Investigation of the performances for different L optics*

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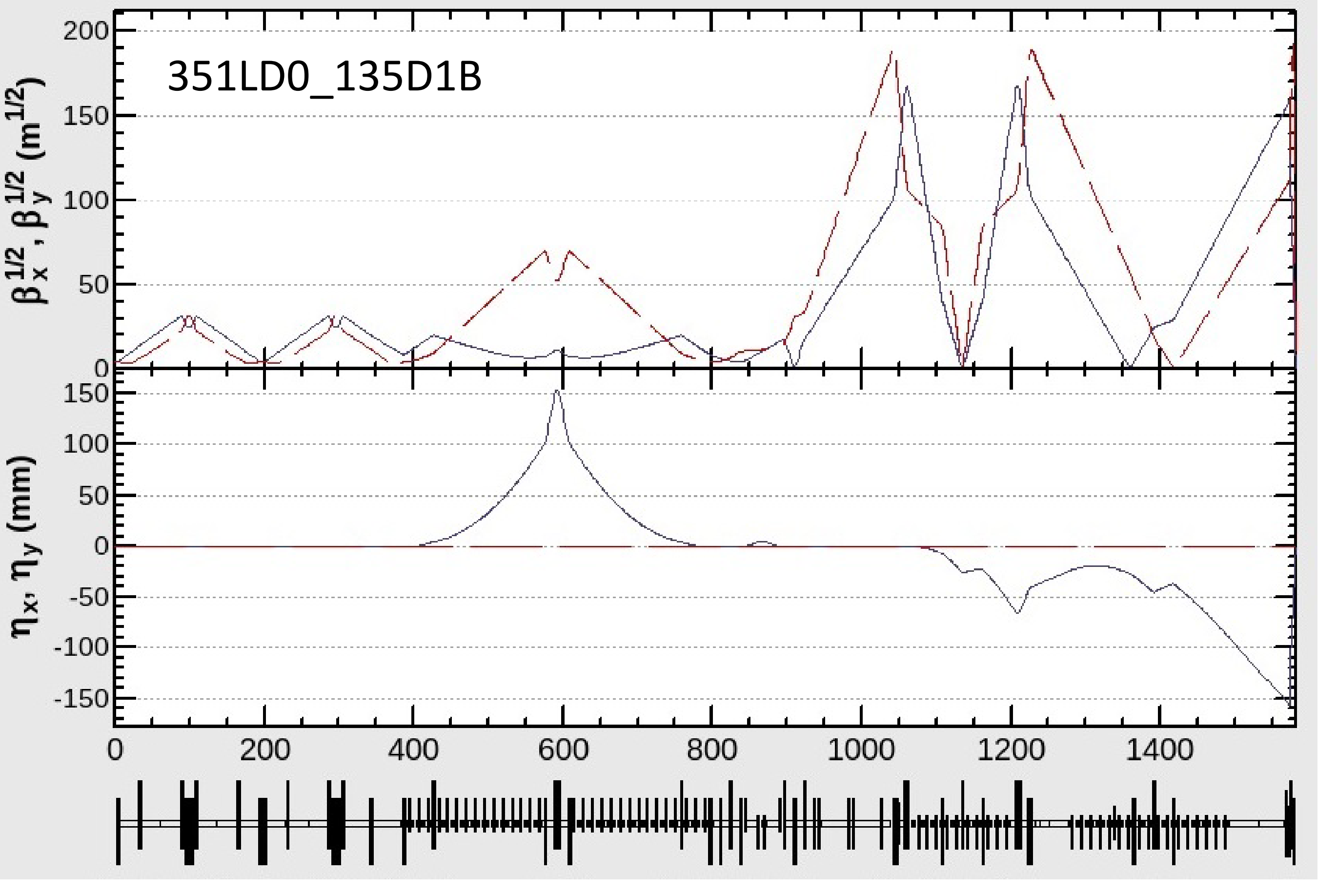
BDS mini-workshop, Ichinoseki

Short Report for AWLC 2014

The IP parameters for TDR

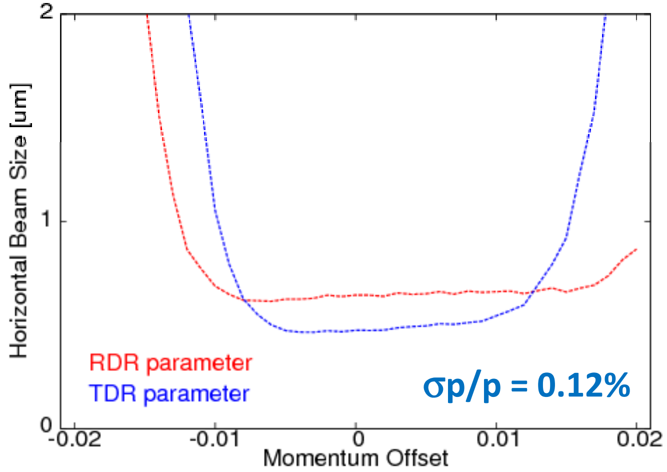
The IP parameters were changed from RDR to TDR by using same optics.

	betaX*	betaY*
RDR	0.021m	0.00040m
TDR	0.011m	0.00048m

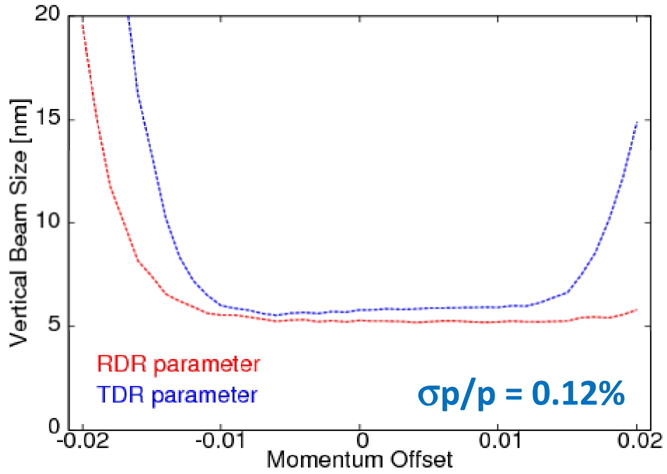


Performances of ILC RDR Optics (351LD0_135D1B)

