Performance of 14 mrad Extraction Line Polarimeter at 500 GeV and 1 TeV Center-of-Mass Collision Energy

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Polarization Session

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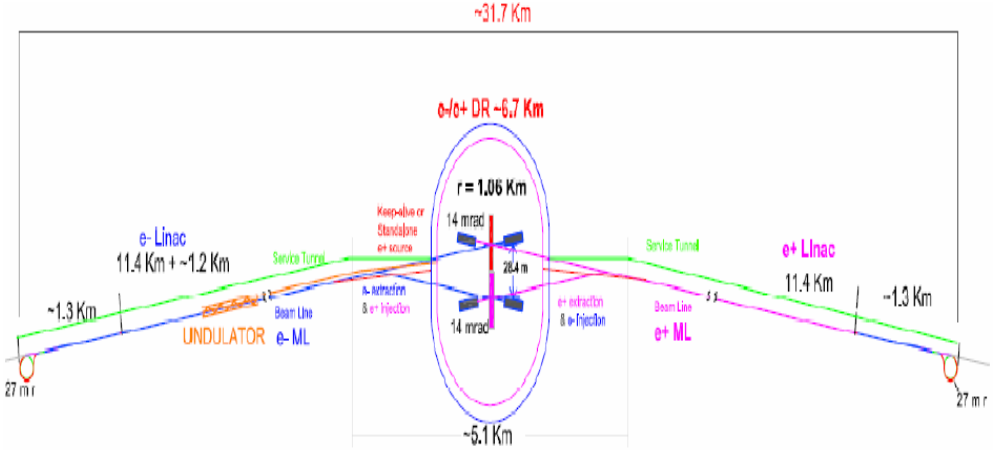
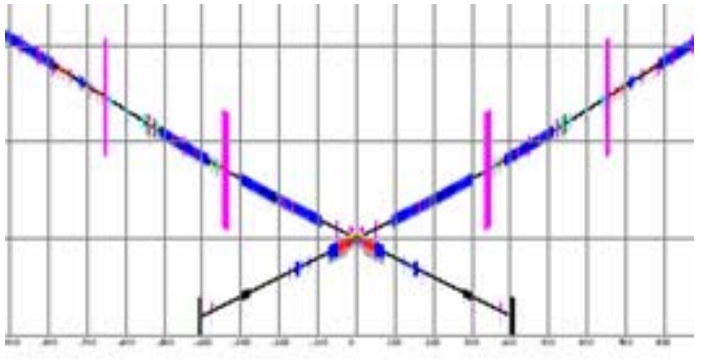
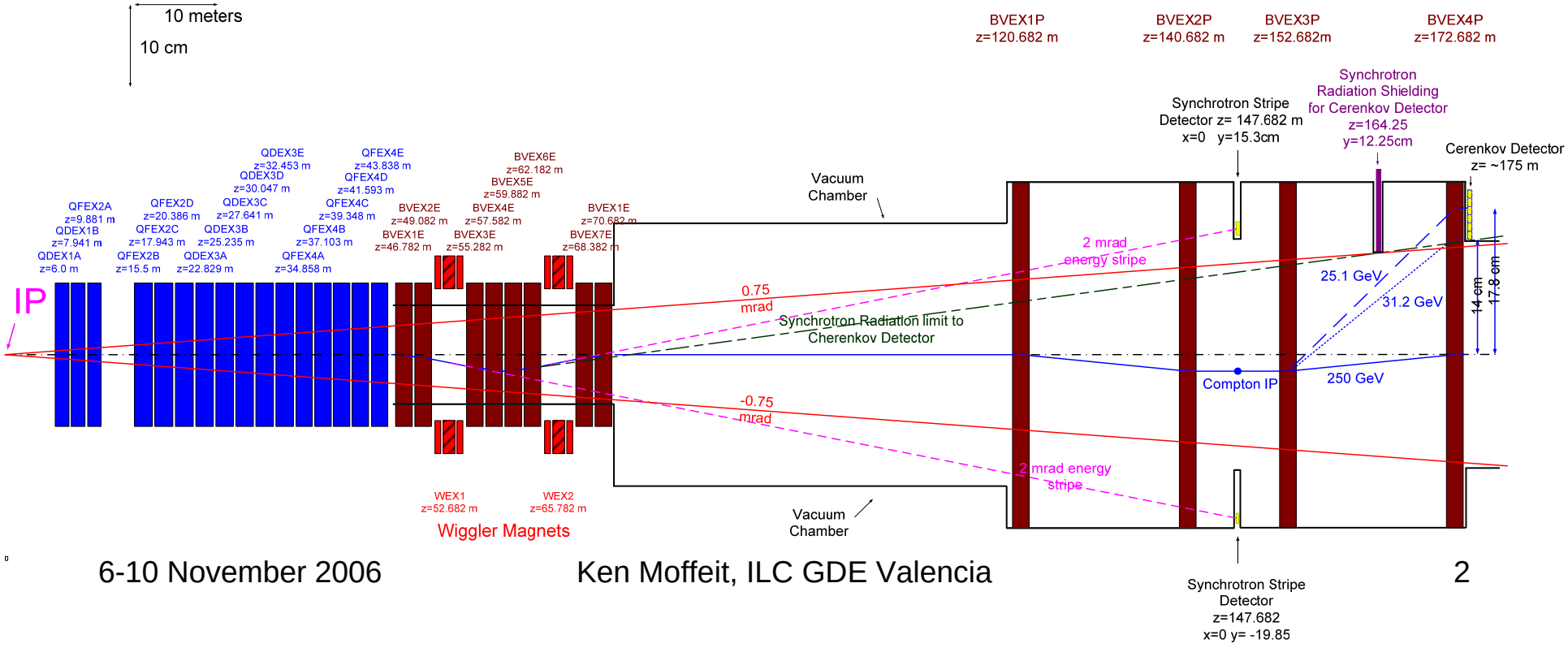
14 mrad Extraction Line



