RE-OPTIMIZATION OF THE FINAL FOCUS SYSTEM OPTICS WITH VERTICAL CHROMATICITY CORRECTION

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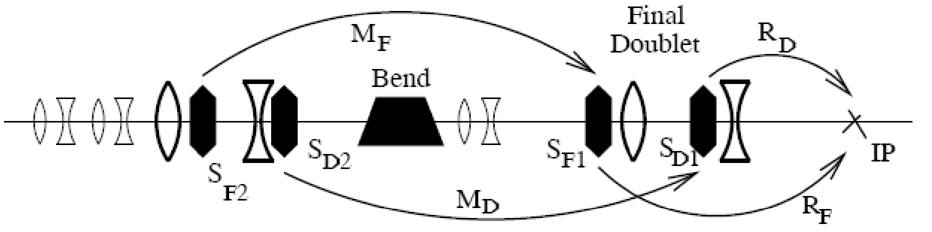
Introduction

- Final Focus System (FFS)
  - demagnify the beam to the required size at the IP
  - This can be done in a compact way based on a local chromaticity correction.

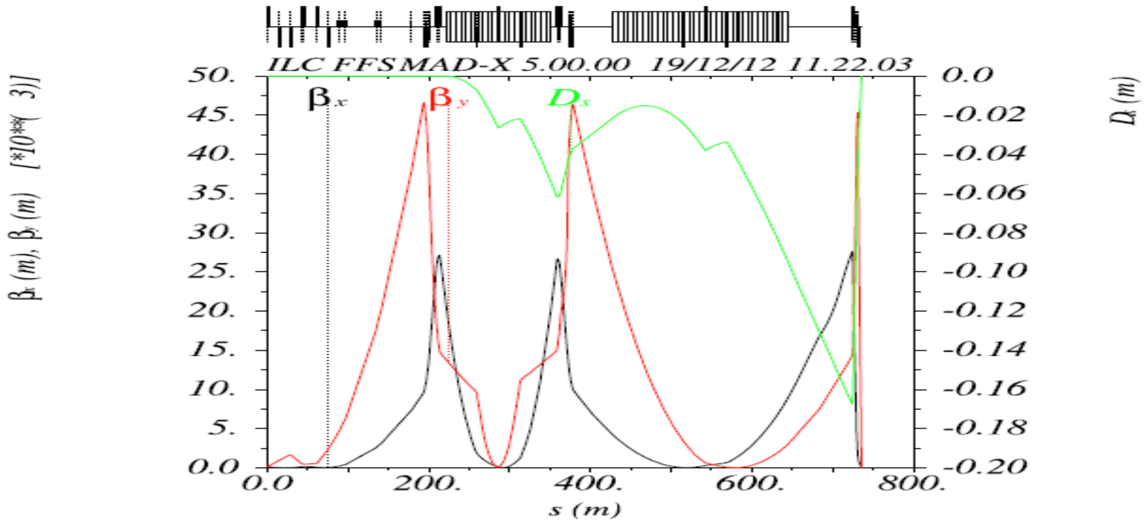
  (P. Raimondi and A. Seryi, SLAC-PUB-8460)



- In FFS (http://clicr.web.cern.ch/CLICr/ILC/):
  - Final doublet (QF1, QD0) provide focusing.
  - Two sextupoles (SF1, SD0) and a bend will locally cancel the chromaticity.
  - Two more sextupoles (SF5, SD4) to cancel geometric second order aberrations and high order ones
  - One more sextupole (SF6) helps to cancel higher order aberrations.
  - First peak of β function needed for T166 cancellation .
  - Matching quadrupoles (QM16-11) to match the incoming β function.

