Present design of ILC BDS

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2024/ 7/ 10
LCWS2024
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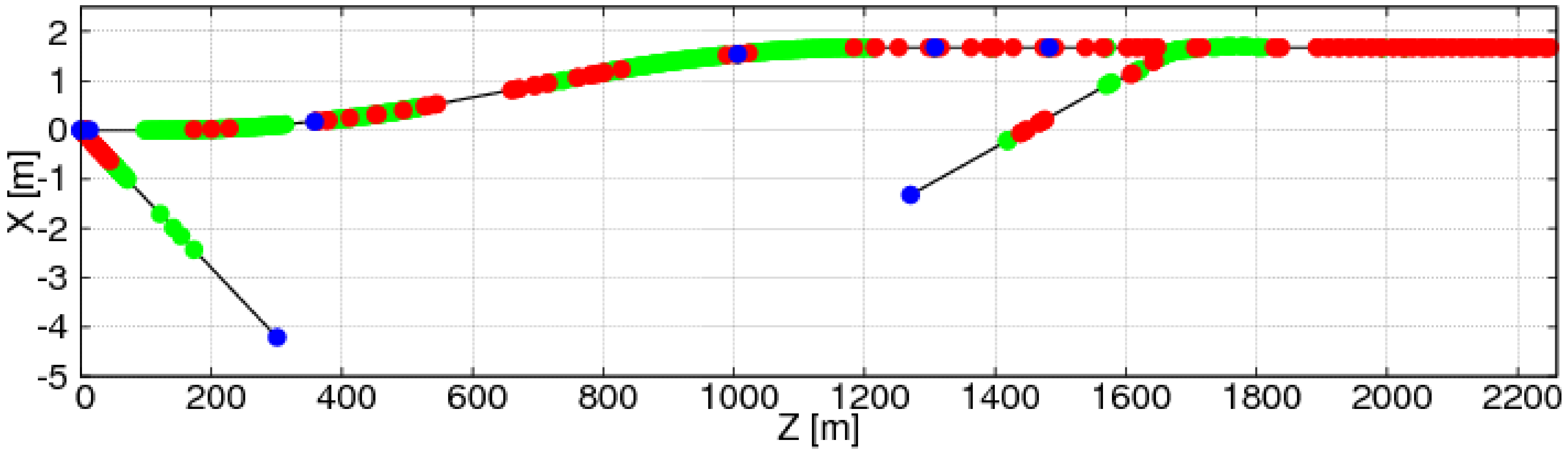
Present ILC BDS Beamline

In the present ILC design,

BDS beamline was designed ***from ECM=250GeV to ECM=1TeV with same geometry****.*

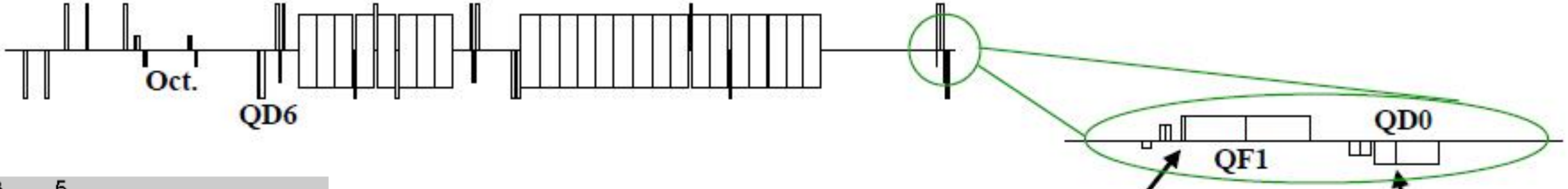
The several magnets will be added for ECM=1TeV operation.