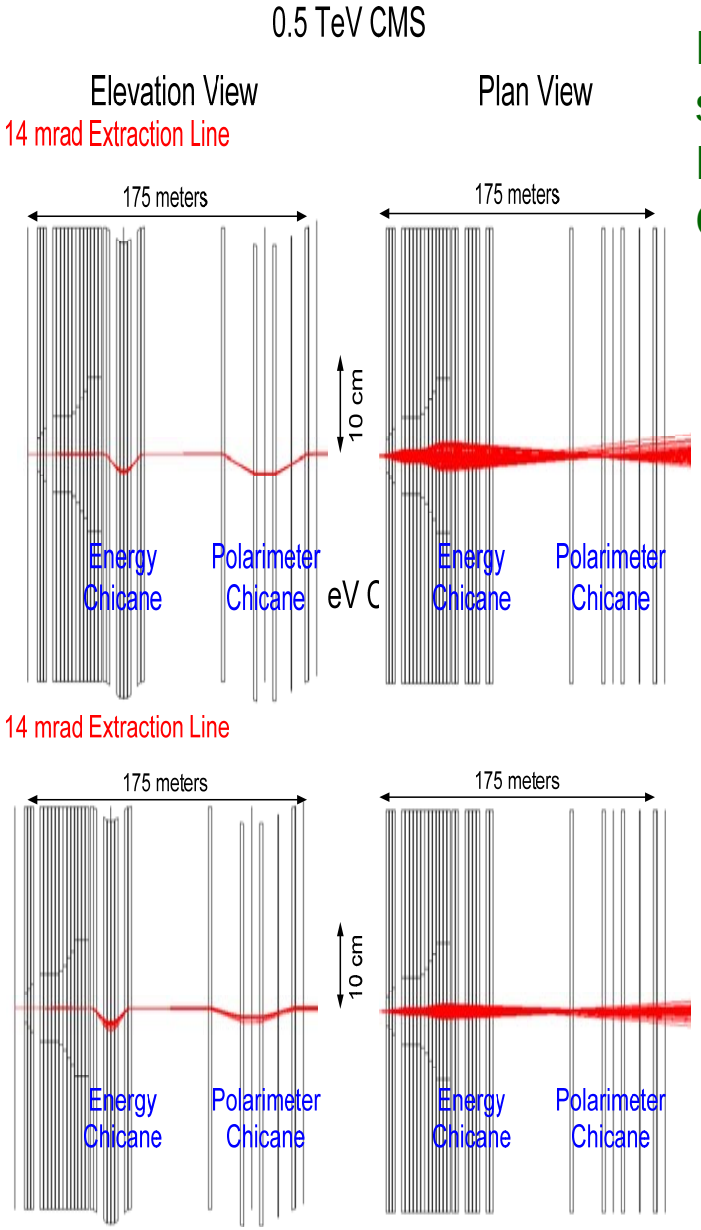
Energy Chicane



Polarimeter Chicane

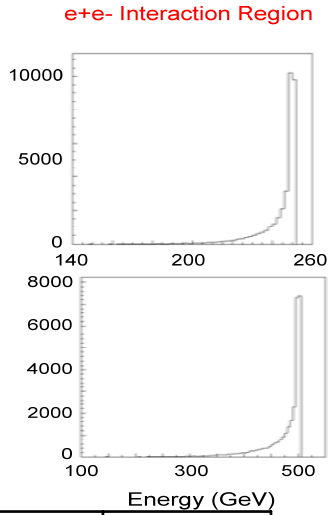


The extraction line transport is simulated using the program GEANT



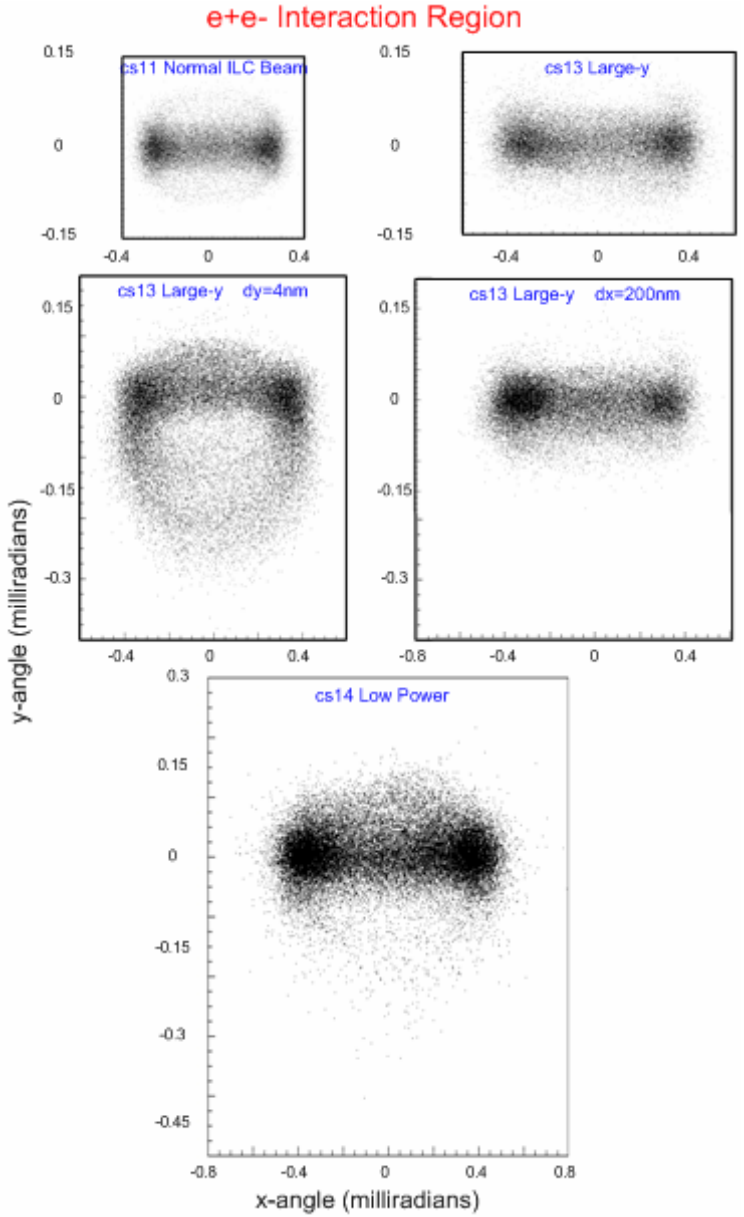
Polarimeter Chicane Magnet powered at same field at all beam energies: Dispersion at Compton IP is 2 cm at 250 GeV and 1 cm at 500 GeV beam energy.