Introduction

- Idea of chromaticity correction mainly in the vertical plane
  - for a small enough beam energy spread and enlarged βx*
  - chromaticity on horizontal plane will be smaller
  - It may be possible to get a smaller vertical beam size with chromaticity correction mainly in the vertical plane using fewer sextupoles: 2 or 3 instead of 5
  - If it works, we will also not need the first peak of β, which will reduce overall vertical chromaticity. This can lead to a simpler and more compact FFS optics.



chromaticity correction in both plane

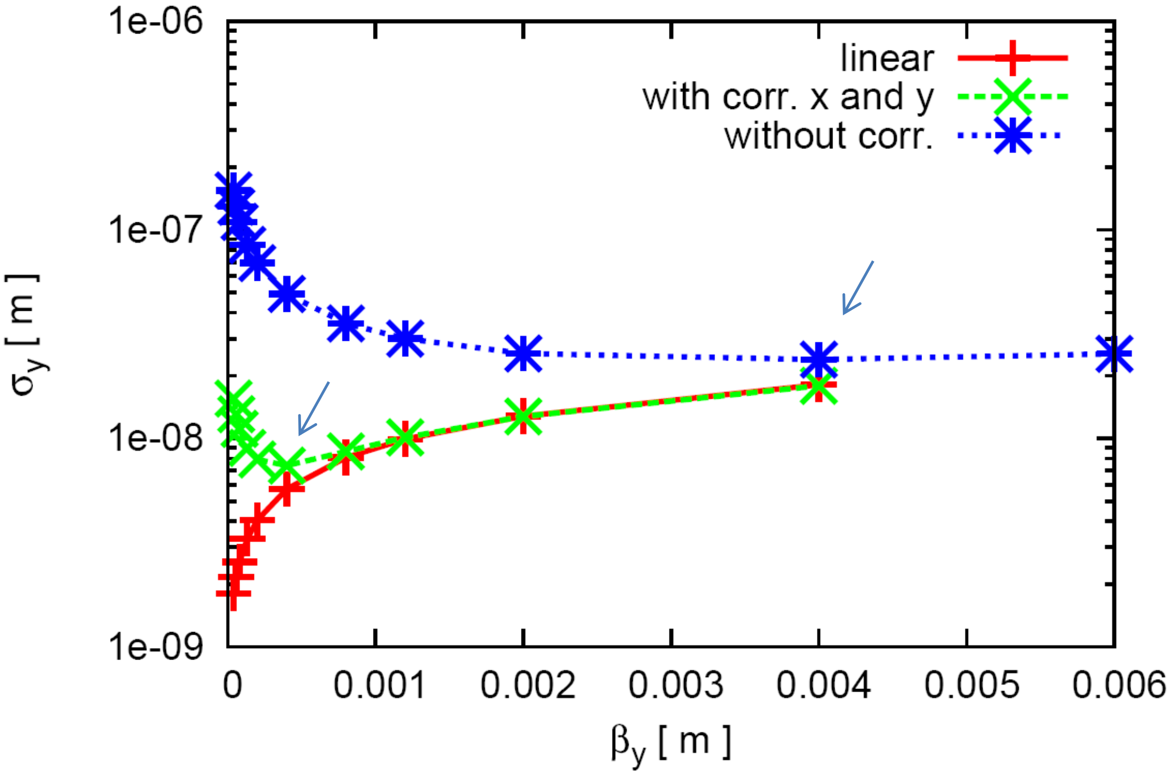
- Parameters at FFS Entrance :
  - emittxn=10um·rad, emittyn=40nm·rad; (same with BDS entrance)
  - σz=300um, σE/E0=0.06%; (same with BDS entrance, gaussian)

chromaticity correction in both plane

- Working procedures:
- Slightly refit QF1
  - get Dx*=0 (original -0.002m)
- Fit matching quadrupoles QMs
  - get wanted βx*, βy*
  - maintain αx*=0, αy* =0
- Fit sextupoles SD0, SF1, SD4, SF5, SF6
  - cancel T122, T126, T166, T324, and T346
- Tracking with MADX to get beam size