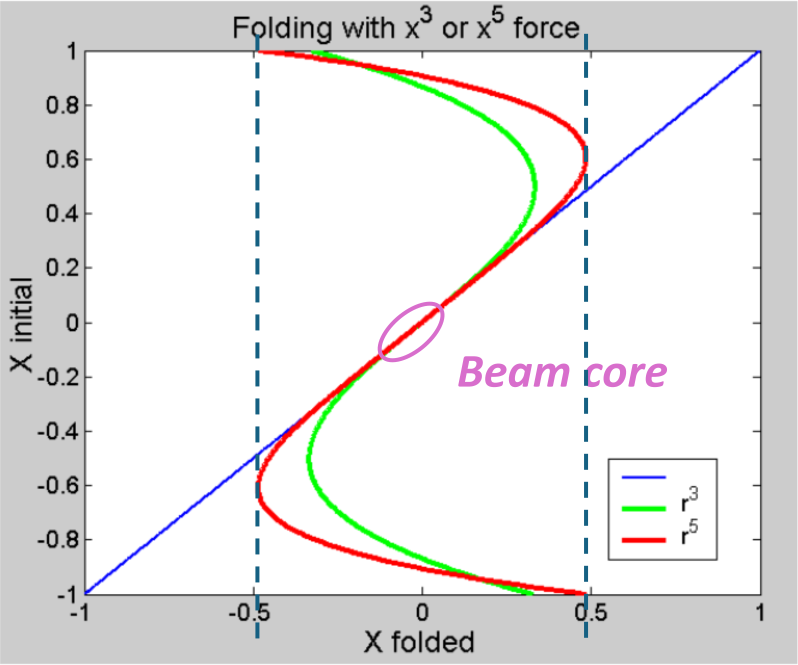


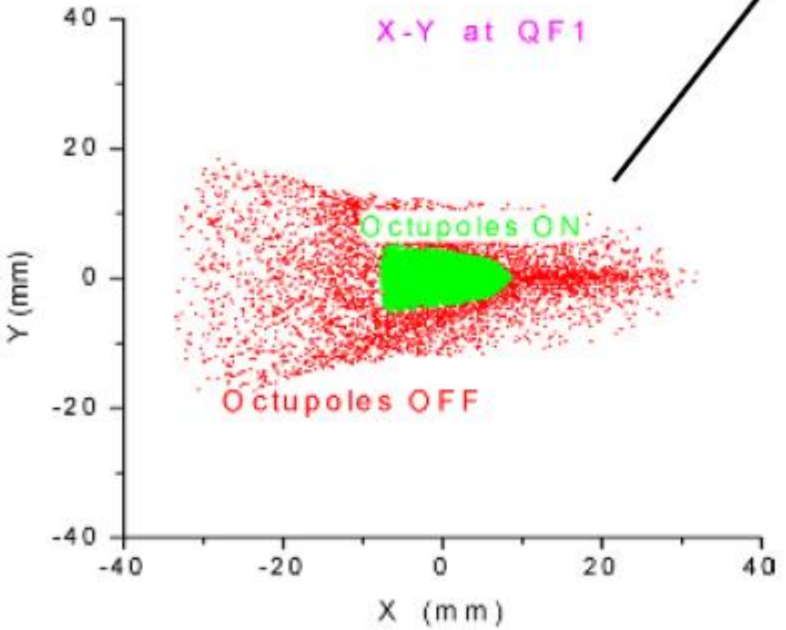
Octupoles for ILC final focus beamline

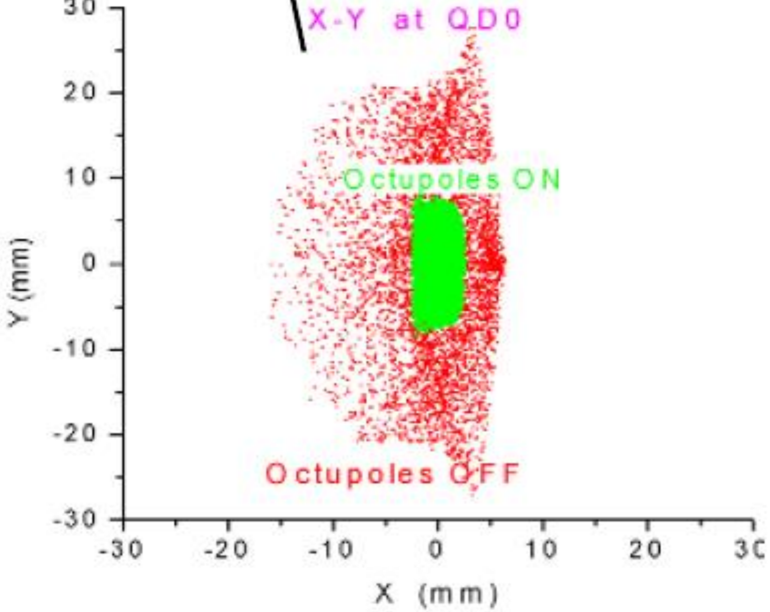
Octupole field was not used for the beam core handling for ILC final focus

Quadrupole : Linear optics
Sextupole : 2nd order optics
Octupole : Tail folding









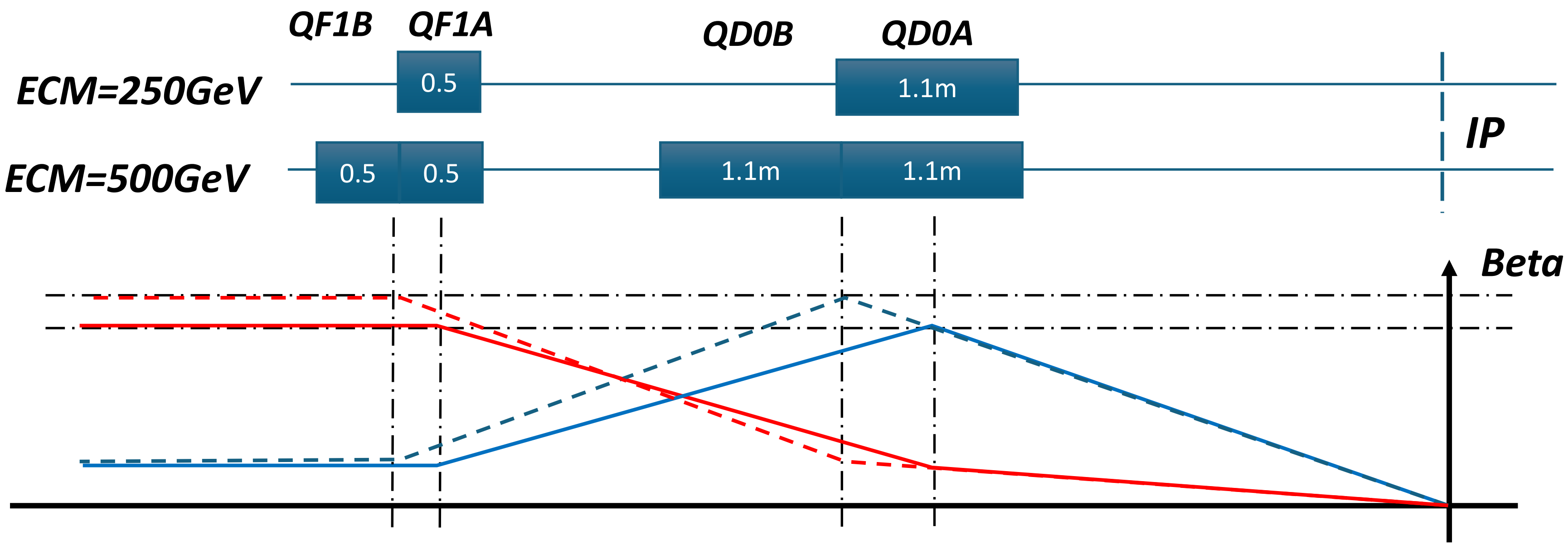
focus beam tails
but not to change the core of the beam

Low Energy Operation (E_{CM}=250GeV)

The field strength for ECM=250GeV is a half to ECM=500GeV.

When we only use a half of FD magnets,
the beta functions at FD magnets are decreased.

Therefore, the collimation depth can be increased.



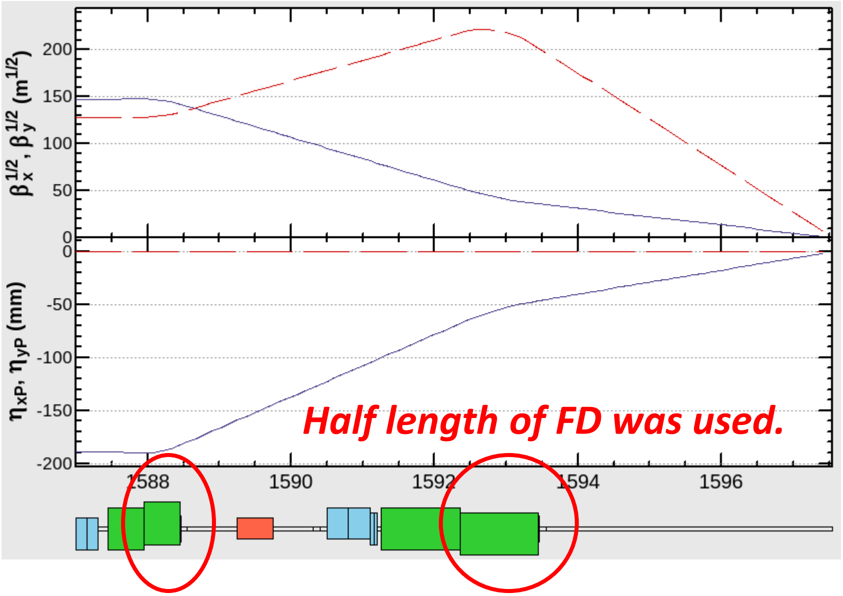
Procedure of optics optimization

Since the optics for ECM=250GeV was used ***half of FD magnets,***
the magnet arrangement for ECM=250GeV was different to others.