Disrupted beam events were taken from files prepared by Andrei Seryi

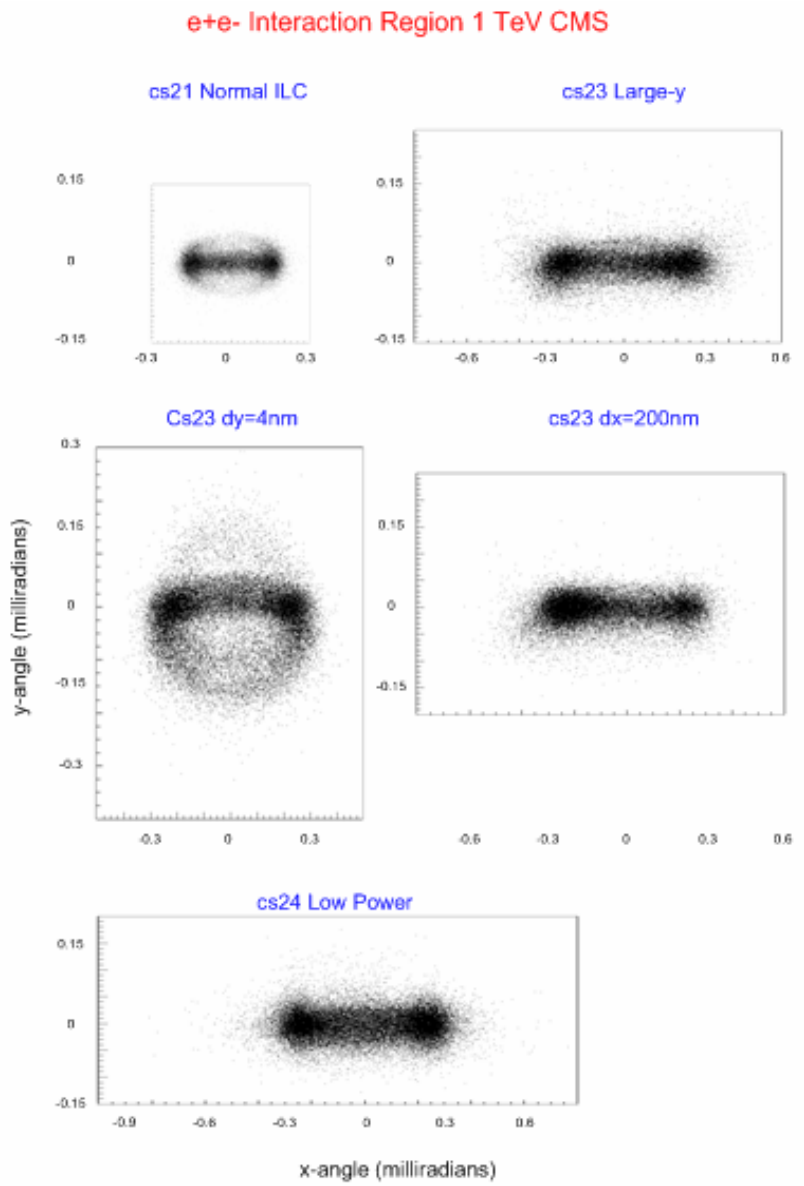


Name	File	σ_x nm	σ_y nm	σ_z nm	E (Mean) (GeV)	E (RMS) (GeV)
Normal ILC	cs11 cs21	554	3.5	300	244.1 475.5	10.98 40.72
Large-y	Cs13 cs23	367	7	600	242.4 463.0	12.0 47.54
Large-y dy=4nm	cs13dy4 Cs23dy4				241.9 461.5	12.48 48.23
Large-y dx=200nm	cs13dx200 cs23dx200				242.7 464.4	11.81 46.38
Low Power	cs14 cs24	350	2.7	200	234.6 439.6	22.1 73.94

