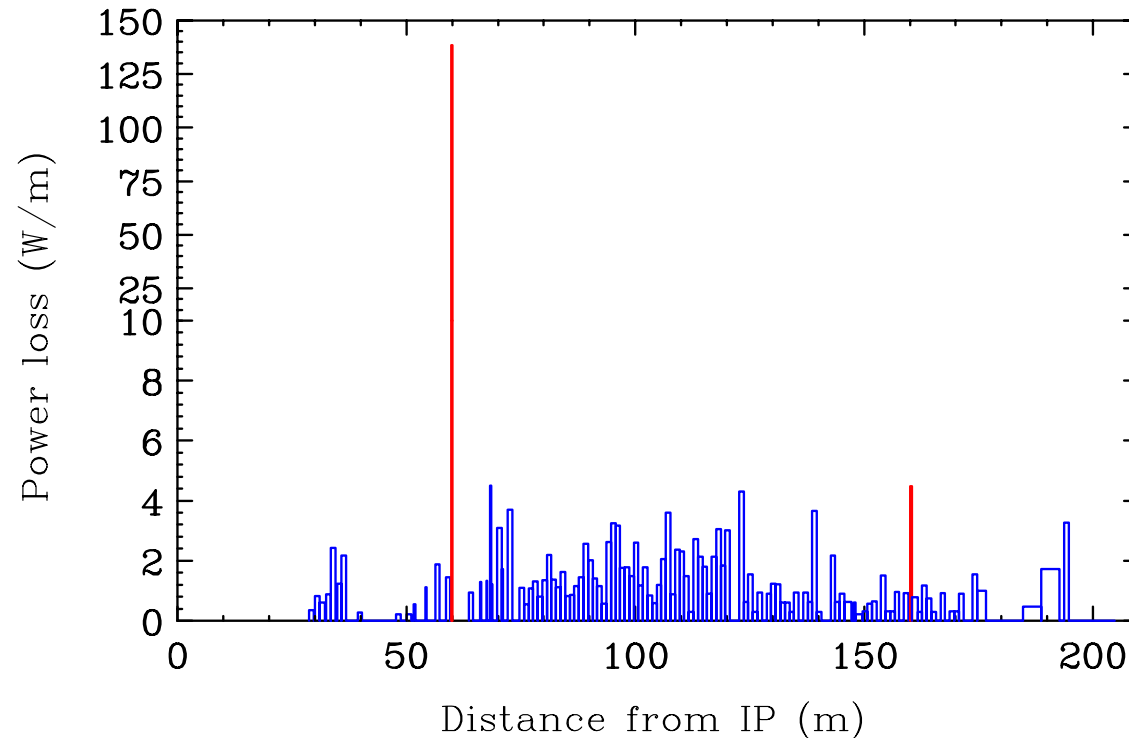


Beam Losses for cs14

Total loss on magnets and pipe: 152 W

At chicane collimators: 42 W, 2.2 W