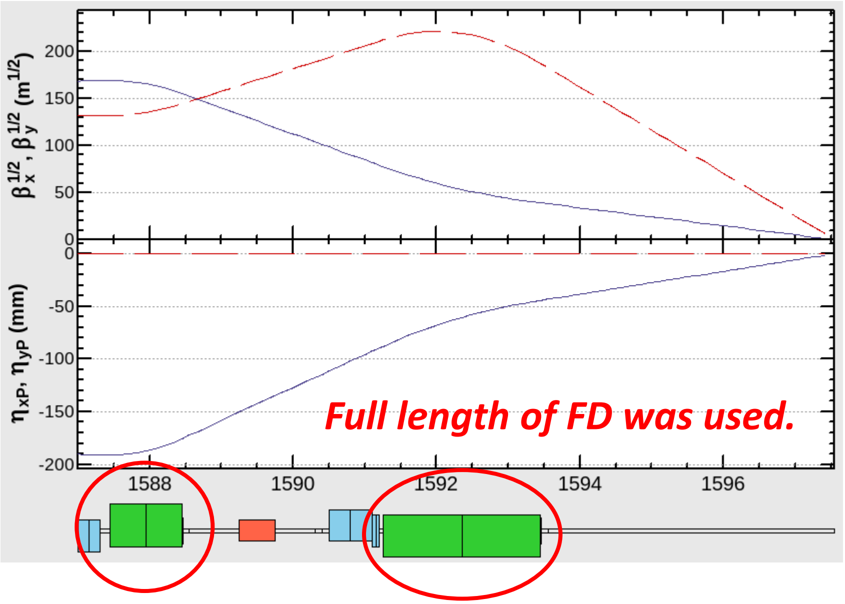
The magnet arrangement was optimized to ECM=250GeV at first,
because the nonlinear effects for ECM=250GeV is stronger than higher energy.

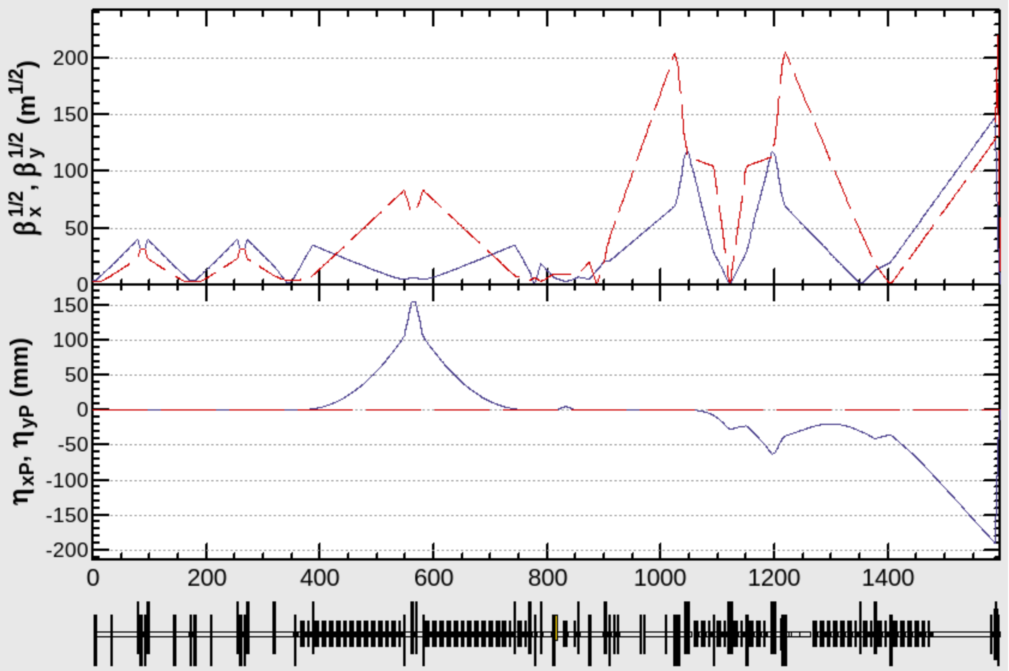
Then, ECM=500GeV optics was designed
with constraint of the arranged magnet to ECM=250GeV*.*

ECM=250GeV



ECM=500GeV

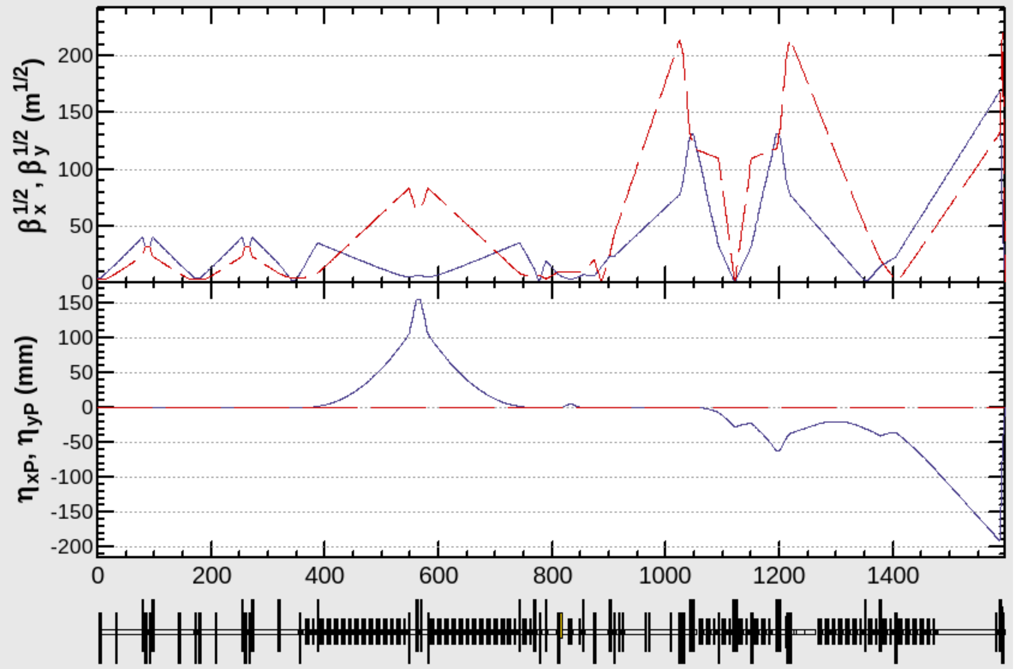




Beam Optics for ***ECM=250GeV***
The half length of FD magnets were used.

betaX* = 13 mm
betaY* = 0.41mm

The ***magnet arrangement and strengths***
(balances of beta and dispersion at sextupoles)
was optimized for this condition.