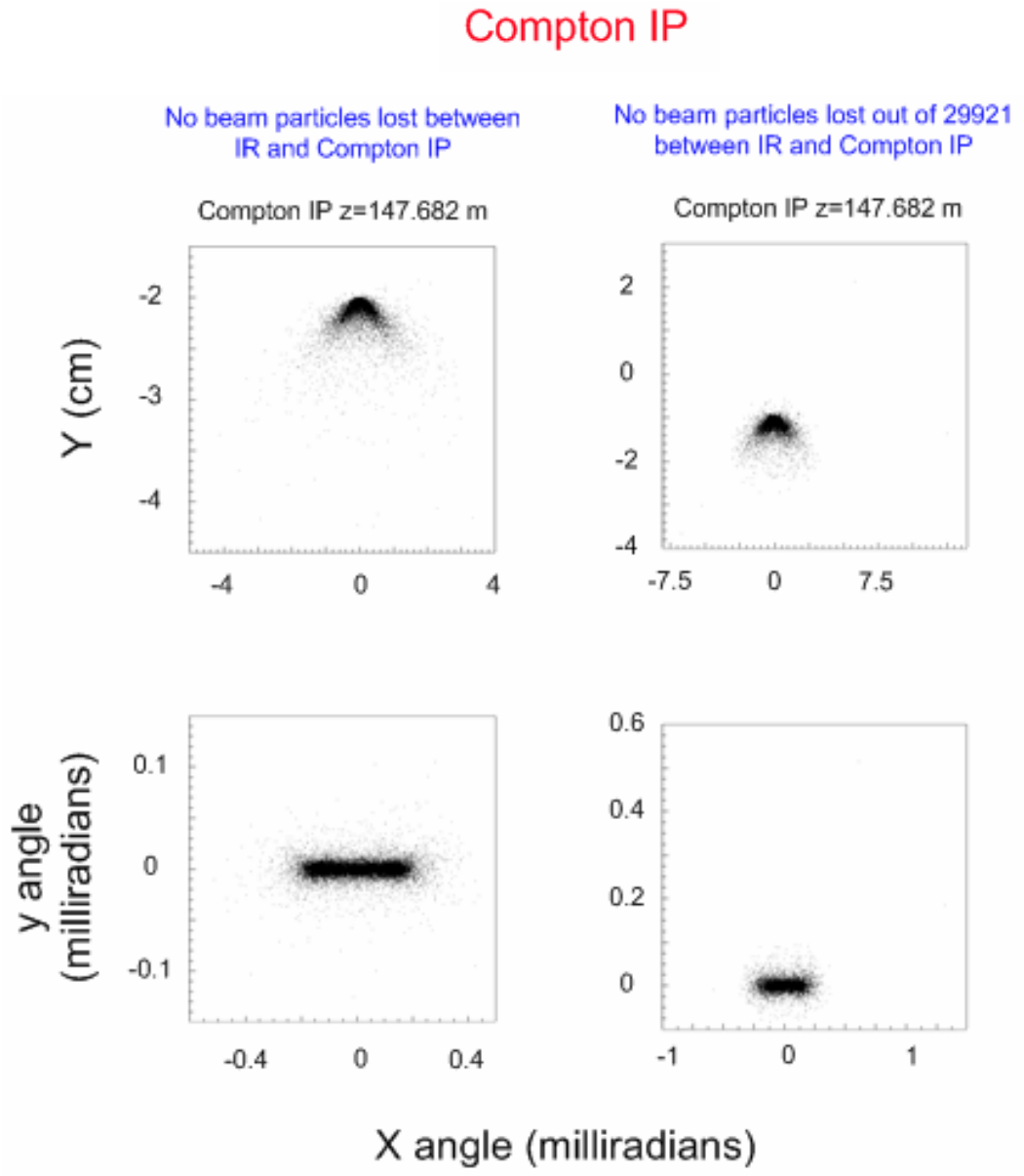
0.5 TeV CMS



1 TeV CMS



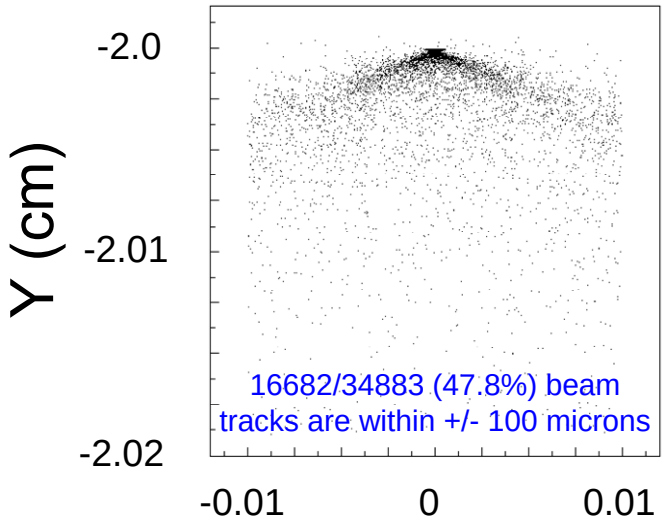
Normal ILC Beam 0.5 TeV CMS 1 TeV CMS



Beam within +-100 microns of the peak

0.5 TeV CMS

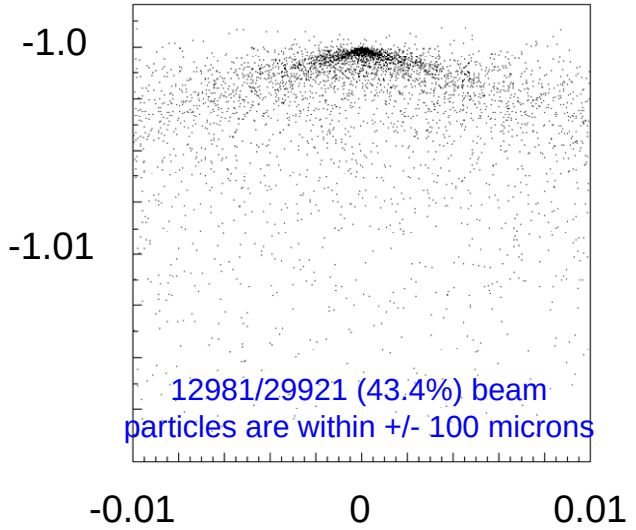
Compton IP z=147.682 m
-2.019<y<-1.999 cm
abs(x)<0.01cm