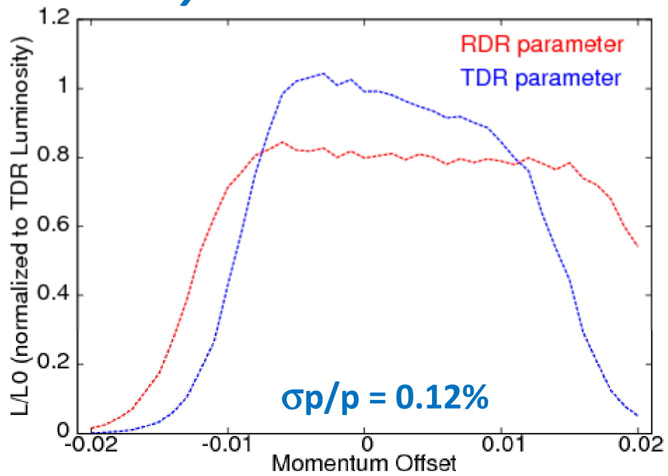
Bandwidth of sigmaX at E=250GeV



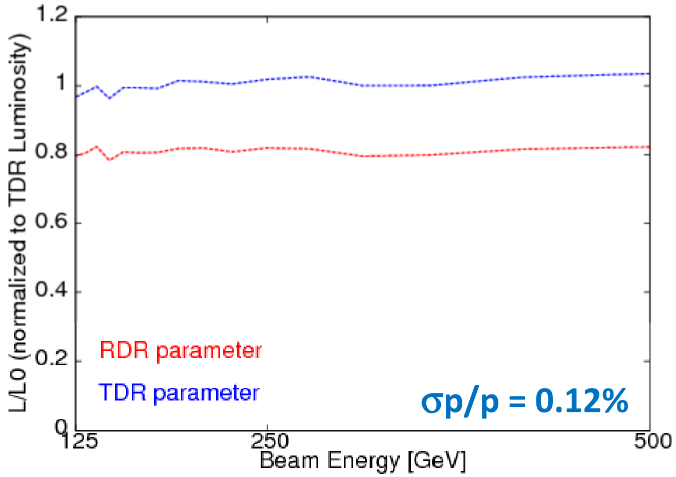
Bandwidth of sigmaY at E=250GeV



Luminosity Bandwidth at E=250GeV



Energy Dependence of Luminosity

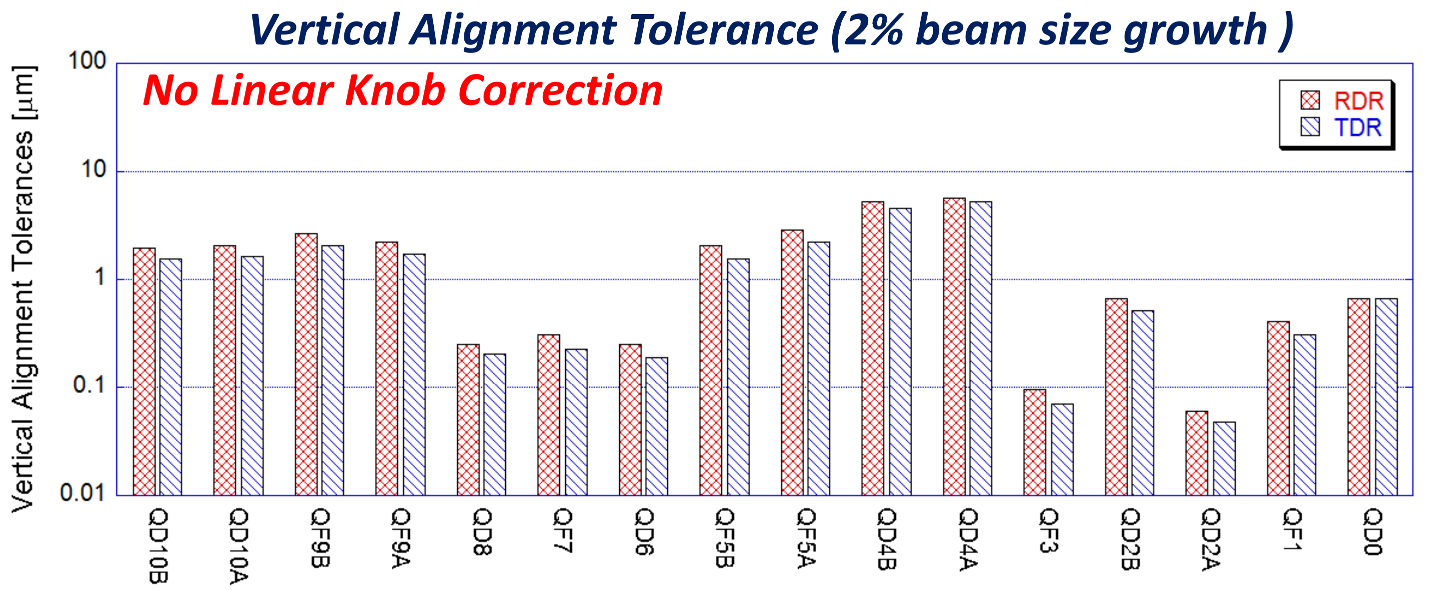


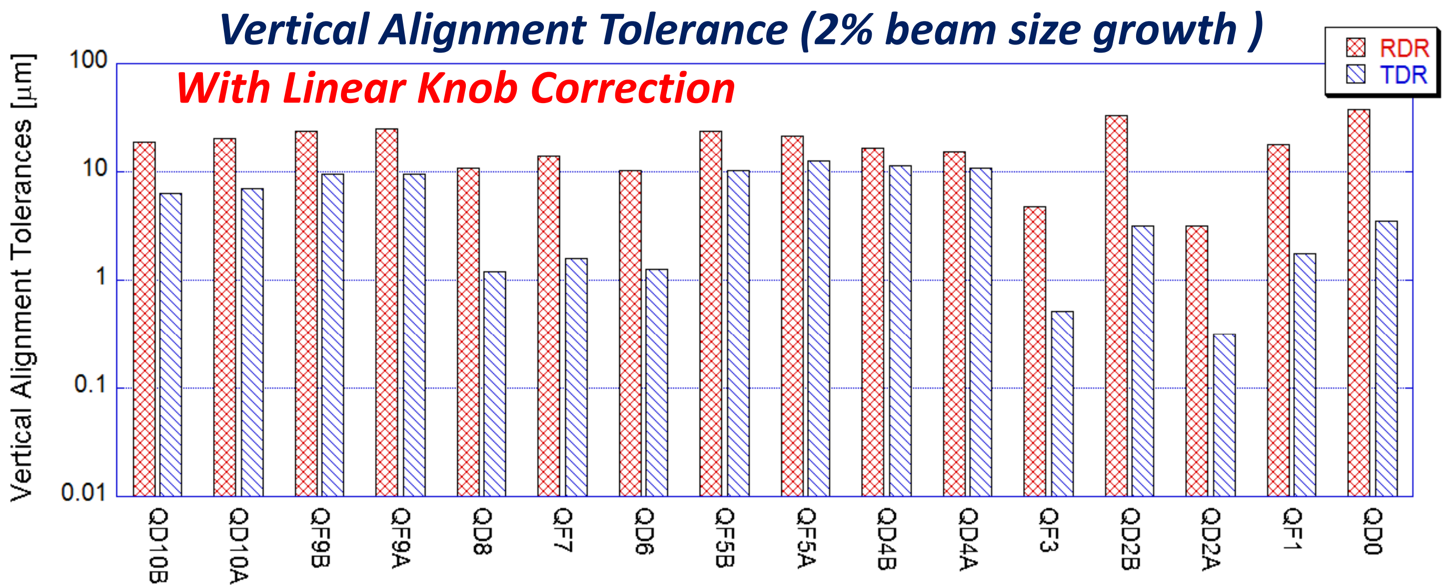
The peak luminosity was increased.

But, the luminosity bandwidth was reduced.

Tolerances of ILC RDR Optics

Presented at LCWS2013 by T.Okugi





The vertical alignment tolerances were reduced by 1 order (some magnets are less than 1um)

ILC Push-Pull Optics

Push-Pull optics were prepared by A. Seryi in 2006 ,

but the optics was not tuned for beam size and band width etc.

- location of QF1 unchanged when L changed.*

(D1B adjusted according to L)*

I roughly optimize the IP beam size

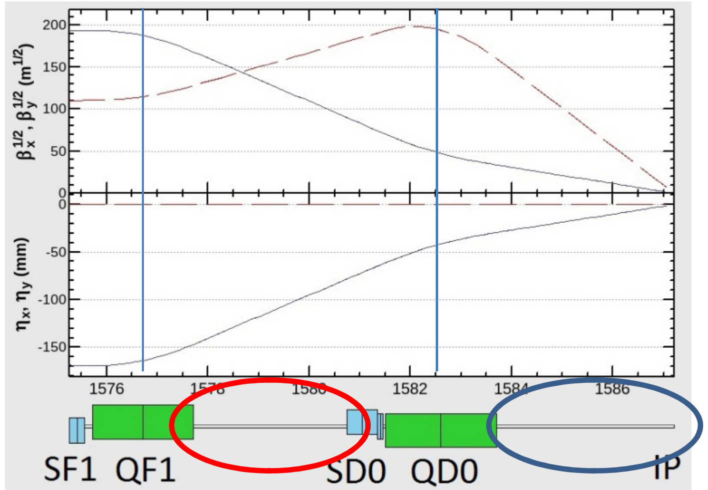
by changing the strengths of

- QD4, QF3, QD2B, QD2A, QF1 and QD0

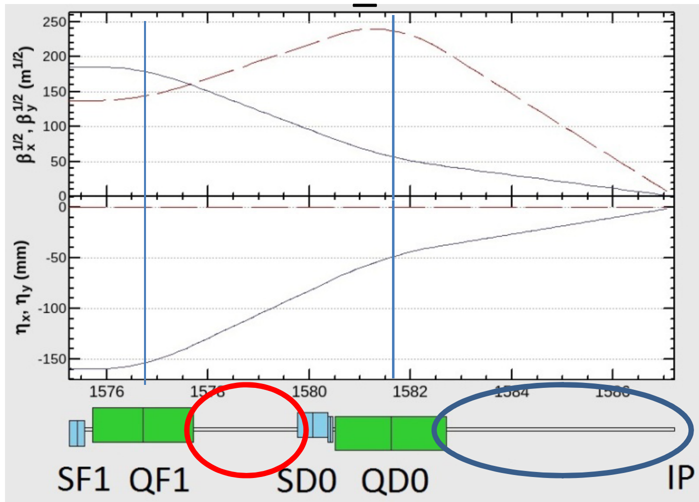
- SF6, SF5, SD4, SF1 and SD0

I also matched the optics to TDR IP parameter

351LD0_304D1B



450LD0_205D1B

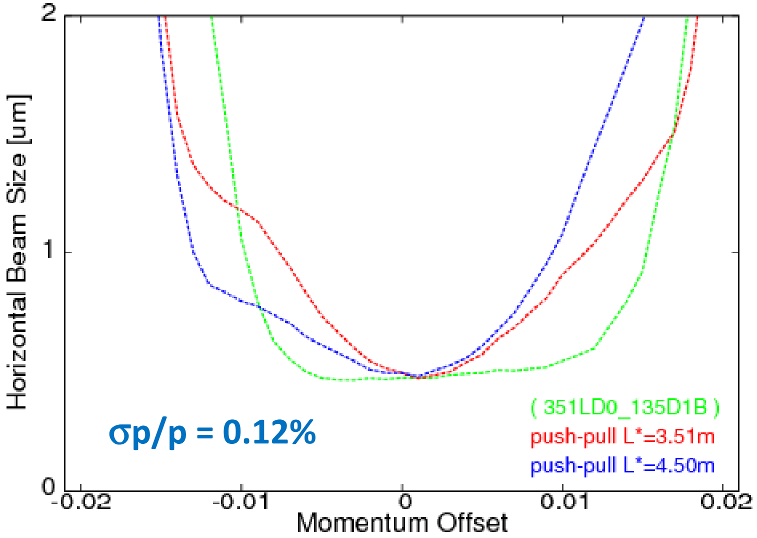


Simulated beam size at E=250GeV

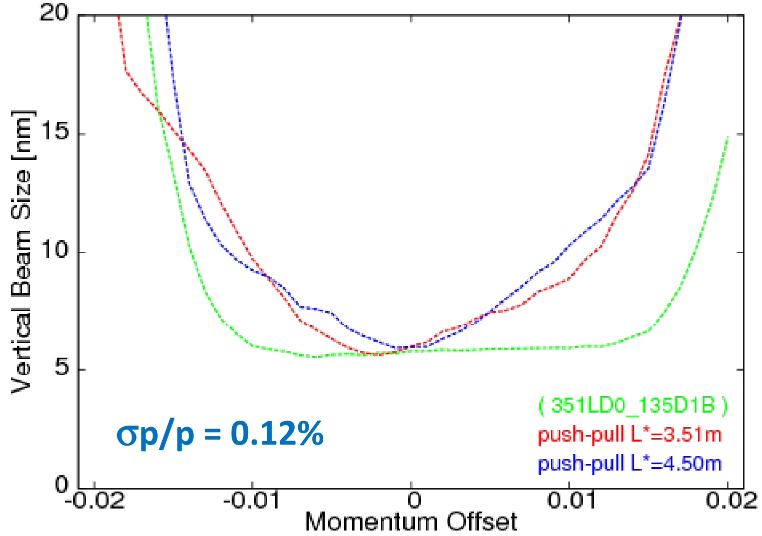
optics	L*=3.51m (351LD0_304D1B)		L*=4.50m (450LD0_205D1B)	
	horizontal	vertical	horizontal	vertical
original	2.17um	8.52nm	0.76um	5.95nm
optimize	0.49um	6.18nm	0.49um	5.99nm