Beam Optics for ***ECM=500GeV***
The full length of FD magnets were used.

betaX* = 11 mm
betaY* = 0.48mm

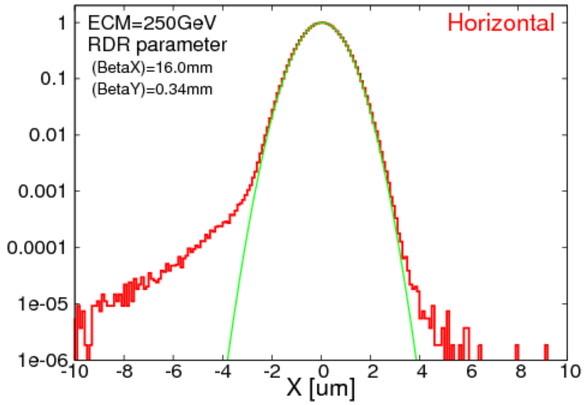
The magnet arrangement
was same to ECM=250GeV.

The ***strengths*** *were changed to optimize.*

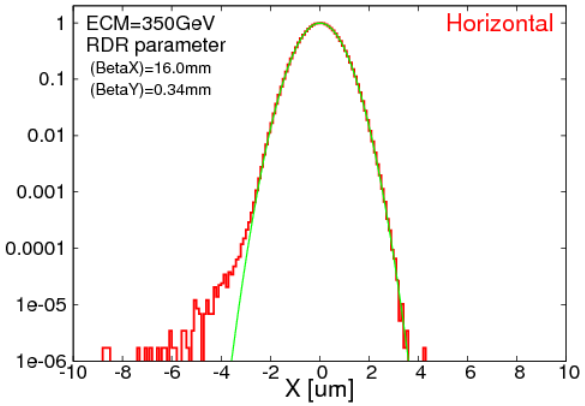
IP beam profile

IP Horizontal Profile

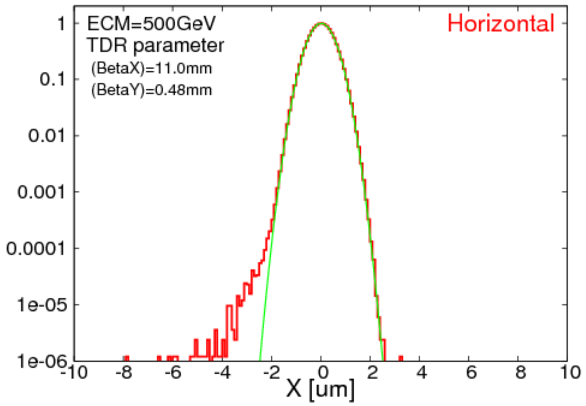
ECM=250GeV



ECM=350GeV

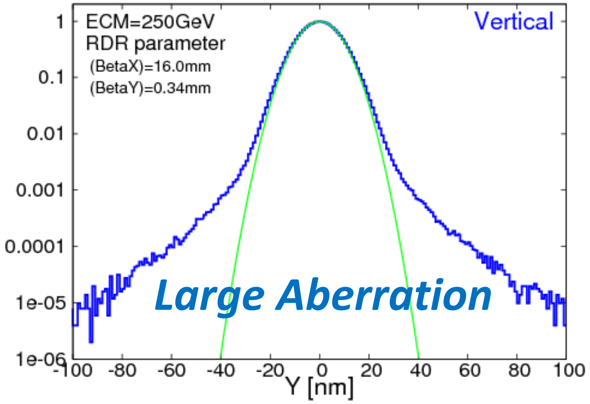


ECM=500GeV

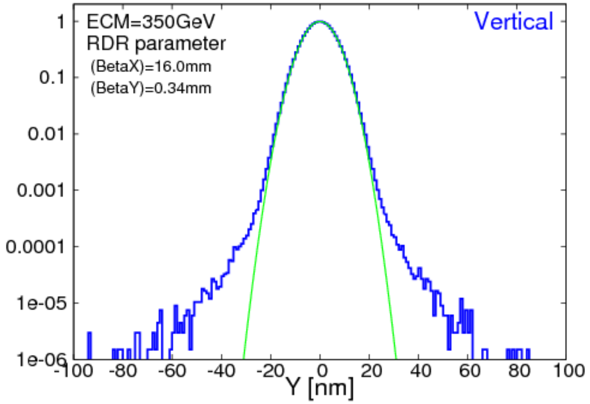


IP Vertical Profile

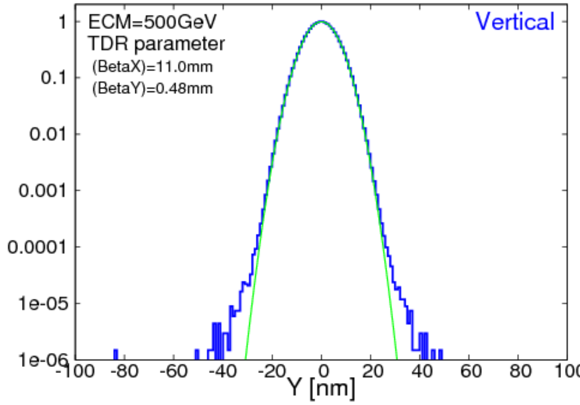
ECM=250GeV



ECM=350GeV



ECM=500GeV



The multipole effect for ECM=250GeV is huge compared to other parameters.

Since the horizontal profile was asymmetric, we could not correct with octupoles.

IP beam size of various beam energy

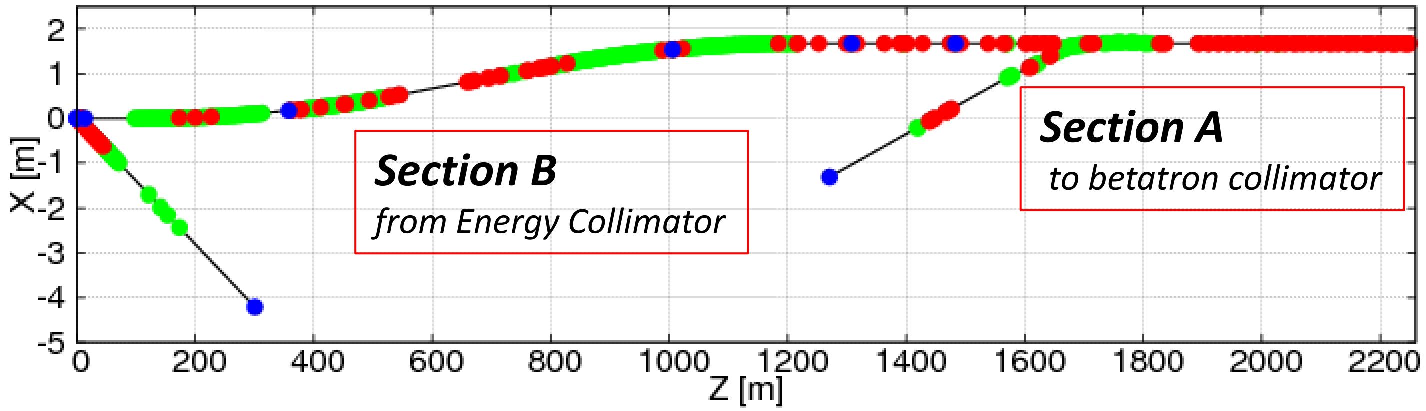
		ECM=250GeV	ECM=350GeV	ECM=500GeV
Horizontal beam size	**design**	0.729 um	0.684 um	0.474 um
	core	0.749 um	0.685 um	0.478 um
	rms	0.756 um	0.705 um	0.489 um
Vertical beam size	**design**	7.66 nm	5.89 nm	5.86 nm
	core	7.84 nm	5.99 nm	5.90 nm
	rms	8.03 nm	6.08 nm	5.93 nm
Relative Luminosity (L/L0)		95.1 %	98.2 %	98.6%