Dispersion =2 cm

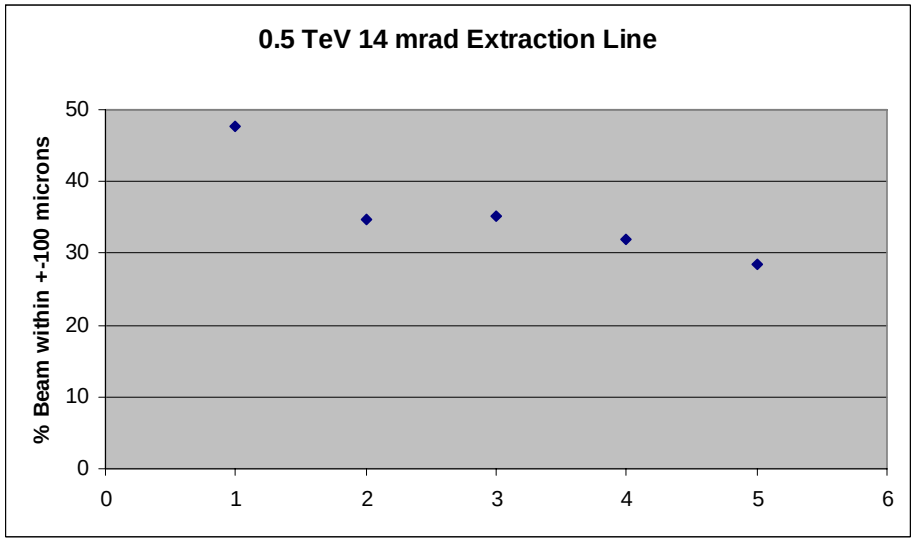
1 TeV CMS

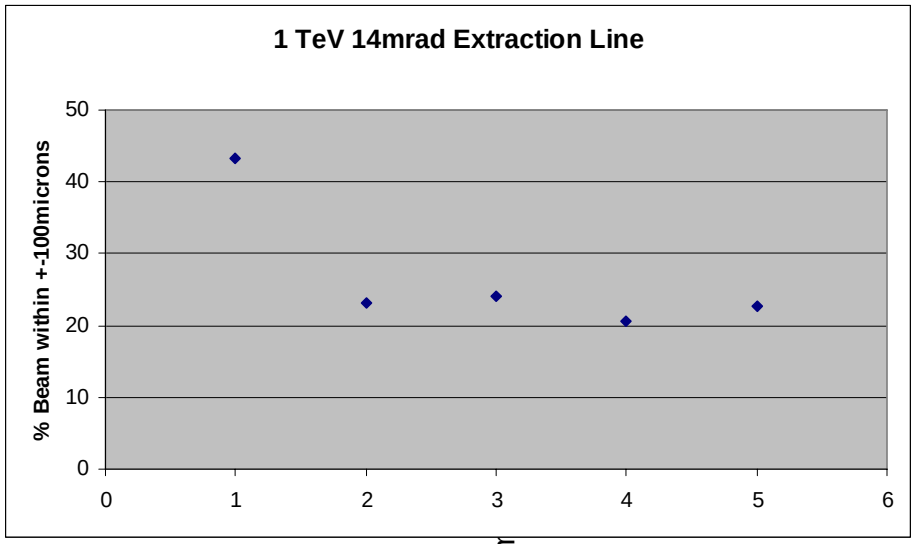
Compton IP z=147.682 m
-1.019<y<-0.999 cm
abs(x)<0.01cm



Dispersion =1 cm

X (cm)





Normal ILC Beam

Large-y

Large-y dx200nm

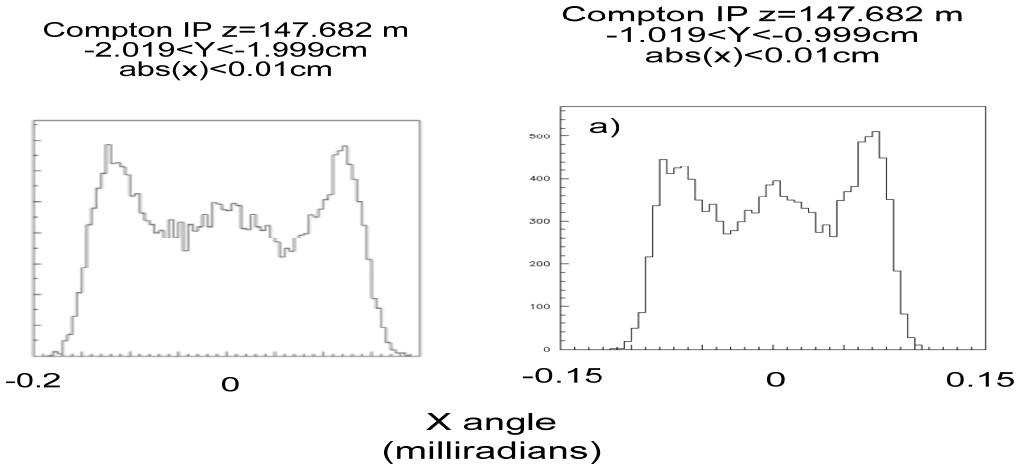
Large-y dy4nm

Low Power

$$P = \cos(\theta_{spin}) = \cos\left(\gamma \frac{g-2}{2} \cdot \theta_{bend}\right) = \cos\left(\frac{E(GeV)}{0.44065} \cdot \theta_{bend}\right)$$