Performances of Push-Pull Optics

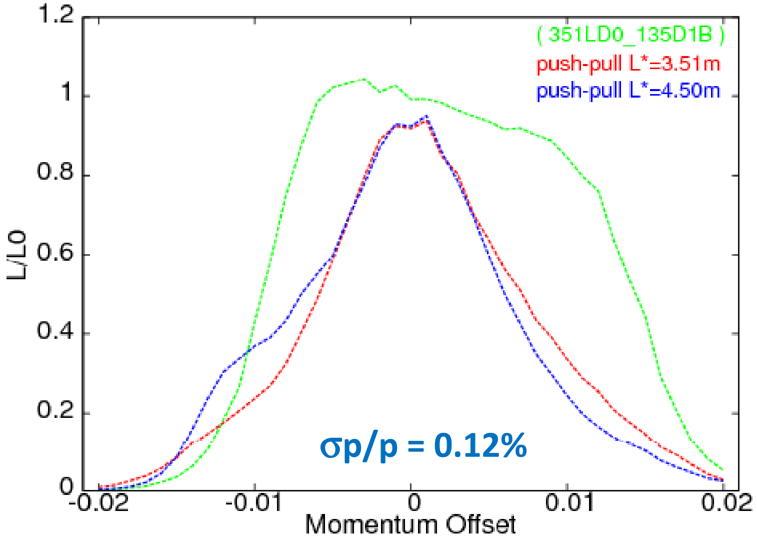
Bandwidth of sigmaX at E=250GeV



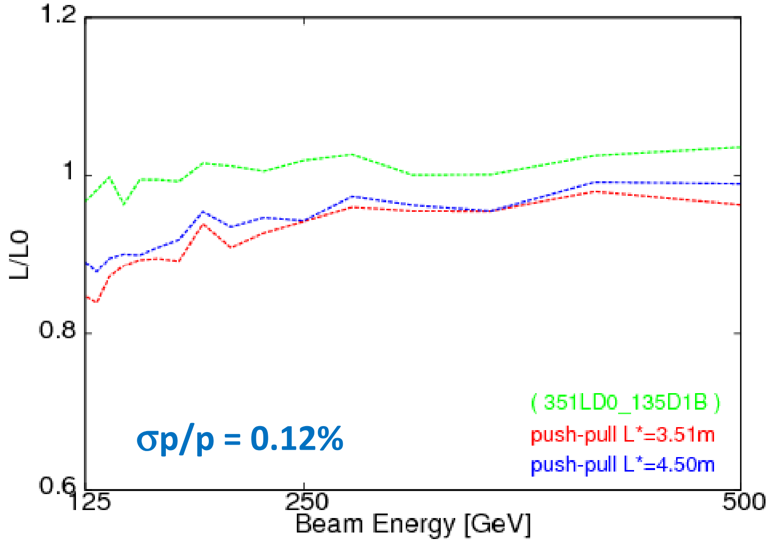
Bandwidth of sigmaY at E=250GeV



Luminosity Bandwidth at E=250GeV



Energy Dependence of Luminosity



The performances were worse than original ILC optics.

Optimization of Fixed L Optics*

Optimization Procedures

RDR optics was used for the base optics .

D1B (distance between SD0 and QF1) was set to various lengths,
because Andrei's push-pull was adopted the larger D1B.

Then, I roughly optimize the IP beam size by changing

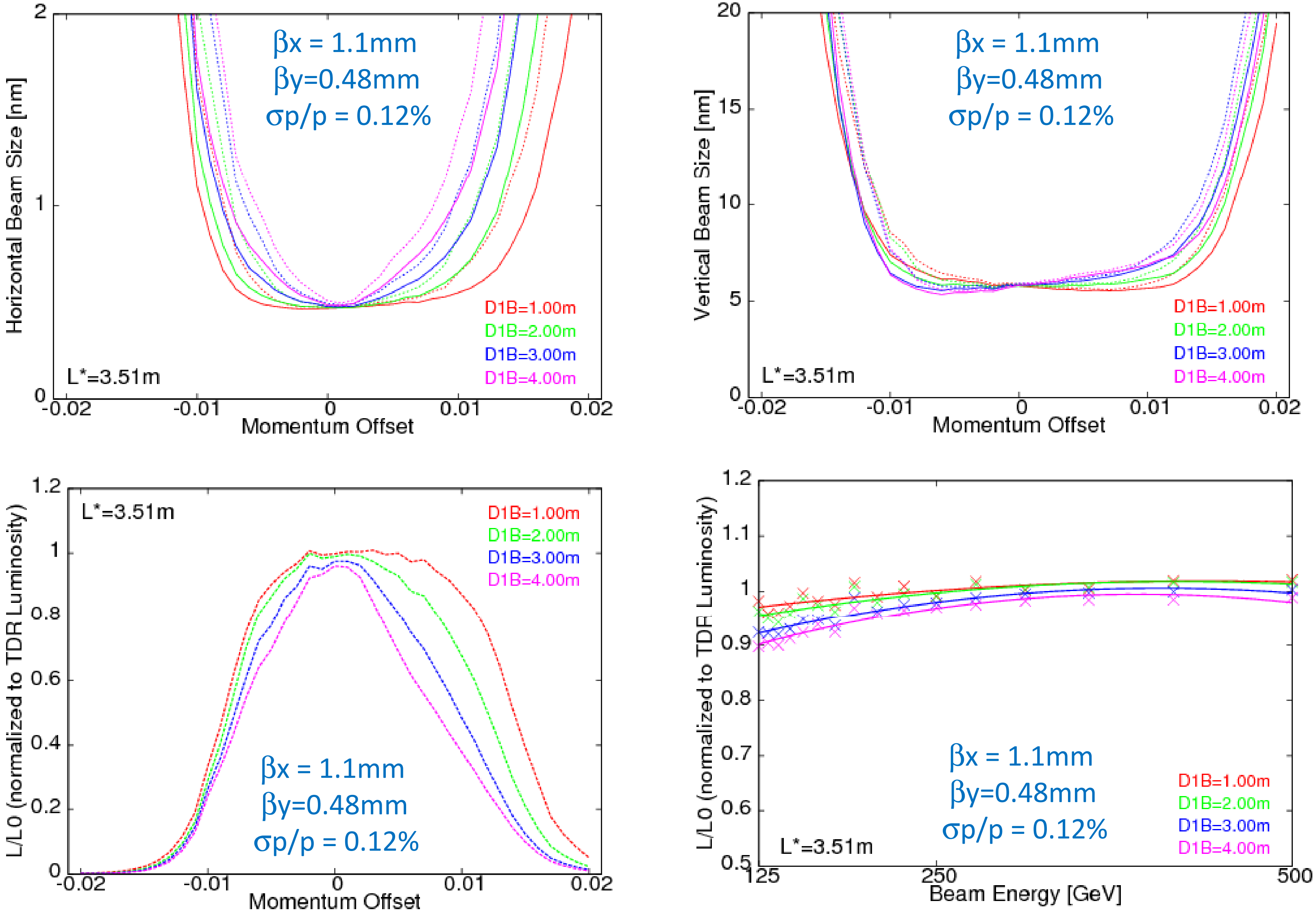
- *the strengths of QF5, QD4, QF3, QD2B, QD2A, QF1 and QD0 (7quads),*
- *the strengths of SF6, SF5, SD4, SF1 and SD0 (5 sexts),*
- *the distance between QD4-to-QD2B and QD2A-to-SF1 (2 drift spaces).*

I also matched the optics to TDR IP parameter

- *the strength of matching quads (QM16-QM11) were changed.*

Bandwidth of RDR L=3.51m Optics*

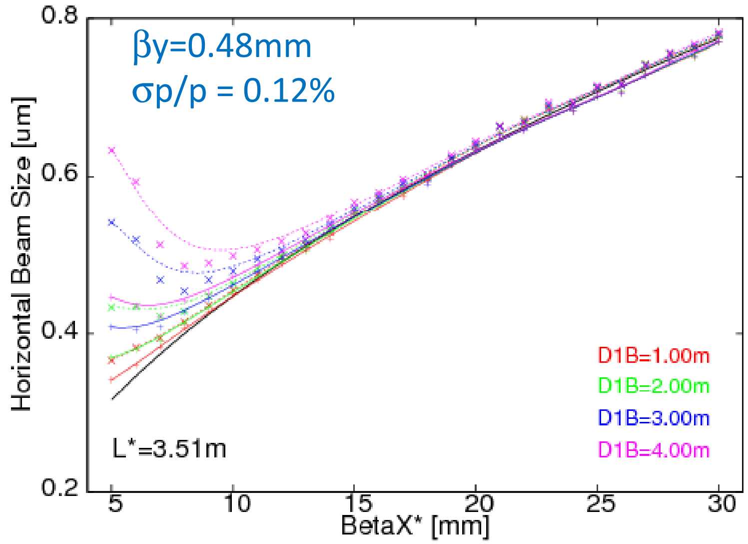
solid line ; core beam size
dotted line ; rms beam size

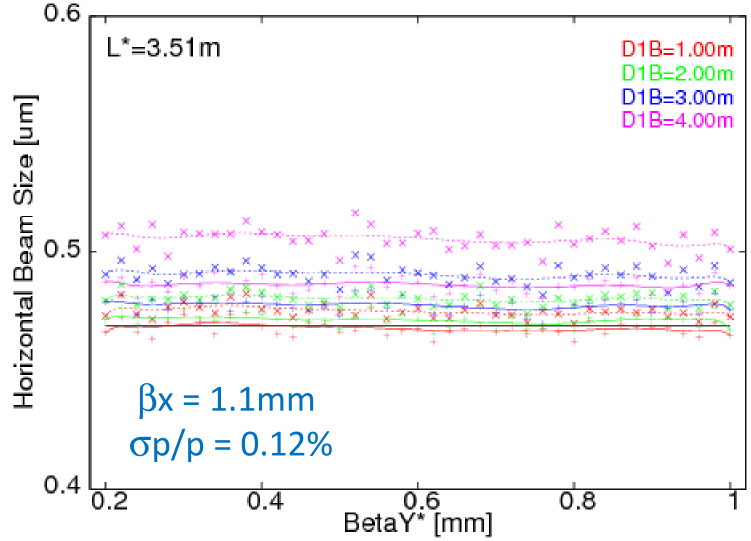


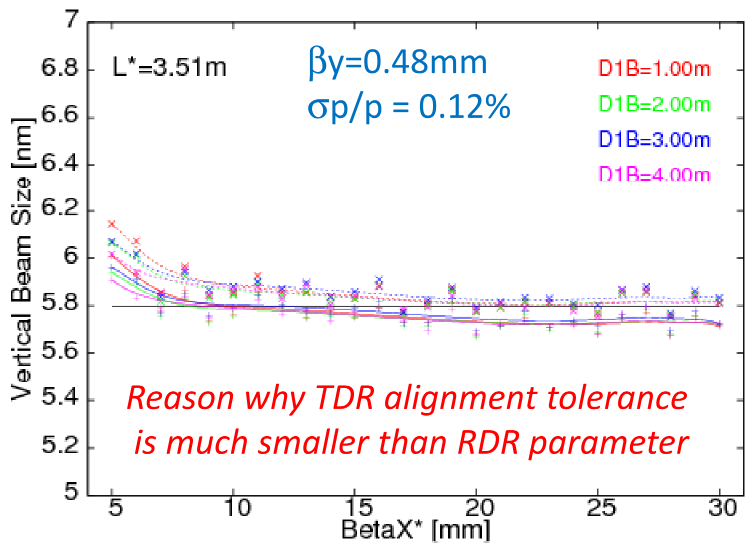
The bandwidth is wider for smaller D1B.
(D1B=1.35m for RDR optics, D1B=3.04m for Andrei's Push-pull)