- *The multipole effects for ECM=250GeV was larger than others, and the final luminosity for ECM=250GeV is also smaller than others*
- *The beam size simulation was not included the effect of Synchrotron radiation..*

BDS optics for ECM=1TeV operation

- *ECM= 500GeV optics can be increased the beam energy up to 300GeV (ECM=600GeV)*
- *The beam optics can be increased to ECM=1TeV by using same geometry.*

  - The most of magnets for ECM=500GeV can reuse to 1TeV optics.
  - Some new magnets should be installed to extend to ECM=1TeV.



The number of components both for ECM=500GeV and ECM=1TeV

(not include the dumpline)

	Energy [GeV]	# of BEND	# of QUAD	# of SEXT	# of Steer	# of PS	# of Mover	# of BPM
Section A	500	16	64	0	19	73	70	78
	1000	43	108	0	19	115	108	116
Section B	500	63	33	7	55	46	40	101
	1000	176	41	7	55	56	48	112

Since the ILC BDS is designed the same beamline for very wide energy range, ***the performance for low energy and high energy optics is not good.***

Performance improvement for low energy operation

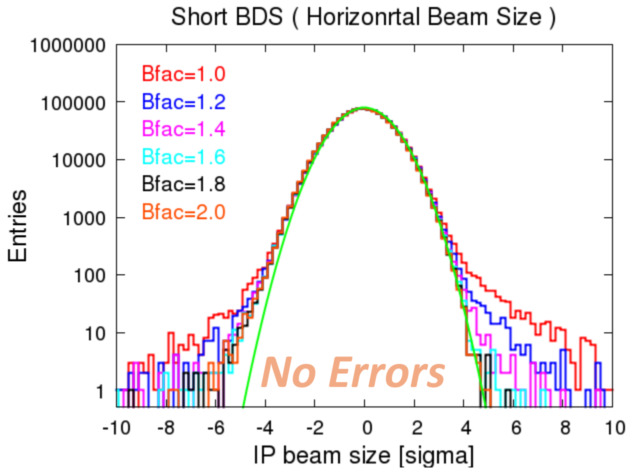
- *The performance of the FF beamline with* ***"strong bending magnet"*** *is better for low energy operation* ***to make sextupole fields weaker.***
- *It is better to optimize the BDS optics to the low energy range especially for the 1st stage.*

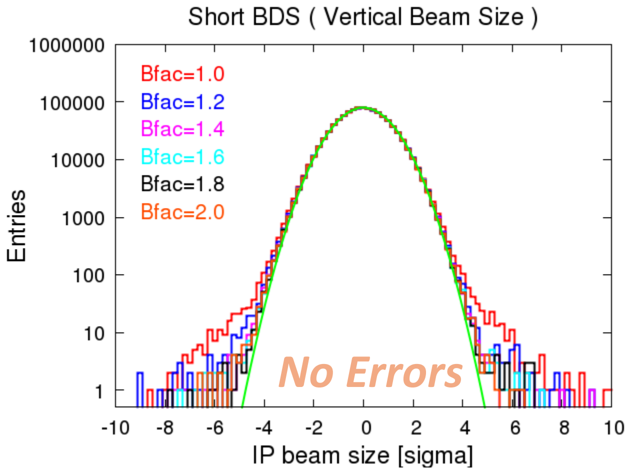
Performance improvement for high energy operation

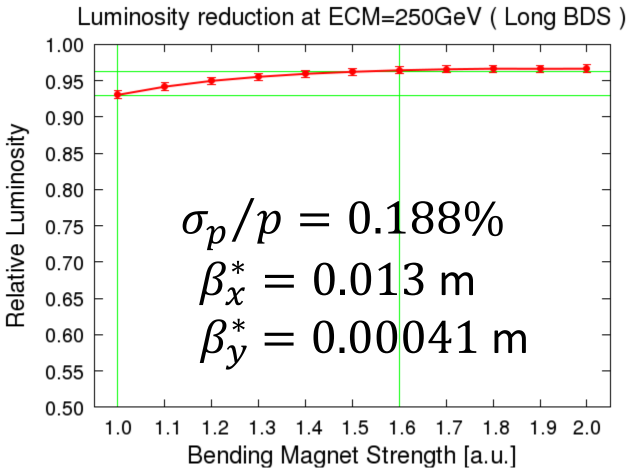
- *The performance of the FF beamline with* ***"weak bending magnet"*** *is better for high energy operation* ***to reduce the effect of Synchrotron radiation.***

Performance for ECM=250GeV with strong BEND

The stronger sextupoles makes the FF dispersion stronger.
Then, the geometrical dispersion will be reduced.



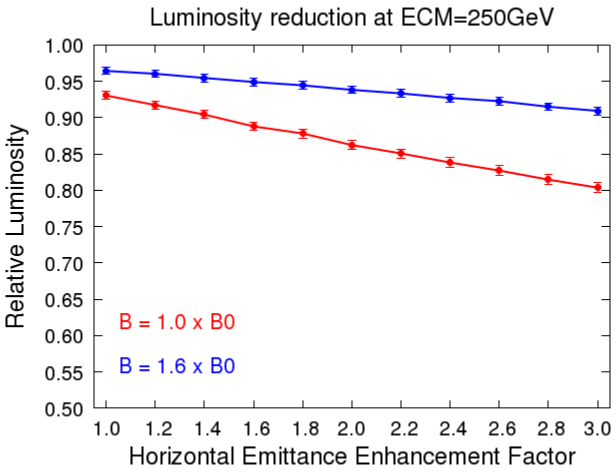




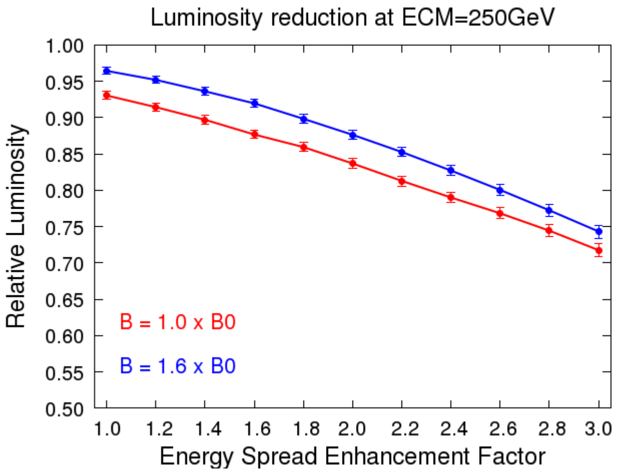
$\sigma_p/p = 0.188\%$
$\beta_x^* = 0.013$ m
$\beta_y^* = 0.00041$ m

When we set to the bending magnet strength to be 1.6 times larger than design.