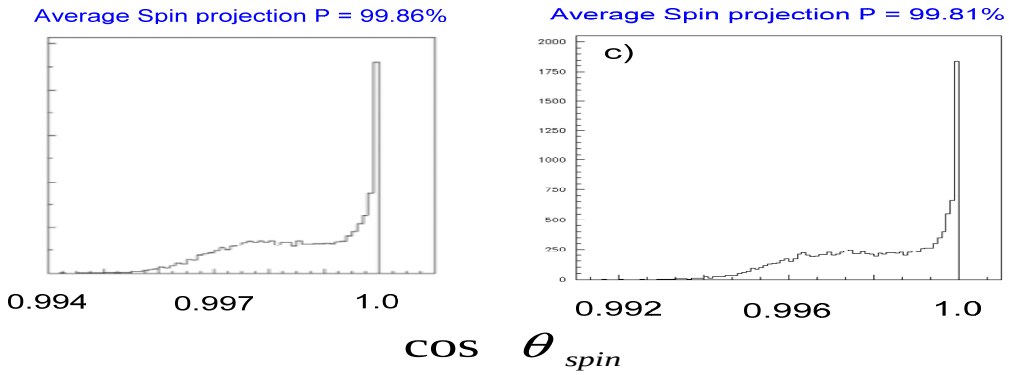
50 μrad bend gives 56.7 mrad change in spin direction and P= 99.84% at 500GeV

0.5 TeV CMS



1 TeV CMS

P=99.86%

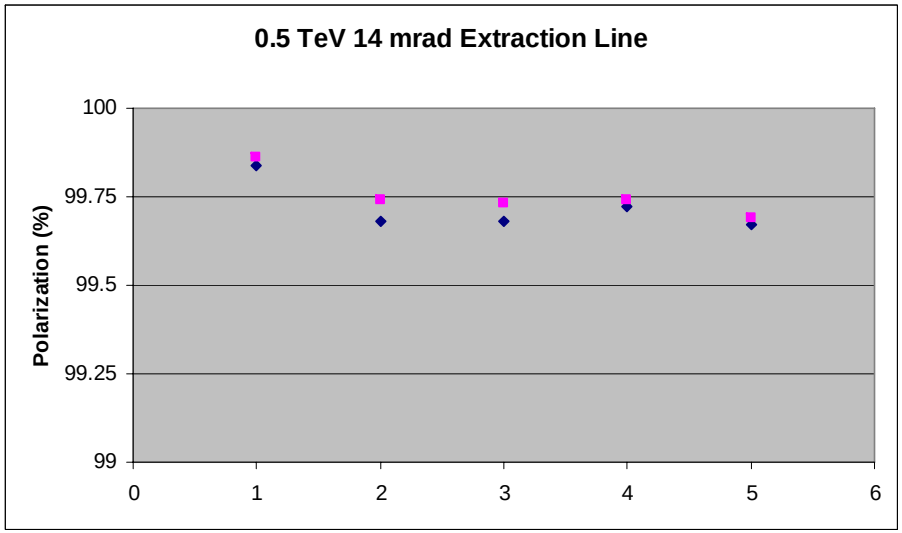


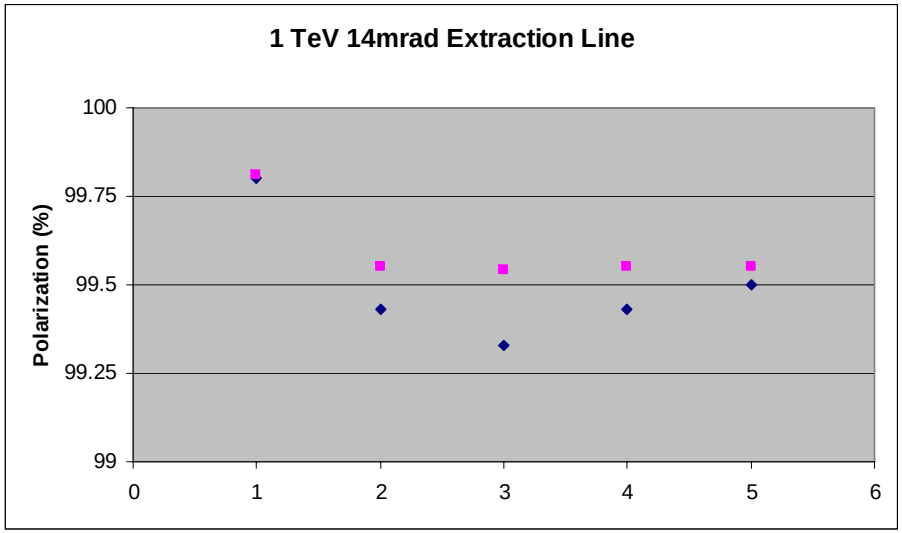
P=99.81%

$$P_{Luminosity Weighted} = Cos(\theta_{SpinLuminosity Weighted}) = Cos\left(\frac{E(GeV)}{0.44065} \cdot \frac{1}{2}\theta^{IR}_{x-angle}\right)$$

$P_{Luminosity Weighted} = 99.84\%$

$P_{Luminosity Weighted} = 99.80\%$





Luminosity Weighted Polarization at IR

Polarization Projection at Compton IP

0.25%

Normal ILC Beam

Large-y

Large-y dx200nm

Large-y dy4nm

Low Power

Beam Losses from the e+e- IR to the Compton Detector Plane

0.5 TeV CMS

Condition (file name)	Losses	# Beam	Lost Beam
Normal ILC Beam Condition (cs11) cs11 tail1 < 0.65E0 or angle > 500mrad	0 0	34883 $1.8*10^{6}$	$<0.5*10^{-4}$ $<10^{-7}$
Large y (cs13)	0	34907	$<0.5*10^{-4}$
Large y horizontal offset 200nm (cs13_dx200)	0	34898	$<0.5*10^{-4}$
Large y vertical offset 4nm (cs13_dy4)	0	34923	$<0.5*10^{-4}$
Low Power (cs14)	4	34913	$1.1*10^{-4}$