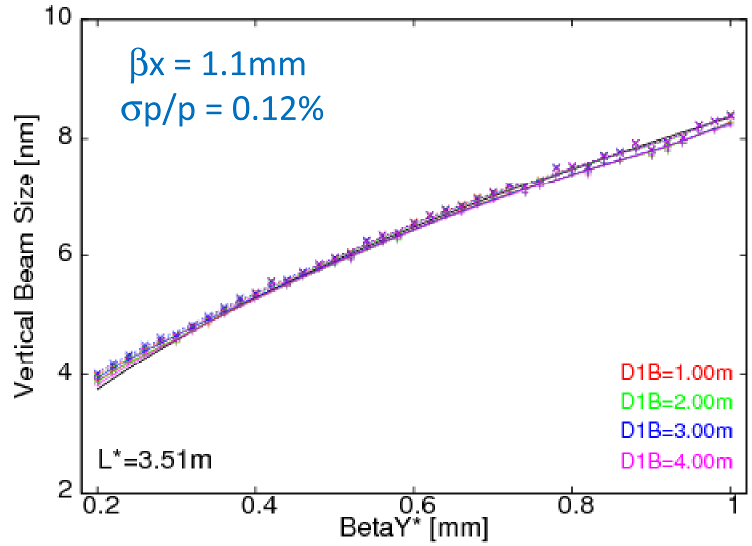
Geometrical Effects of RDR L=3.51m Optics*

solid line ; core beam size
dotted line ; rms beam size







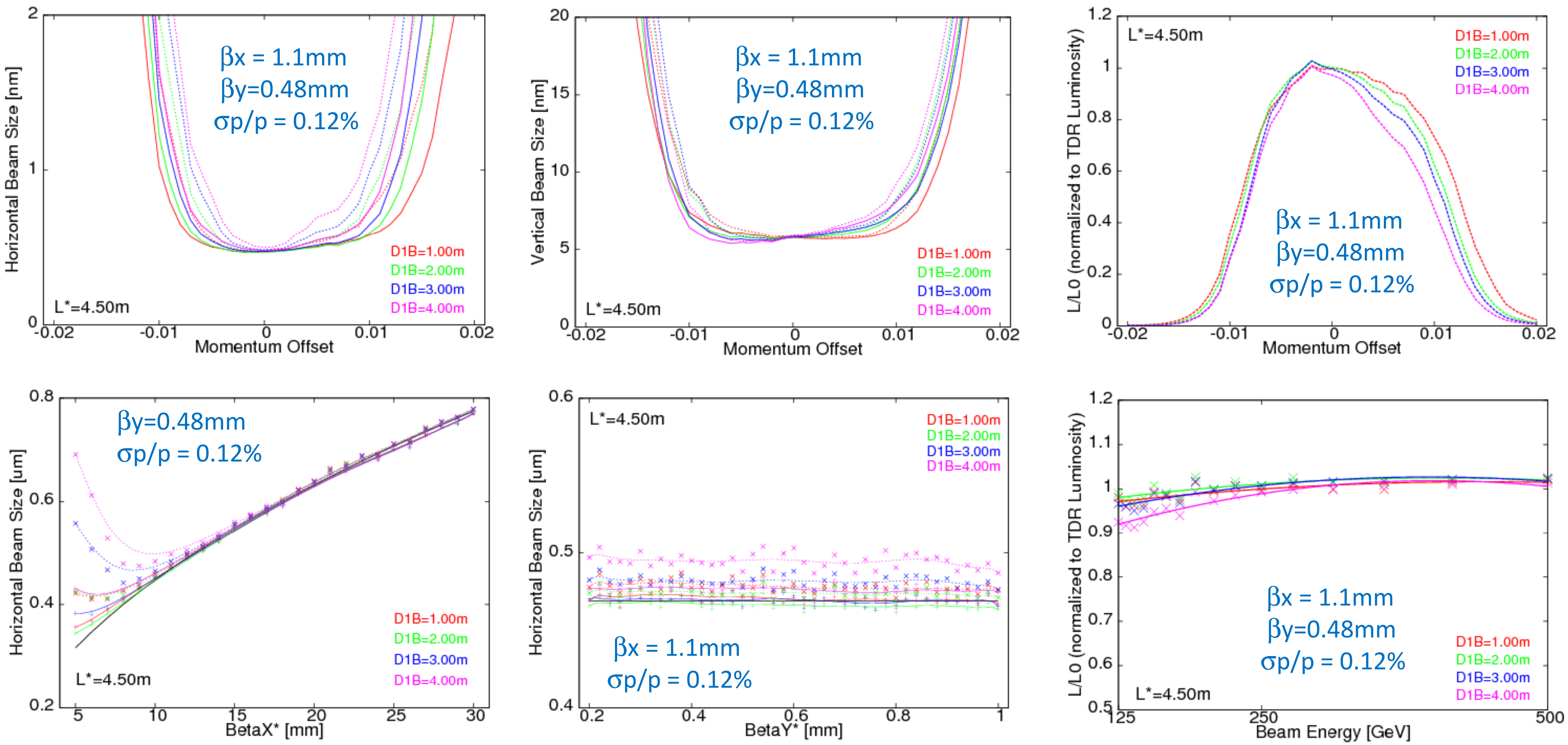


Horizontal geometric aberration is wider for smaller D1B.
(D1B=1.35m for RDR optics, D1B=3.04m for Andrei's Push-pull)

Optimization of L=4.50m optics, based on RDR optics*

I tied to optimize L=4.50m optics with same procedure for L*=3.51m.*

solid line ; core beam size
dotted line ; rms beam size



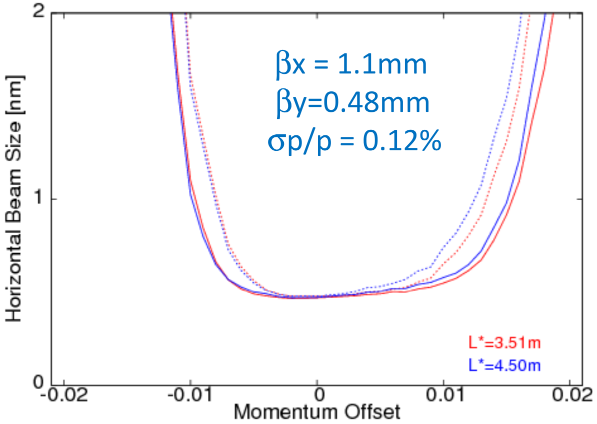
Performances are almost same to L=3.51m optics*

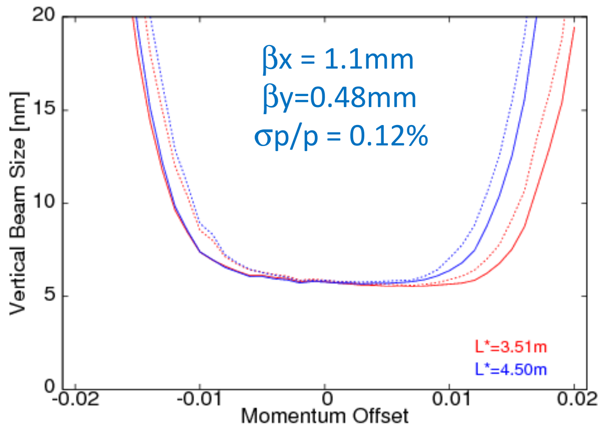
Bandwidth and geometric aberration are wider for smaller D1B.
(D1B=1.35m for RDR optics, D1B=3.04m for Andrei's Push-pull)

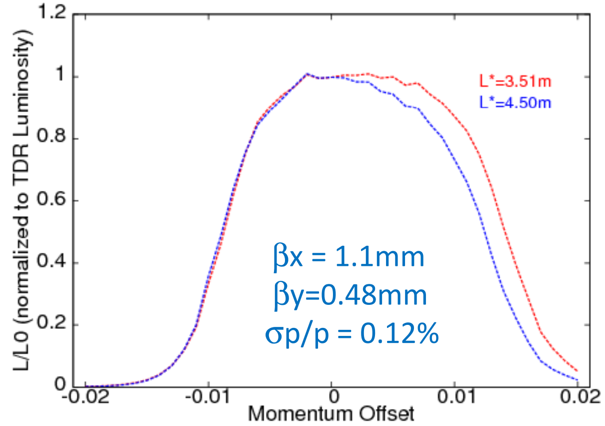
Comparison of L=3.51m and 4.50m*

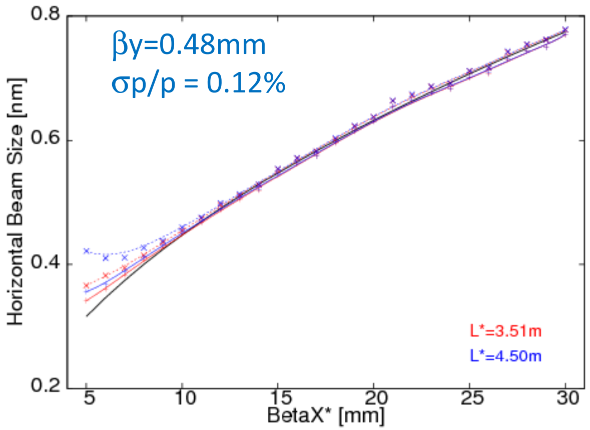
Performances of L=3.51m and 4.50m for D1B=1.00m.*