Horizontal emittance is larger than design

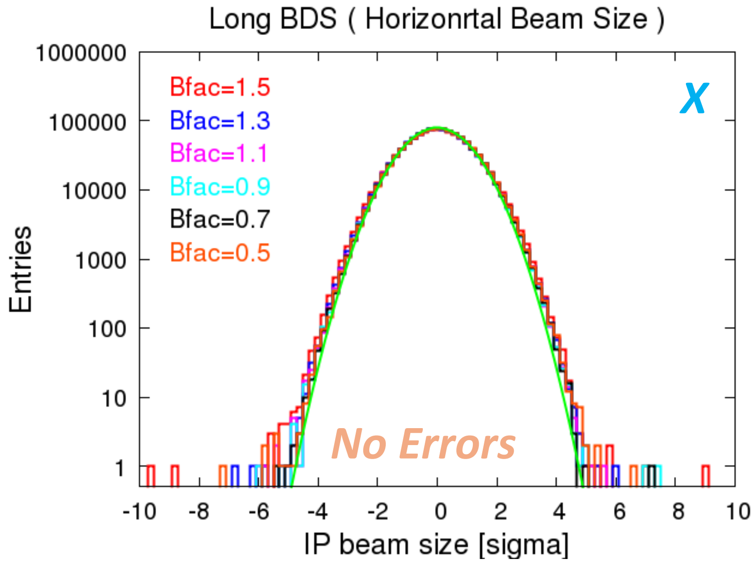


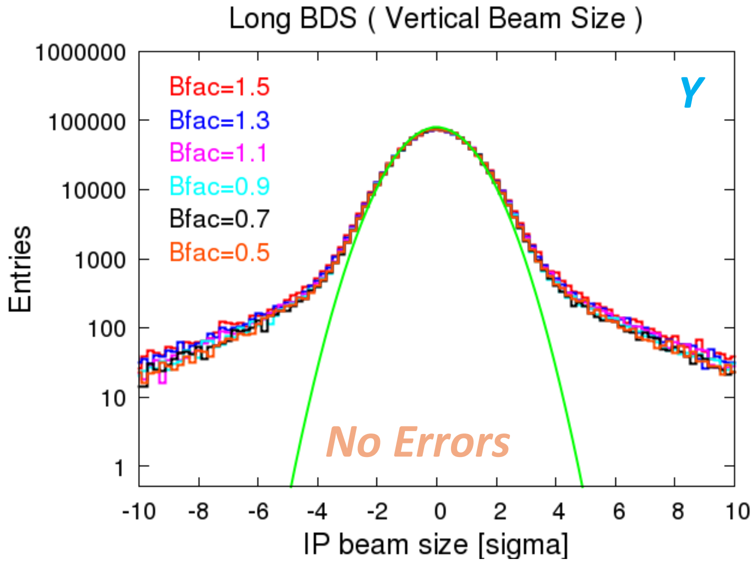
Energy spresd is larger than design

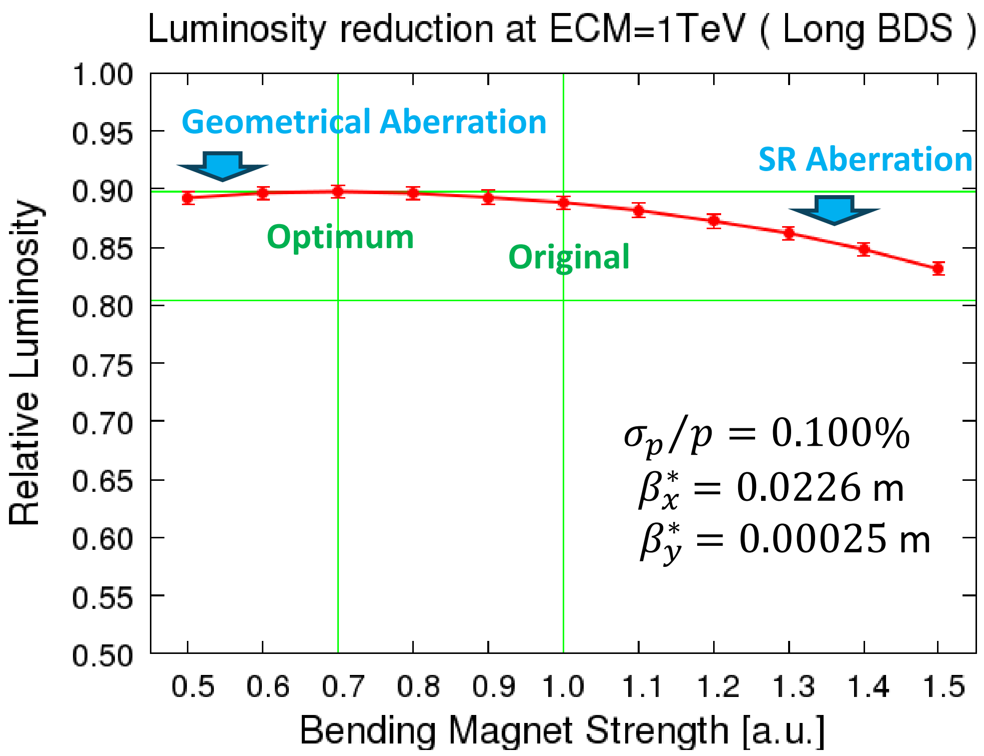


Tolerances are increased for the strong bend.