1 TeV CMS

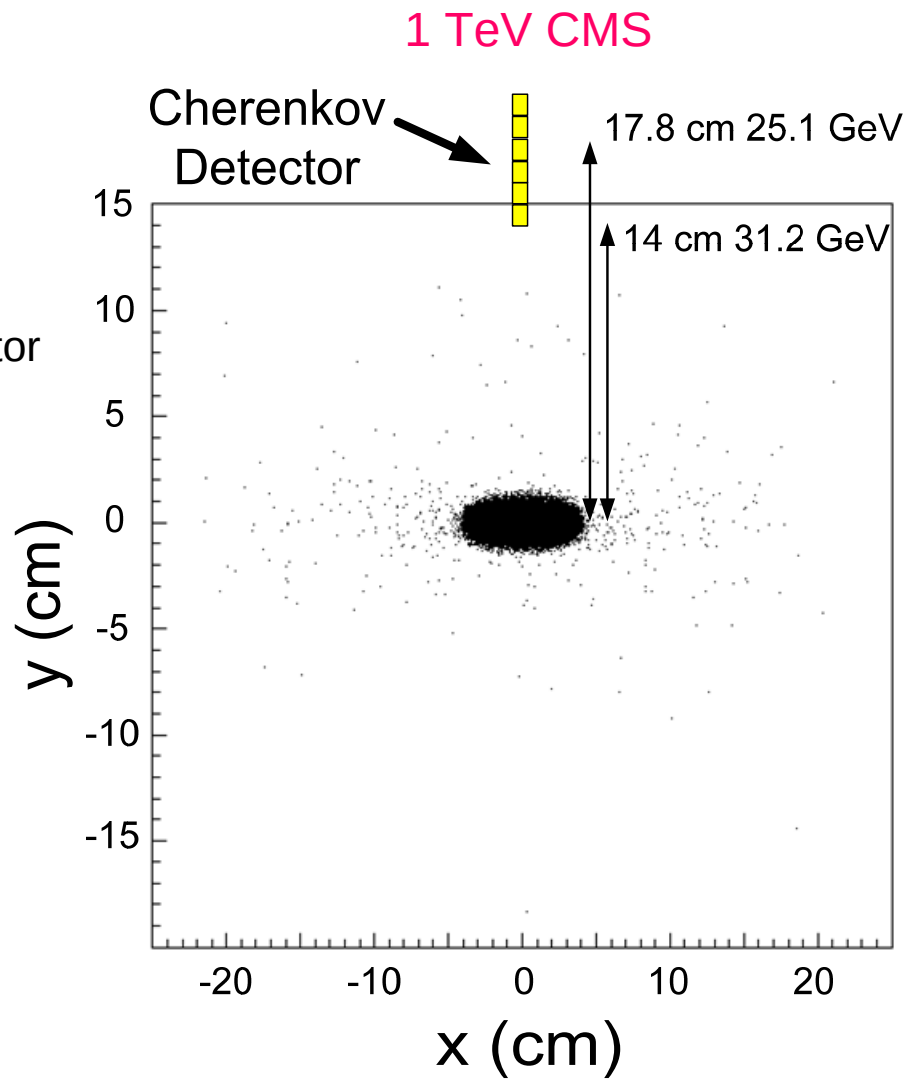
Condition (file name)	Losses	Beam	Lost Beam
Nominal Beam Condition (cs21) cs21 tail1 < 0.65E0 or angle > 500mrad	0 57	29921 $3.2*10^{6}$	$<0.6*10^{-4}$ $1.8*10^{-5}$
Large y (cs23)	3	29916	$1.0*10^{-4}$
Large y horizontal offset 200nm (cs23_dx200)	2	29918	$0.7*10^{-4}$
Large y vertical offset 4nm (cs23_dy4)	3	29928	$1.0*10^{-4}$
Low Power (cs24)	186	34905	0.53 %

Beam Loss Background at Compton Detector Plane

Beam Loss at 0.5TeV is $<10^{-7}$

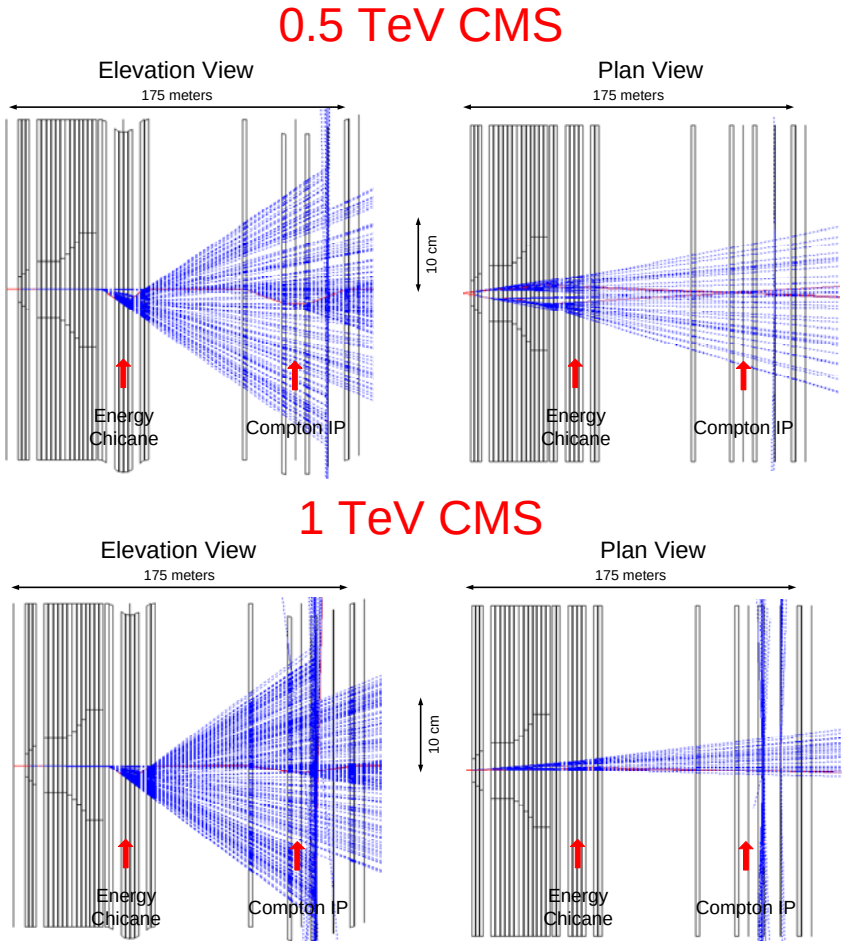
Beam Loss at 1TeV is $1.8*10^{-5}$

No background in region of Cerenkov Detector
($< 50/cm^2$ per $2*10^{10}$ beam particles)