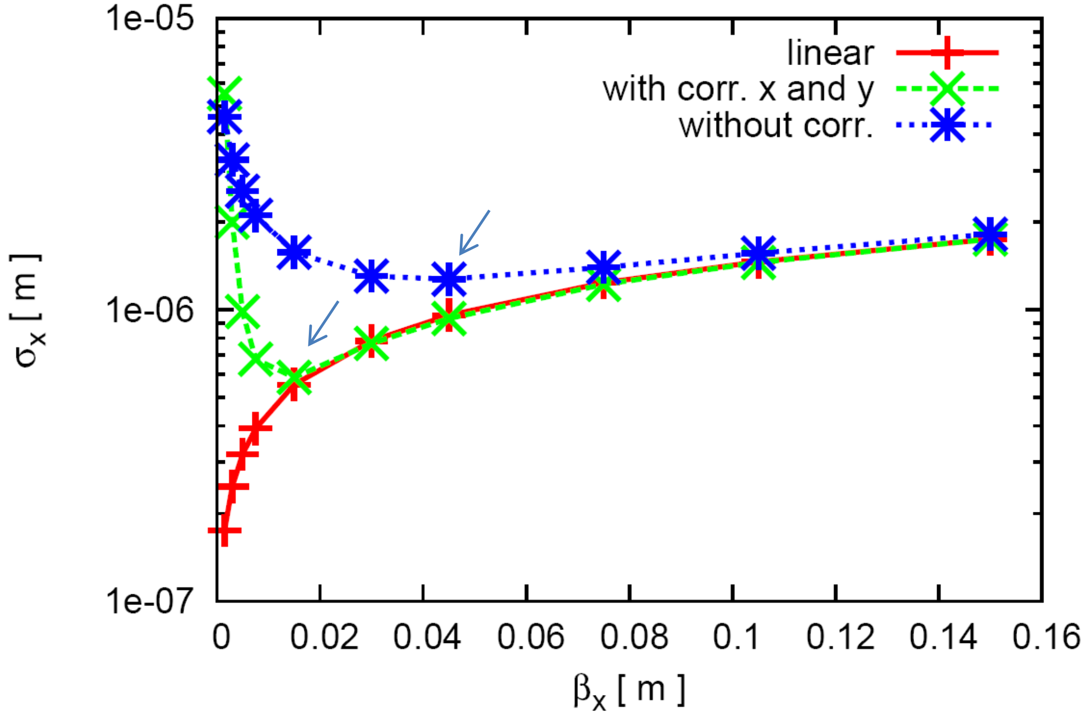
chromaticity correction in both plane

- nominal βx*=15mm, variable βy*
  - without chromaticity correction: σy* minimized when βy*=4mm --- focusing and chromaticity balanced
  - with chromaticity correction: σy* minimized when βy*=0.4mm (nominal)