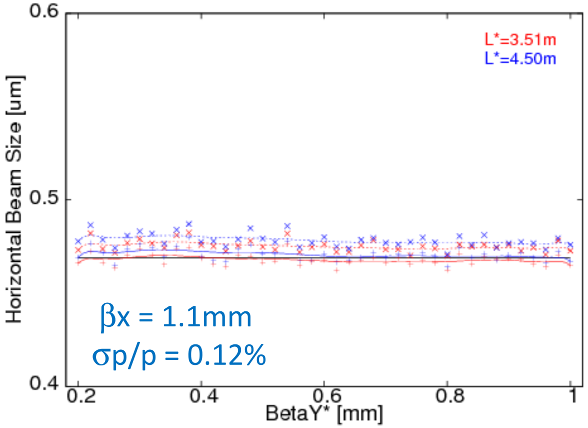
solid line ; core beam size
dotted line ; rms beam size

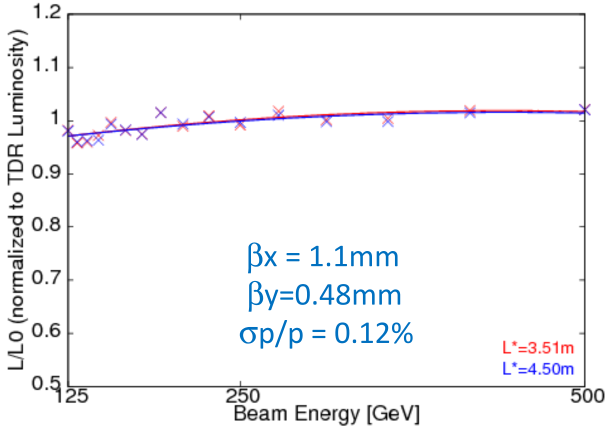










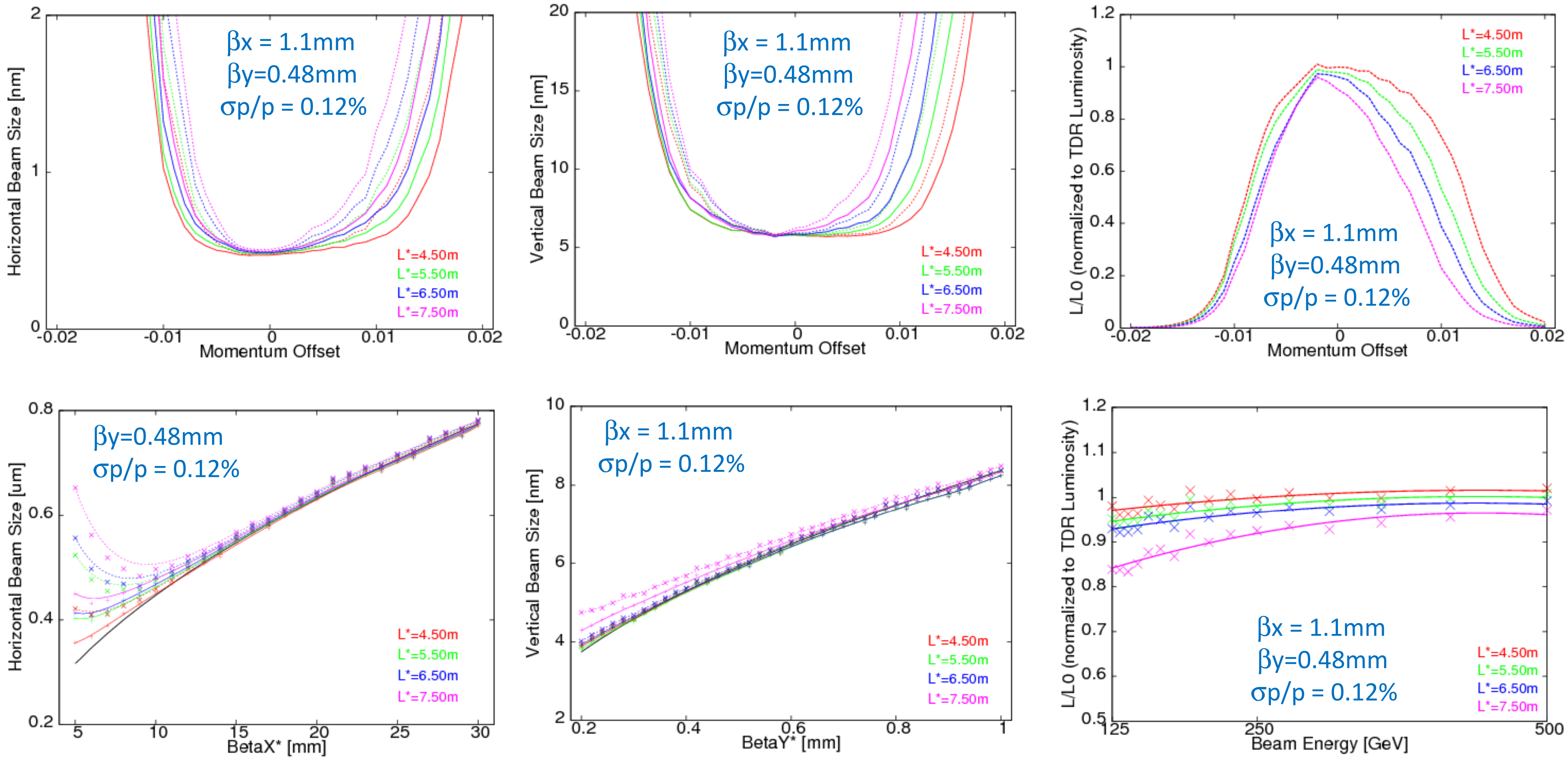


Bandwidth and geometric aberration for L=3.51m are slightly wider than those for L*=4.50m.*

*Toward longer L**

The same optimization was done for longer L optics .*
D1B was fixed to 1.00m.

solid line ; core beam size
dotted line ; rms beam size



We can expanded the L to 7.50m with small luminosity loss.*
But, the performances were worse for longer L (need to optimize more) .*

Optimization of Push-pull Optics

1. *I made L*=4.00m D1B=1.00m optics, based on RDR optics.*
   (Same procedure for previous optimization)
2. *I changed L* by changing D0 and D1B to keep same total length.*

*Procedure to change L**

The strengths for QF5 to QD0 (7 parameters) are changed to

(AX at IP) = 0

(AY at IP) = 0

(EPX at IP) < 1μm

R12=0, R34=0 (SD4 to SD0)