At dump collimators: 2.8 kW, 6.7 kW, 10.7 kW

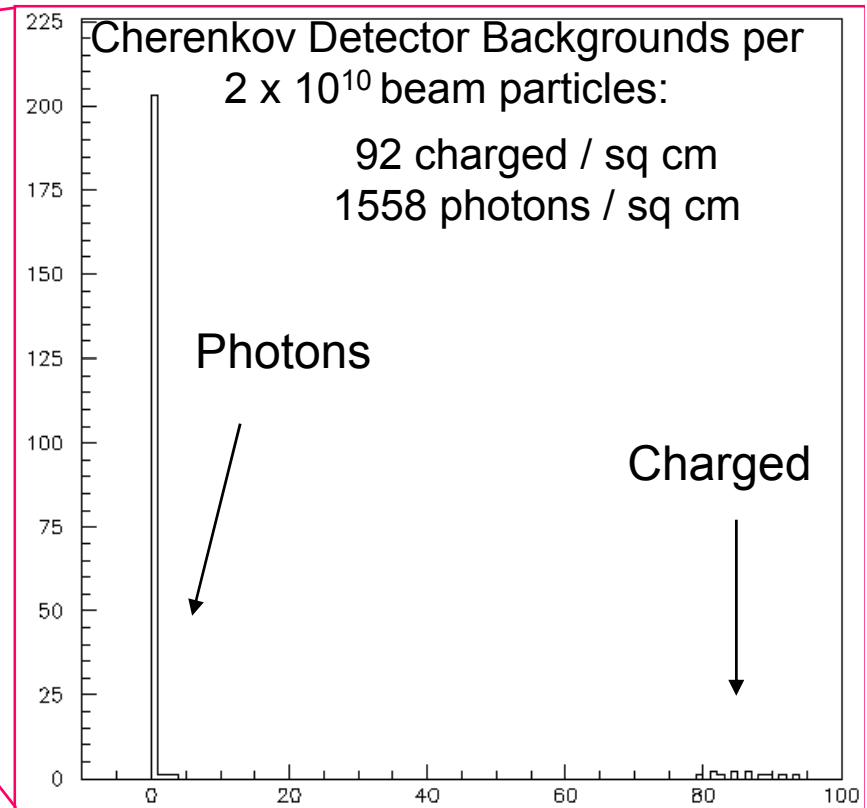
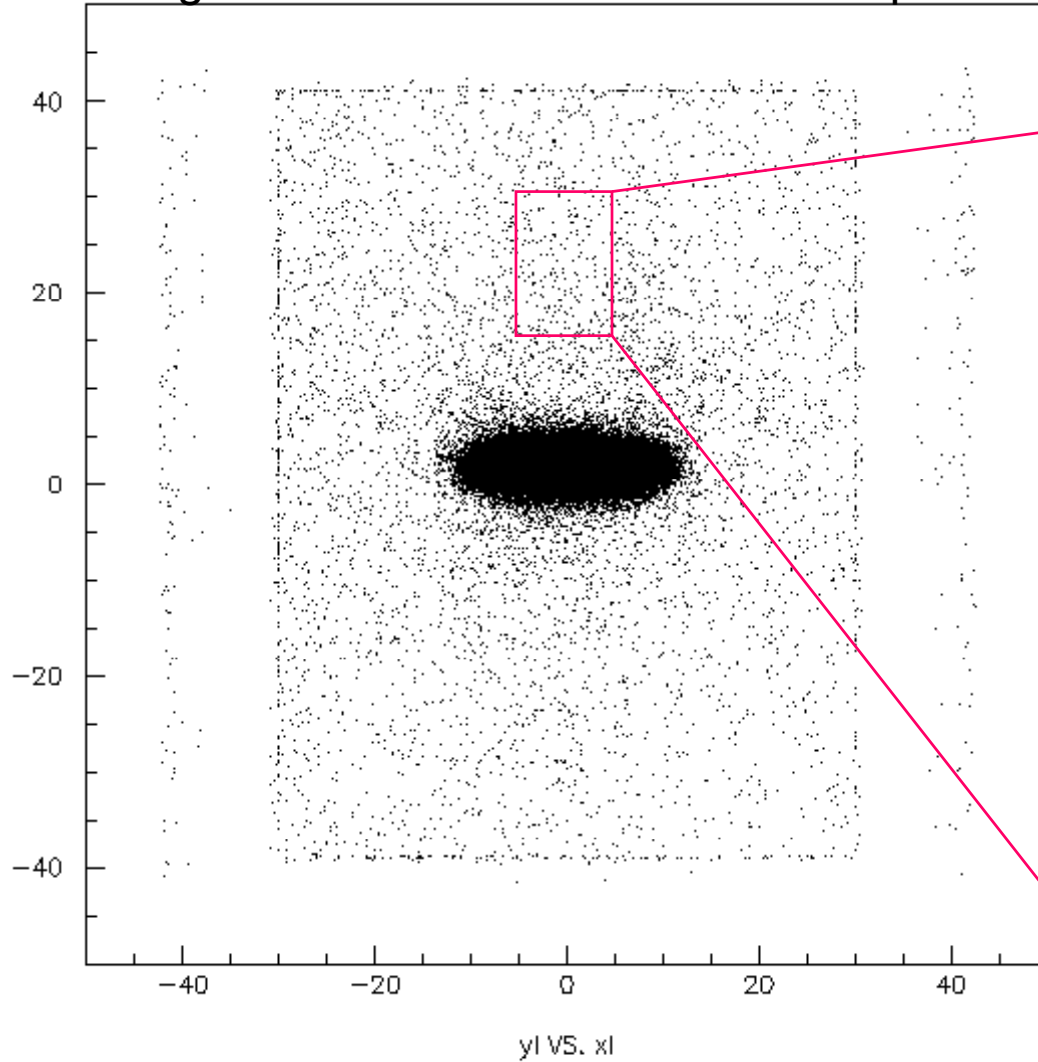