Performance for ECM=1TeV with various strength of BEND





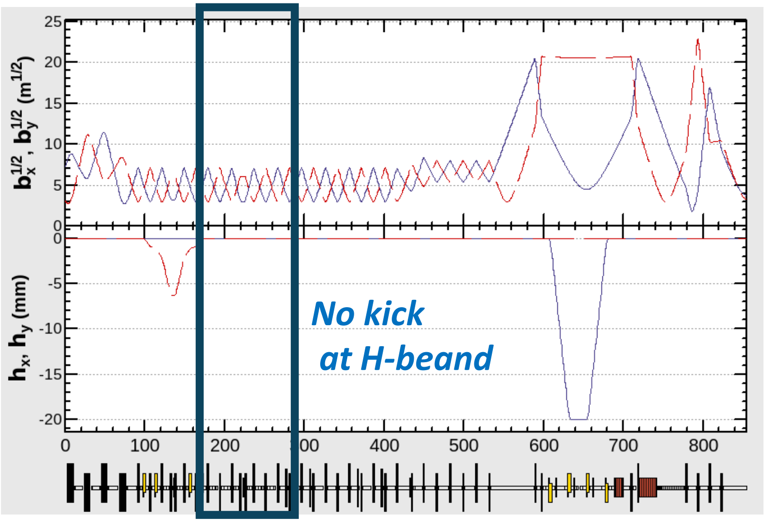


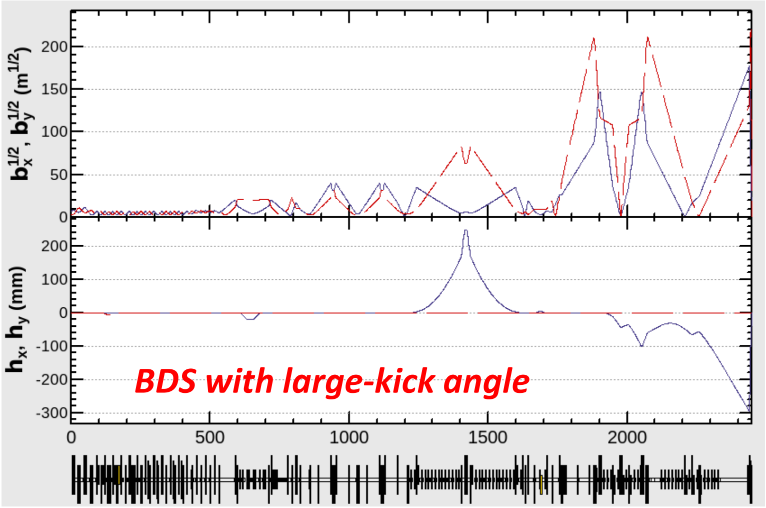
*Optimum bending angle is **70% of original**.*

(balanced geometrical aberration and SR aberration)

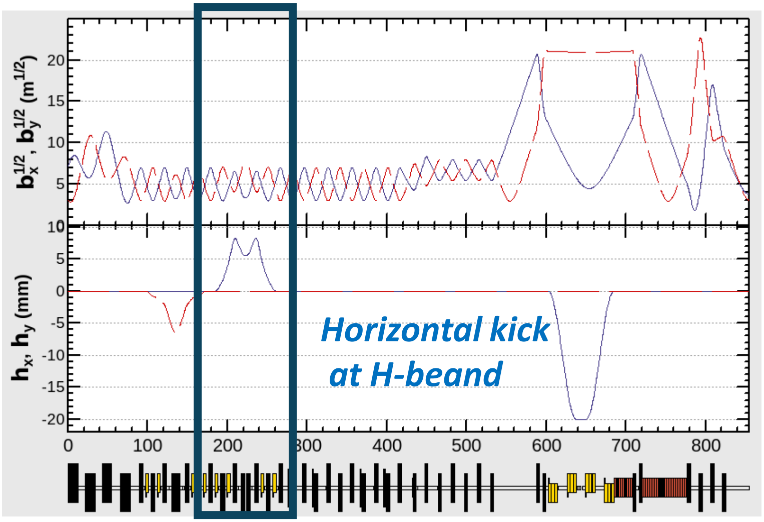
Beam optics for ECM=500GeV and ECM=1TeV

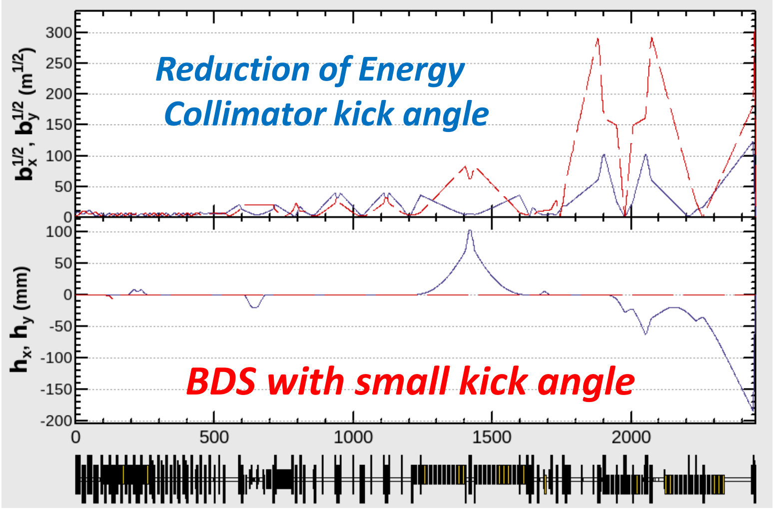
Upstream beamline ECM=500GeV Overall beamline





Upstream beamline ECM=1TeV Overall beamline



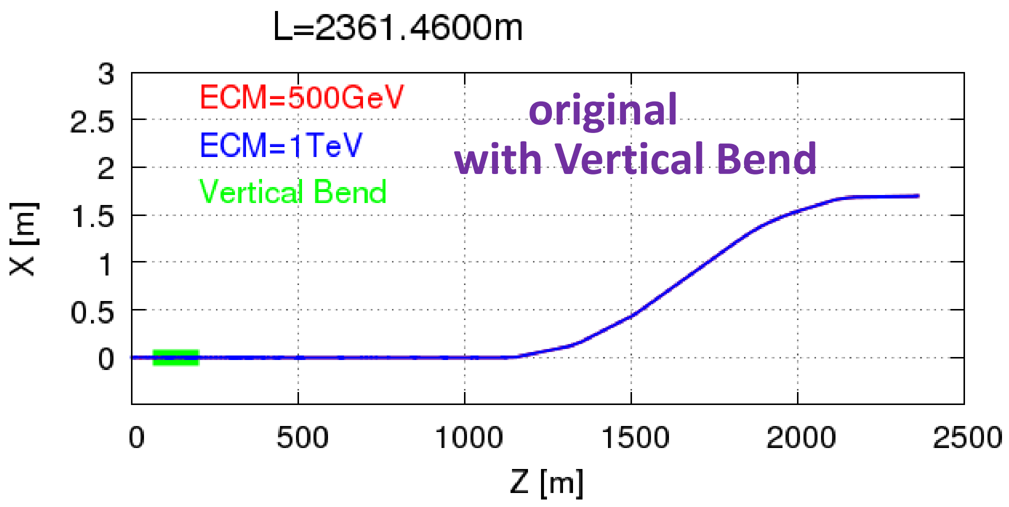


Put the horizontal bend system at the entrance of BDS.

The BDS kick angle at ECM=1TeV will be adjusted by changing the kick angles of H-bend and energy collimator.