Δ(BetaX at SD0) / (BetaX at SD4) < 5%

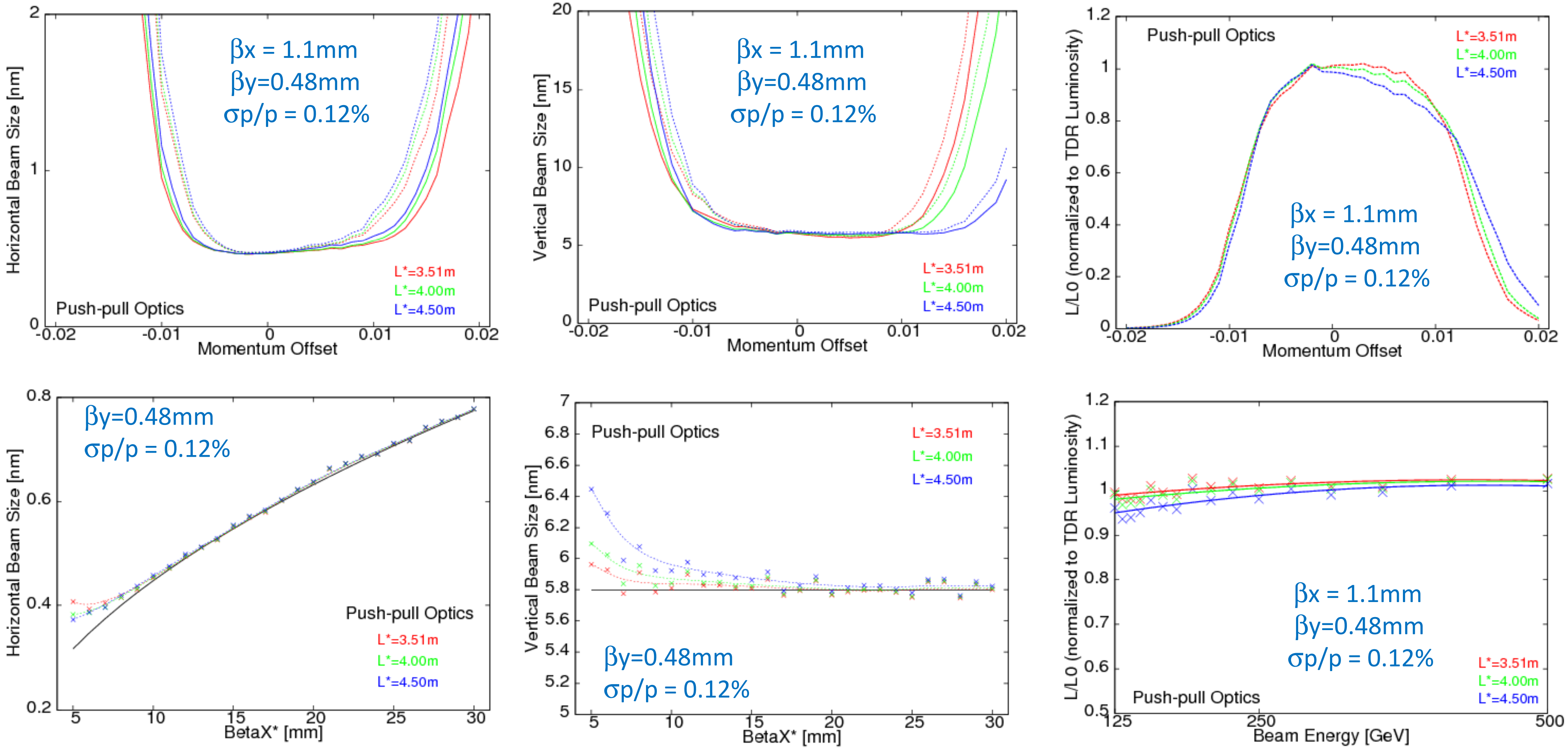
Δ(BetaY at SD0) / (BetaY at SD4) < 5%

(BetaX at QD2B) < 100m

(BetaY at QD2A) < 100m

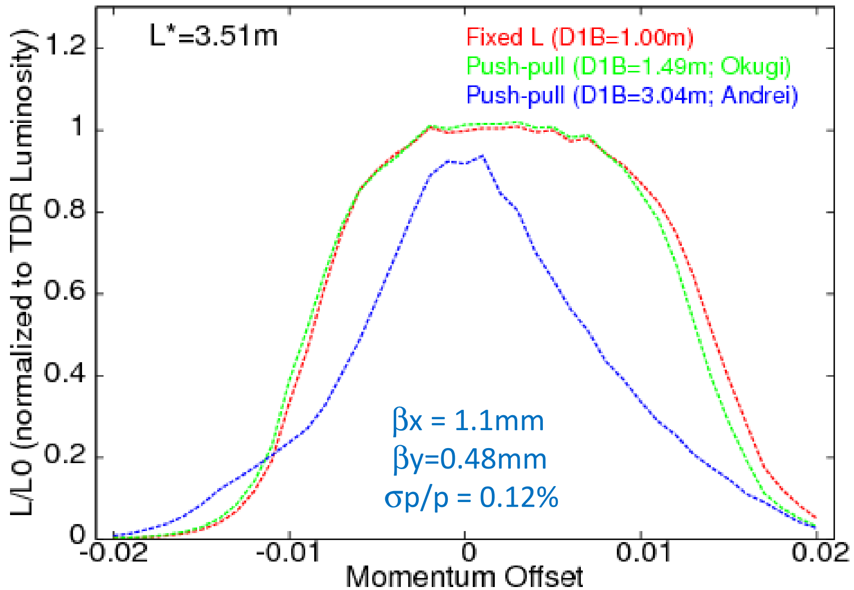
Optimization of Push-pull optics.

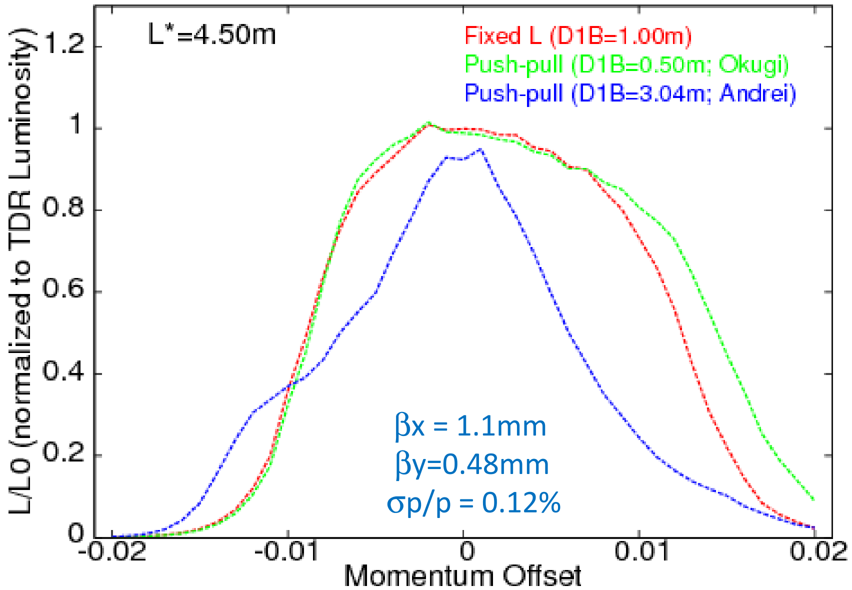
solid line ; core beam size
dotted line ; rms beam size



The bandwidth and aberration for L=3.51m and 4.50m was comparable to those for L*=4.00m optics.*

Comparison with fixed L optics*





Since the Andrei's push-pull optics was not optimized the magnet geometries, the bandwidths were much smaller than fixed L optics.*

But, we can make a push-pull optics with comparable performance to the fixed L optics for small D1B by optimizing the geometries of magnets.*

Summary and Discussion

Since the horizontal beta function was almost limit for TDR IP parameter, the magnet tolerances were much small to the RDR IP parameters.
The reason is the horizontal geometrical aberration, and it is difficult to reduce.
In order to relax the geometrical aberration, we need

1) further optimization of FF optics.
2) to change the aspect ratio of IP beam size.

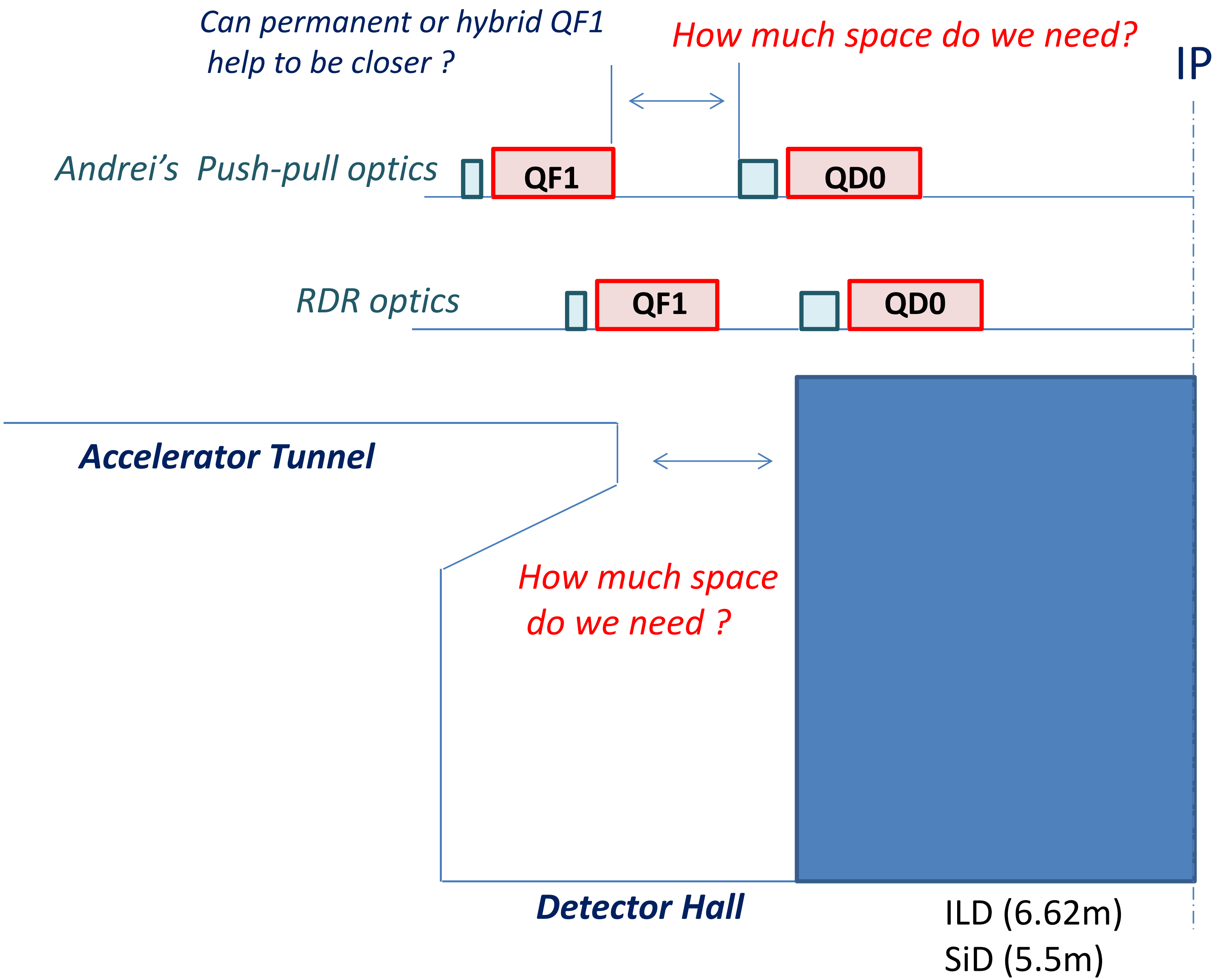
We made the L=4.50m optics.*
The performances were a little bit worse than L=3.51m optics.*
We need to check whether L=4.50m optics is acceptable or not.*

We can expand the L to 7.50m with almost same luminosity.*
(with same total length and same strengths of bending magnets.)
But, the tolerances were smaller than shorter L optics.*
We need further investigation to use the longer L optics.*

We made the push-pull optics based on (L=4.00m and D1B=1.00m).*
The performances were comparable to the fixed L optics at least D1B=1.00m.*
We need , however, to check by the optics with appropriate D1B.