Longitudinal density of the primary beam loss for the ILC low beam power parameter option "cs14" at 250 GeV beam energy. The two red lines show loss on the energy and polarimeter chicane collimators.



Low power option cs14 “tail file” with $E < 162.5$ GeV or $\theta > 0.5$ mrad

Backgrounds from 17.45 million beam particles



Energy (GeV)



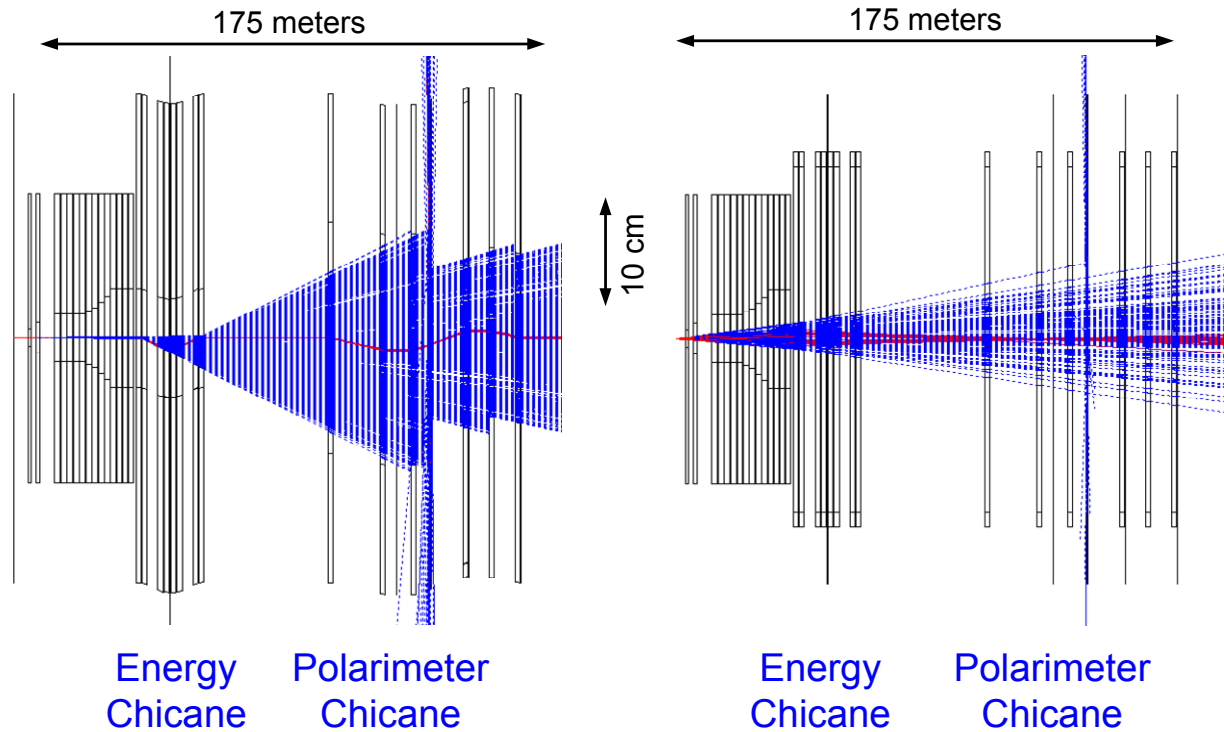
Synchrotron Radiation

20 beam tracks

Modified 14 mrad Extraction Line at 0.5 TeV CMS

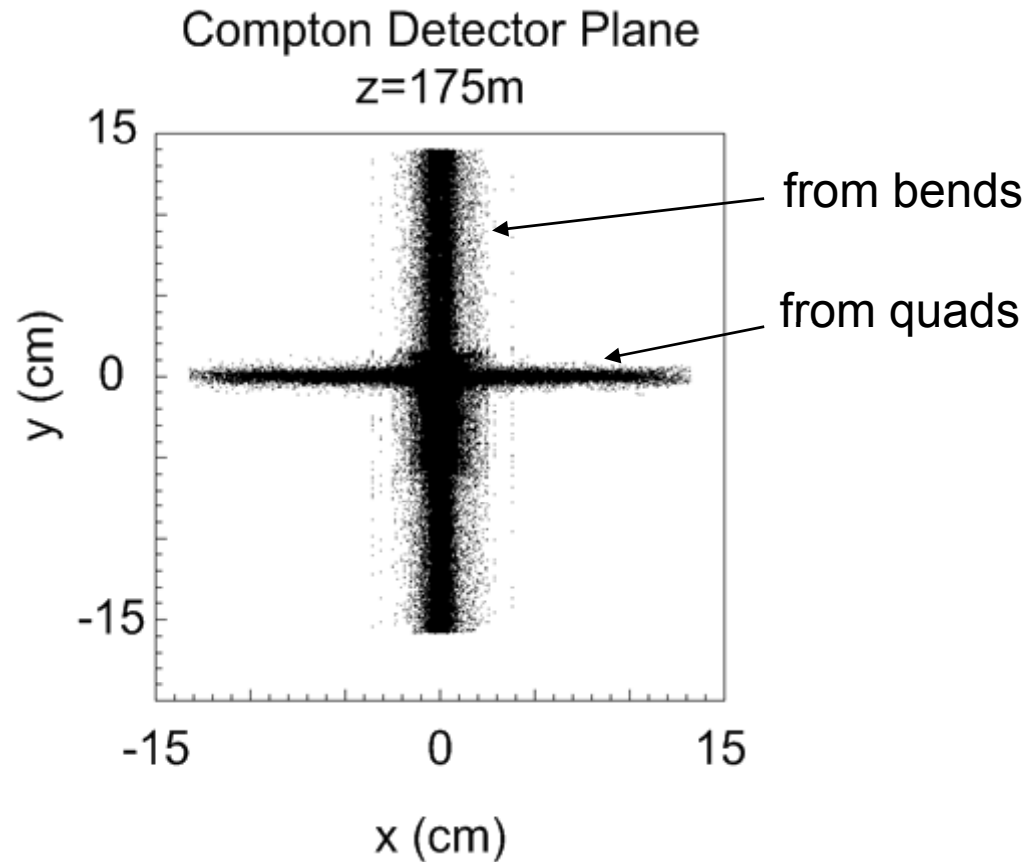
Elevation View

Plan View





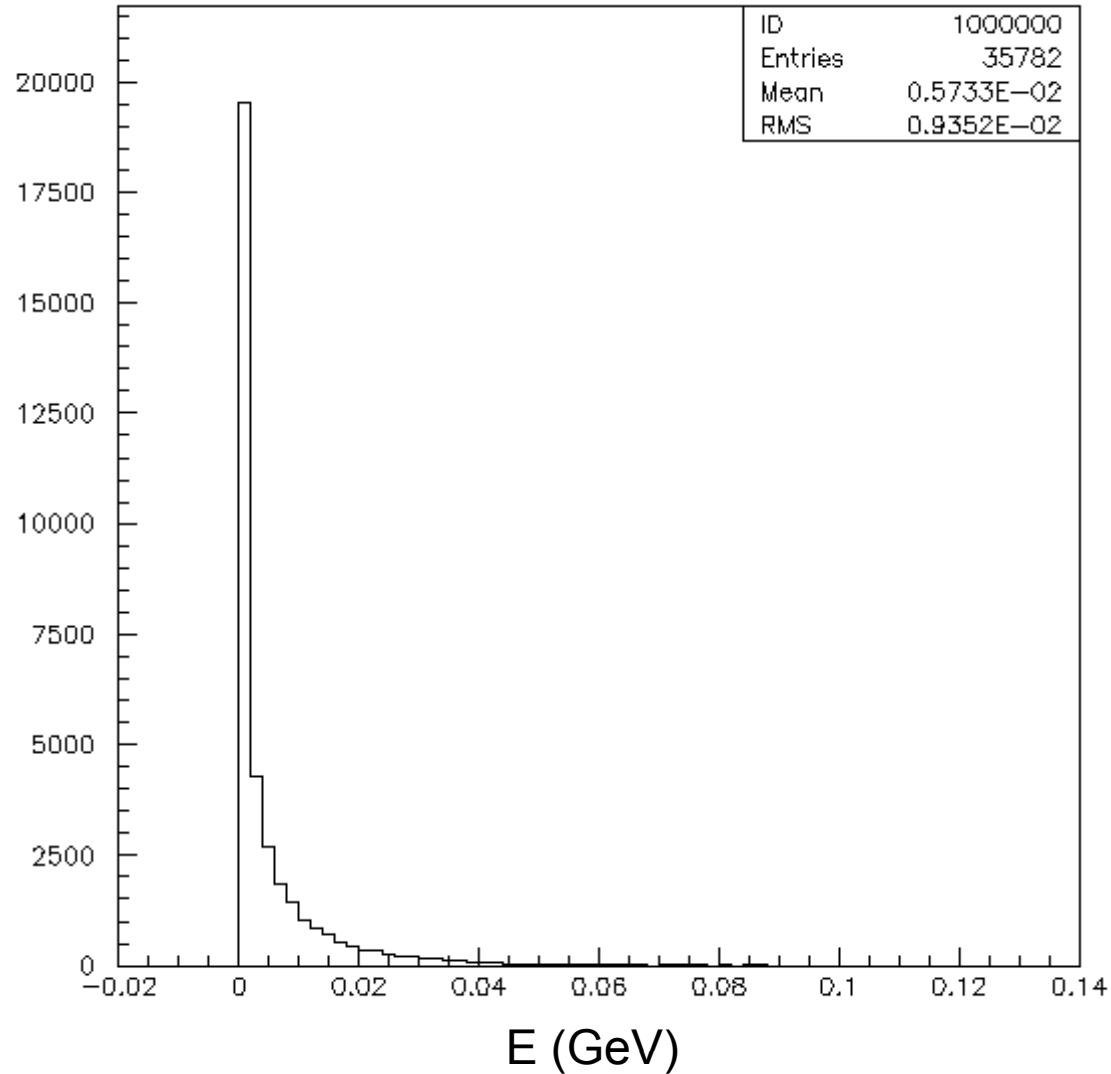
Synchrotron Radiation x,y Distribution at Compton Detector Plane



- The sharp cutoff at 14 cm is the shadow from the special collimator located at $z = 160$ m.
→ There are no synchrotron radiation photons above 14.04 cm.



Energy distribution for synchrotron radiation photons for $y > 10$ cm at the Compton Detector Plane





Conclusions

The proposed modified extraction line with two additional magnets

(+ including modifications in IR quad configuration to accommodate push-pull)

- improves the acceptance of the Compton scattered electrons, allowing detection over a larger part of the Compton electron energy spectra
- 2 additional magnets can be used for GAMCAL
- Beam losses are acceptable and similar to existing extraction line design
- Backgrounds from synchrotron radiation produced upstream of the Cherenkov detector and from lost particles along the beam line are similar to that in the existing extraction line design, and will be small compared to the Compton scattered electron signal.

A next step in our design work is to write a detailed Technote documenting the Compton Polarimeter systems in the RDR, to be done in collaboration with the upstream polarimeter group.