Compton Signal ~650 backscattered electrons per GeV or >1000 per 1cm cell

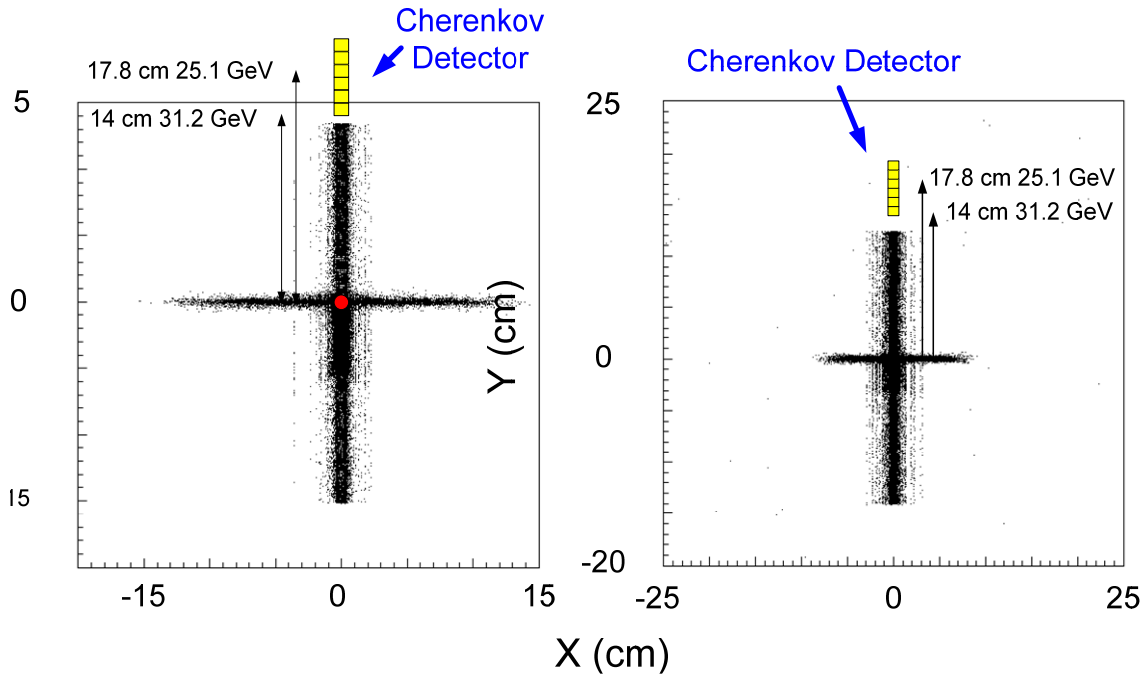
Synchrotron Radiation



Synchrotron radiation at Compton Detector Plane z=~175m

0.5 TeV CMS

1 TeV CMS



Estimate at 1TeV: $<2*10^4/cm^2$ per $2*10^{10}$ beam particle with E>15MeV in the region of the Cherenkov detector

Important: careful design of collimators and shielding of Cherenkov detector

Conclusions

14 mrad extraction line

0.5 TeV CMS

•Core of beam within +-100microns has 48% of the beam.

•The polarization projection at the Compton IP is in good agreement with the luminosity weighted polarization at the e+e- interaction region. A precision measurement of +-0.25% will be possible.

•No beam losses from e+e- IR to Compton detector plane out of 17.6 million beam tracks for Normal ILC and Large-y beam parameter data sets. The Low Power beam parameter data set has losses of $1.1 * 10^{-4}$.

•The collimator at z=164.25 meters needs to be designed. It absorbs the synchrotron radiation above the 0.75 mrad beam stay clear allowing the Cherenkov detector to begin at y~14 cm. Background from scattered synchrotron radiation occurs at the Cherenkov detector and will require careful design of the collimation and shielding.

•Performance of Polarimeter Meets Goals

14 mrad extraction line

1 TeV CMS

•Core of beam within +-100microns has 43% of the beam. The large-y and low power parameter data sets have a lower Compton luminosity by a factor 2.

•The polarization projection at the Compton IP is in good agreement with the luminosity weighted polarization at the e+e- interaction region. A precision measurement of +-0.25% will be possible.

•Beam losses of $1.8*10^{-5}$ occur between the e+e- IR and the Compton detector plane for the Normal ILC beam parameter data set. Beam losses are also small but not negligible for the Large-y beam parameter data set. There are large losses of 0.53% of the beam for the Low Power beam parameter data set that will require insertion of a new collimator between the e+e- IR and the Compton detector plane or an increase in the beam stay clear from 0.75 mrad.

•The collimator at z=164.25 meters absorbs the synchrotron radiation above the 0.75 mrad beam stay clear allowing the Cherenkov detector to begin at y~14 cm. Background from scattered synchrotron radiation is very large at the Cherenkov detector and will require careful design of the collimation and shielding.

•Performance of Polarimeter Meets Goals
•Background from scattered synchrotron radiation photons at the Cherenkov Detector
•Concern about large beam losses for Low Power beam parameters