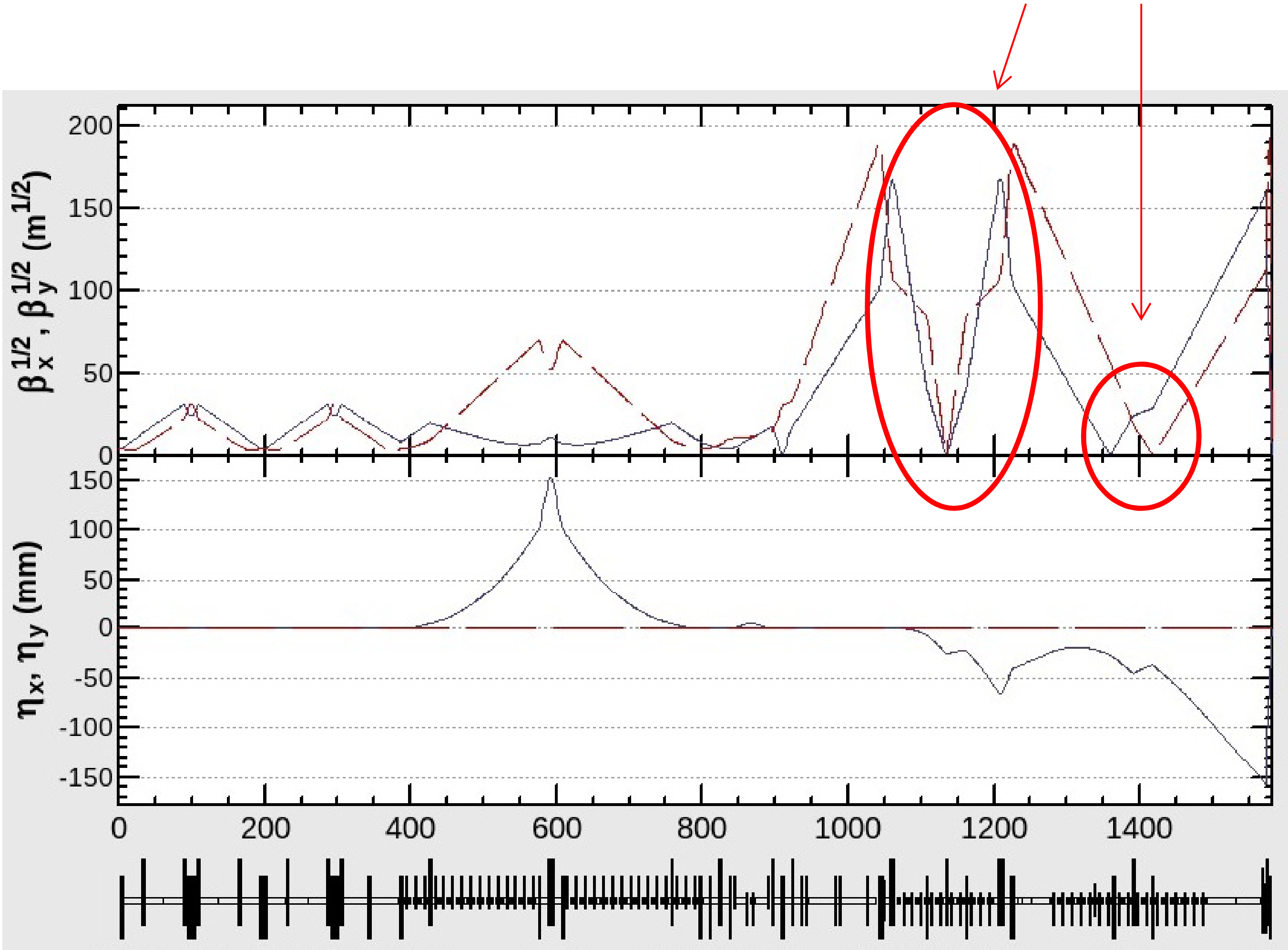
The present ILC FF optics was optimized to small distance between QF1 and SD0 (D1B).
We should check how much D1B can we accept.

Question to MDI/CFS group



Backup

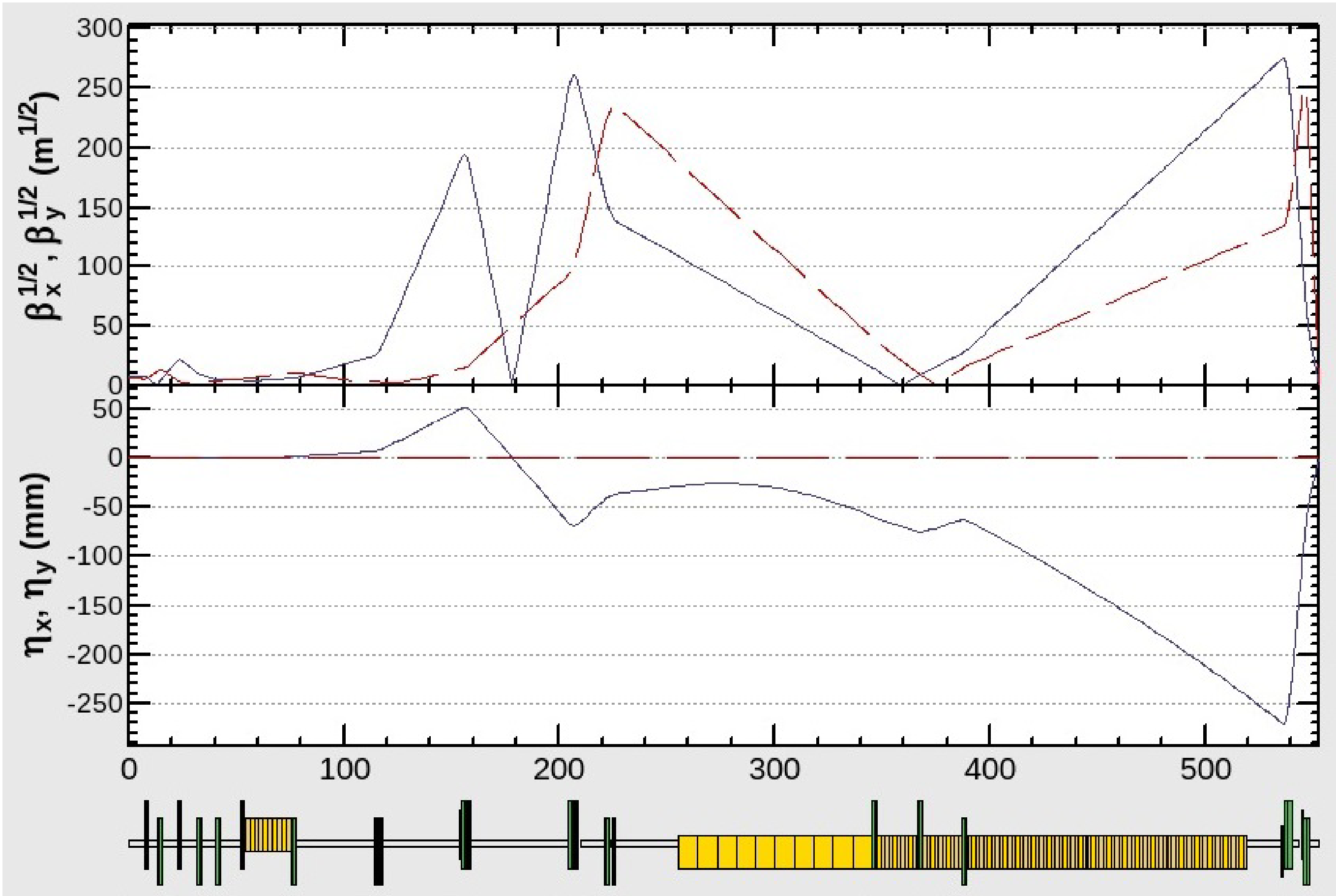
We did not optimize these geometries.



CLIC Final Focus Optics

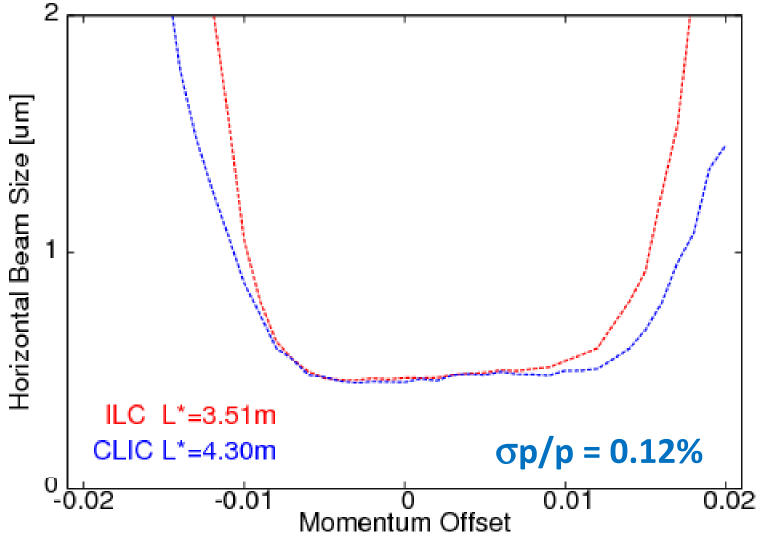
R. Tomas and H. Morales prepared the low energy version of CLIC optics.
The total length is comparable to the ILC RDR FF (351LD0_135D1B).

The optics deck was translated to SAD deck, and matched to ILC TDR parameters,
and I evaluated the performances of CLIC low energy optics with same procedure to ILC.

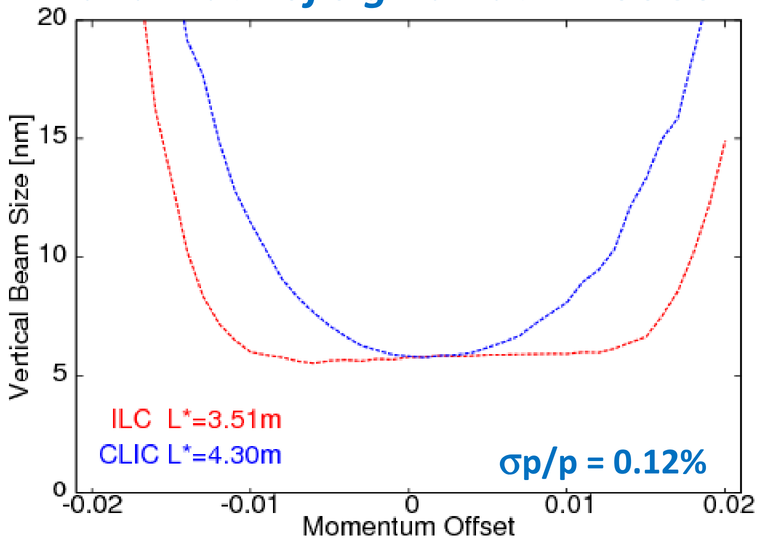


Performances of CLIC FF Optics

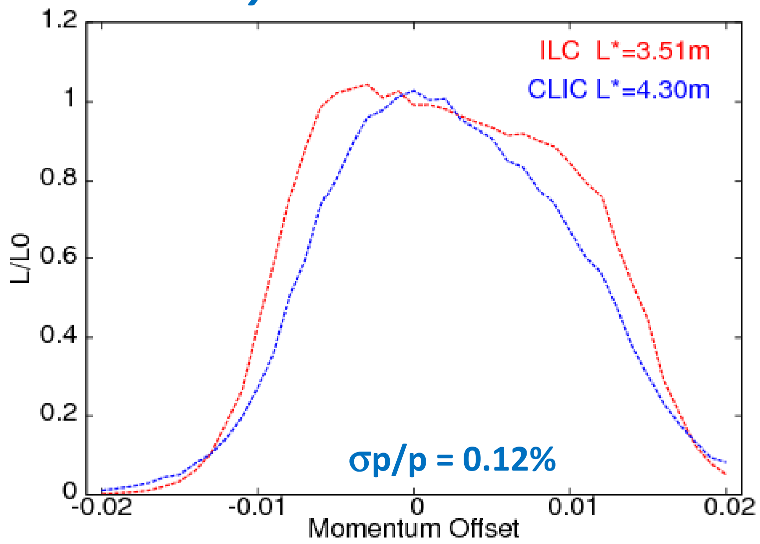
Bandwidth of sigmaX at E=250GeV



Bandwidth of sigmaY at E=250GeV



Luminosity Bandwidth at E=250GeV



- The bandwidth of horizontal beam size is wider than ILC.