(Not yet included the ILC design.)

The beamline geometry to achieve better performance

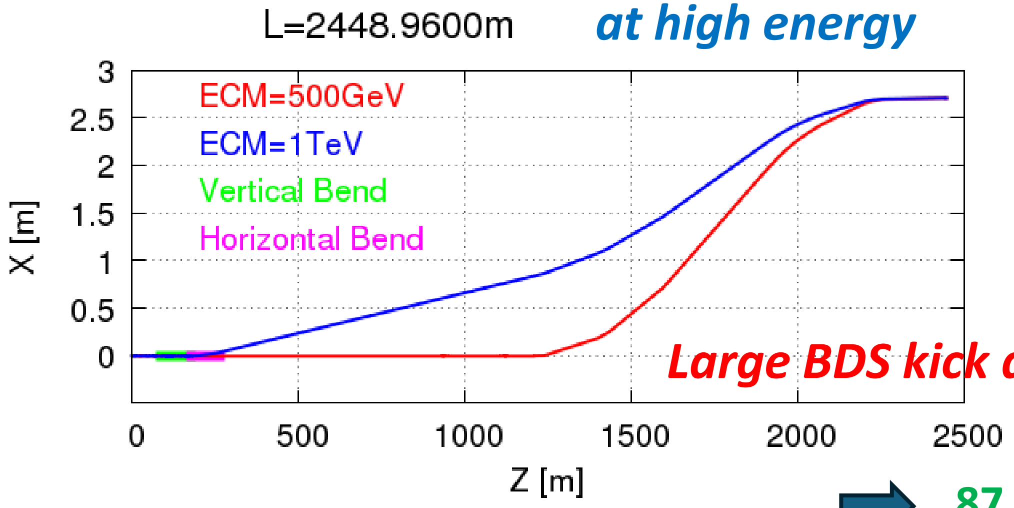


The total BDS beamline will be lengthened by 87.5m of horizontal bend system.

The horizontal beamline will be extended by 1m for large BDS angle kick.

Small BDS kick angle at high energy

(Not yet included the ILC design.)



1m shifted

Large BDS kick angle at low energy

87.5m lengthen

Summary

ILC BDS was designed to be operated very wide energy range with same geometry.

- *For low energy, a half length of FD was used to make L* shorter.*
- *For high energy, several magnets will be added.*

IP beam size will be tuned by quadrupoles and sextupoles.

- *Octupoles will be used only for the tail folding.*

(Not yet included the ILC design.)

In order to make better performances both for lower and higher beam energy, it is better to change the bending angle in the final focus beamline for the operating energy.

- *Stronger bend is better for lower energy.*
- *Weaker bend is better for higher energy.*
- *We can make the compatible beam line both for strong and weak bend.*

Thank you for your attention !

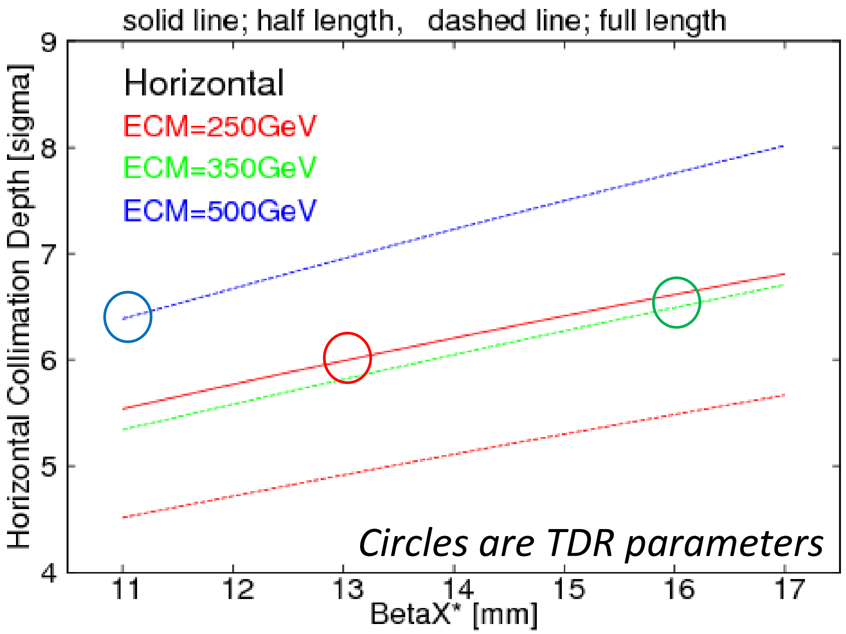
Backup

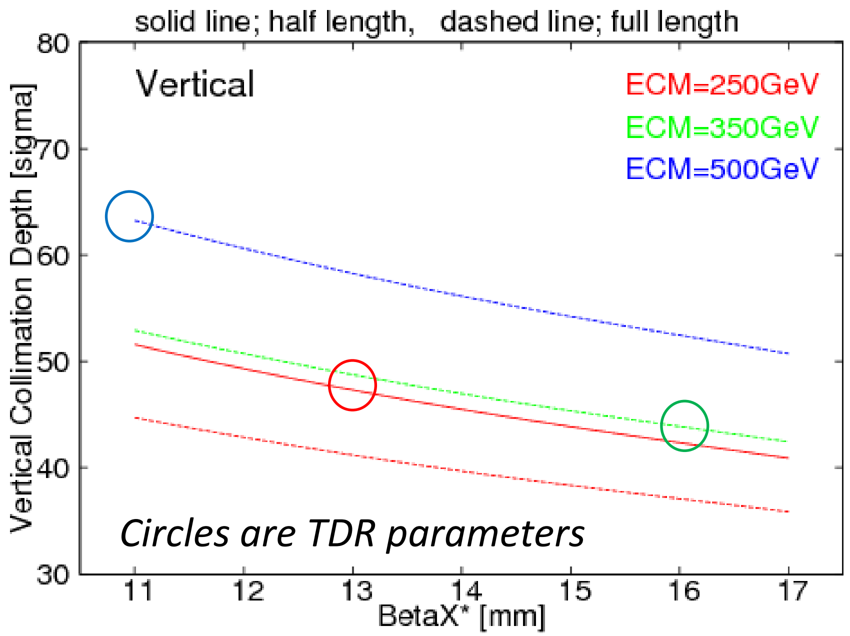
The collimation depth for various beam energy

ECM	BetaX*	BetaY*
250GeV	13mm	0.041mm
350GeV	16mm	0.034mm
500GeV	11mm	0.048mm

(QF1 L) = 9.5m*

(QD0 L) = 4.1m*





The collimation depths for ECM=250GeV is comparable to ECM=350GeV and 500GeV, because we can focus the beam only with half of final doublets for ECM=250GeV.

But, the horizontal beam size at FF sextupoles are much larger than ECM=350GeV.