- The bandwidth of vertical beam size is narrower than ILC.

- The luminosity bandwidth is narrower than ILC, but the L is larger than ILC.*

We should compare after small adjustment to increase the vertical bandwidth (not yet).

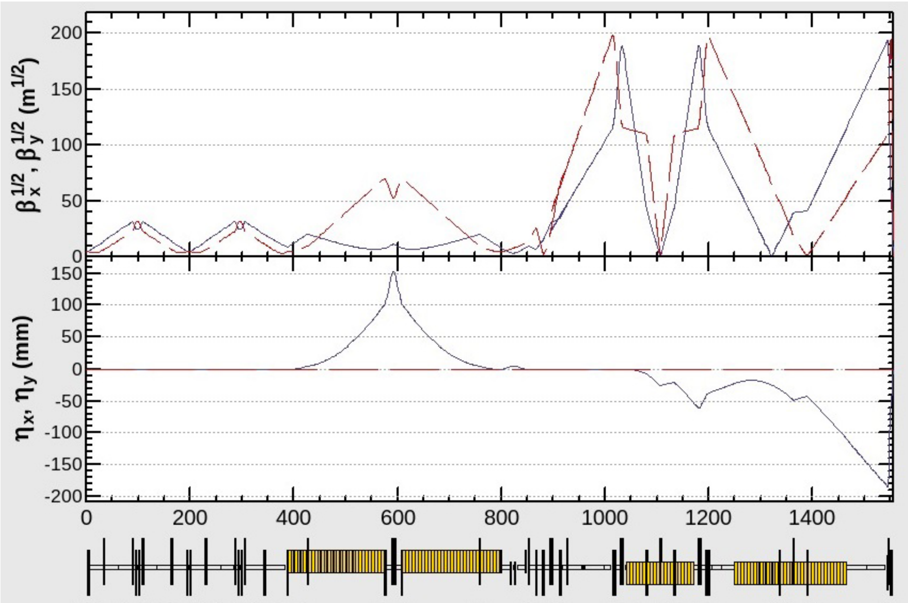
Short Push-Pull Optics

2) R. Versteegen also tuned up the push-pull final focus optics by changing the magnet location by keeping to D0=3.51m and D1B=3.04m.

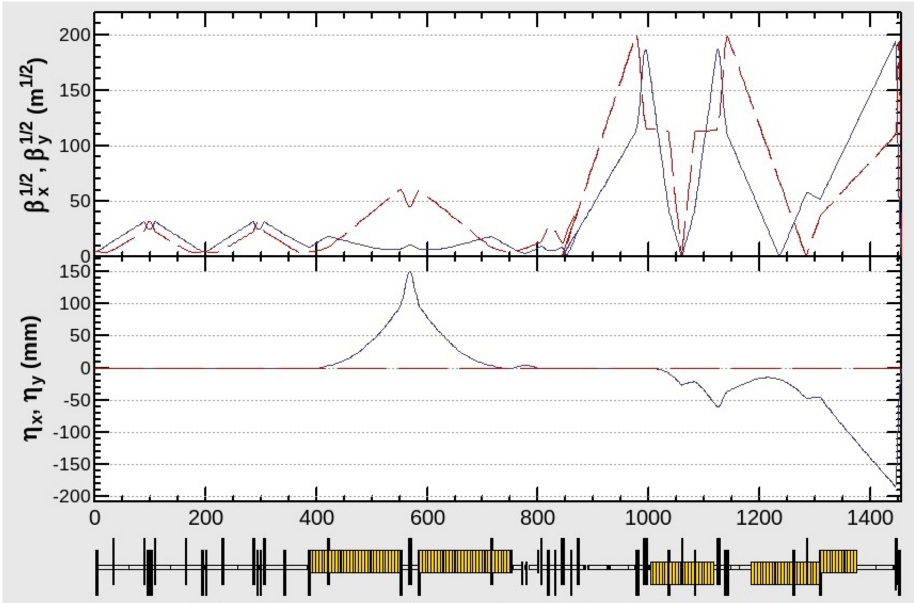
The linear optics and sextupoles were re-tuned to optimise the luminosity and the bandwidth.

Beamline length is reduced by ~130m by reducing all the dipole lengths and drifts by 0.87 in the energy collimator and the FFS in order to approximately double emittance growth .
(original RDR deck is (emit/emit0) = 1.0078 at E=500GeV.)

Old Optics (Long Optics)

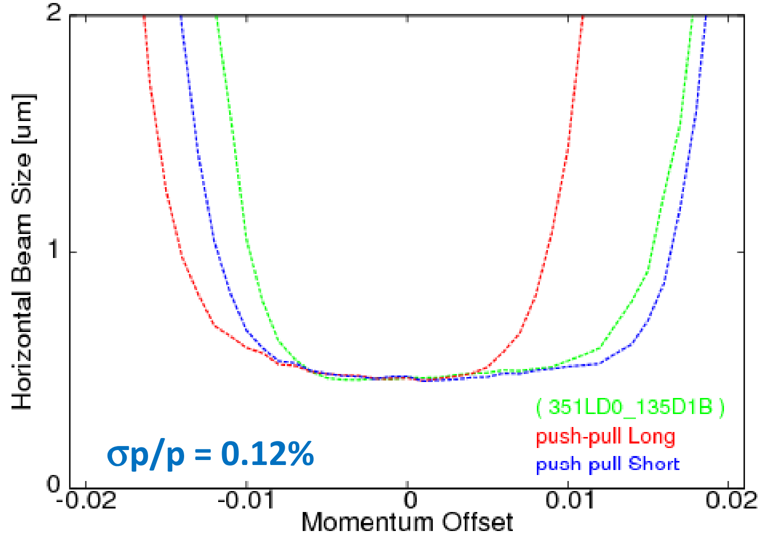


New Optics (Short Optics)

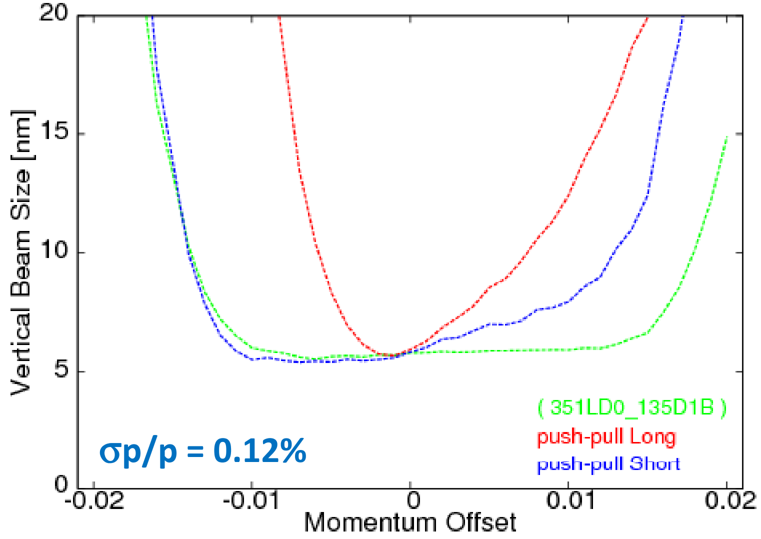


Performances of Short Push-Pull Optics

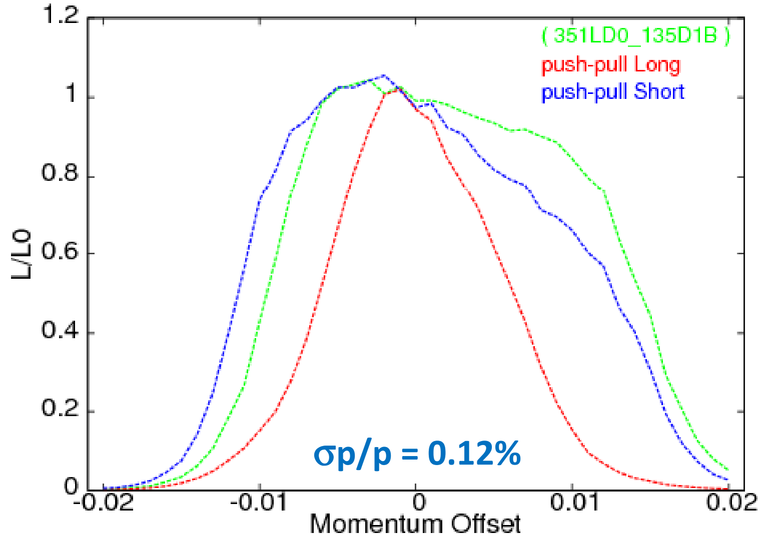
Bandwidth of sigmaX at E=250GeV



Bandwidth of sigmaY at E=250GeV



Luminosity Bandwidth at E=250GeV



The luminosity bandwidth was improved from original Push-Pull optics.