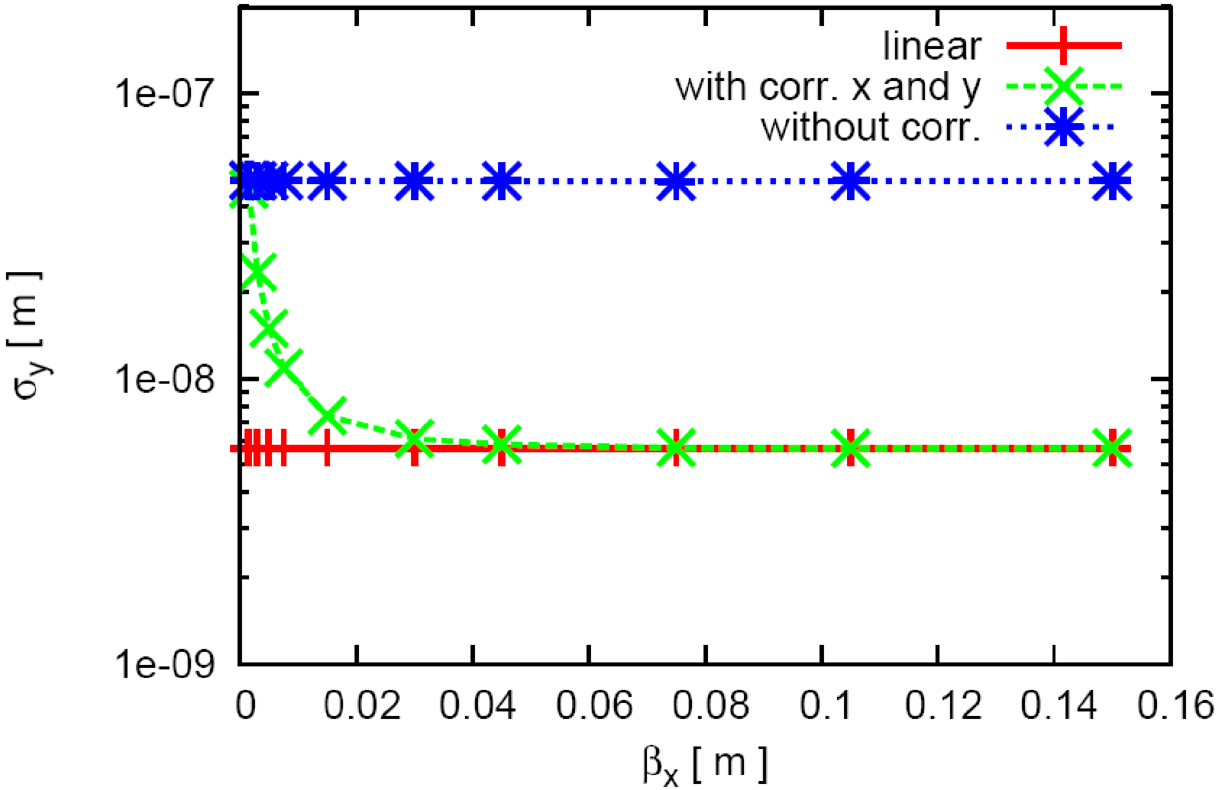
chromaticity correction in both plane

- nominal βy*=0. 4mm, variable βx*
  - without chromaticity correction: σx* minimized when βx*=45mm
  - with chromaticity correction: σx* minimized when βx*=15mm (nominal)



chromaticity correction in both plane

- nominal βy*=0. 4mm, variable βx*
  - Influence of variable βx* on σy*
  - Third order coupling aberrations enhance the vertical beam size for small βx*.

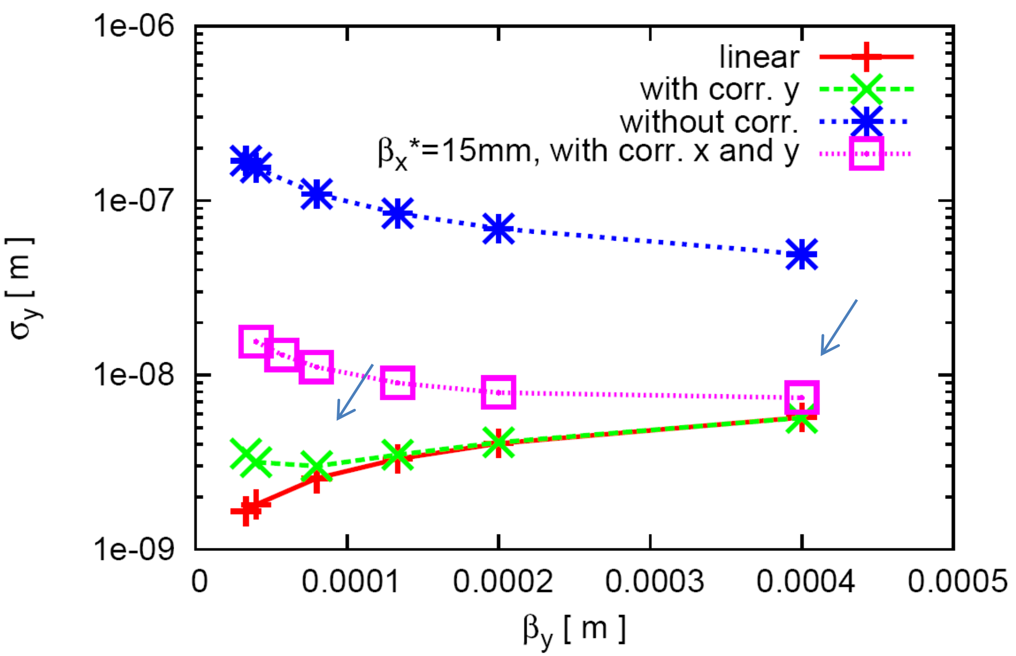


chromaticity correction mainly in the vertical plane

- Working procedures:
- Fit matching quadrupoles QMs
  - get wanted βx^*, βy^*
  - maintain $\alpha x^*=0$, $\alpha y^* =0$
- Turn off SF1, SF5, SF6 and fit sextupoles SD0, SD4
  - cancel T324, T346
- Tracking with MADX to get beam size

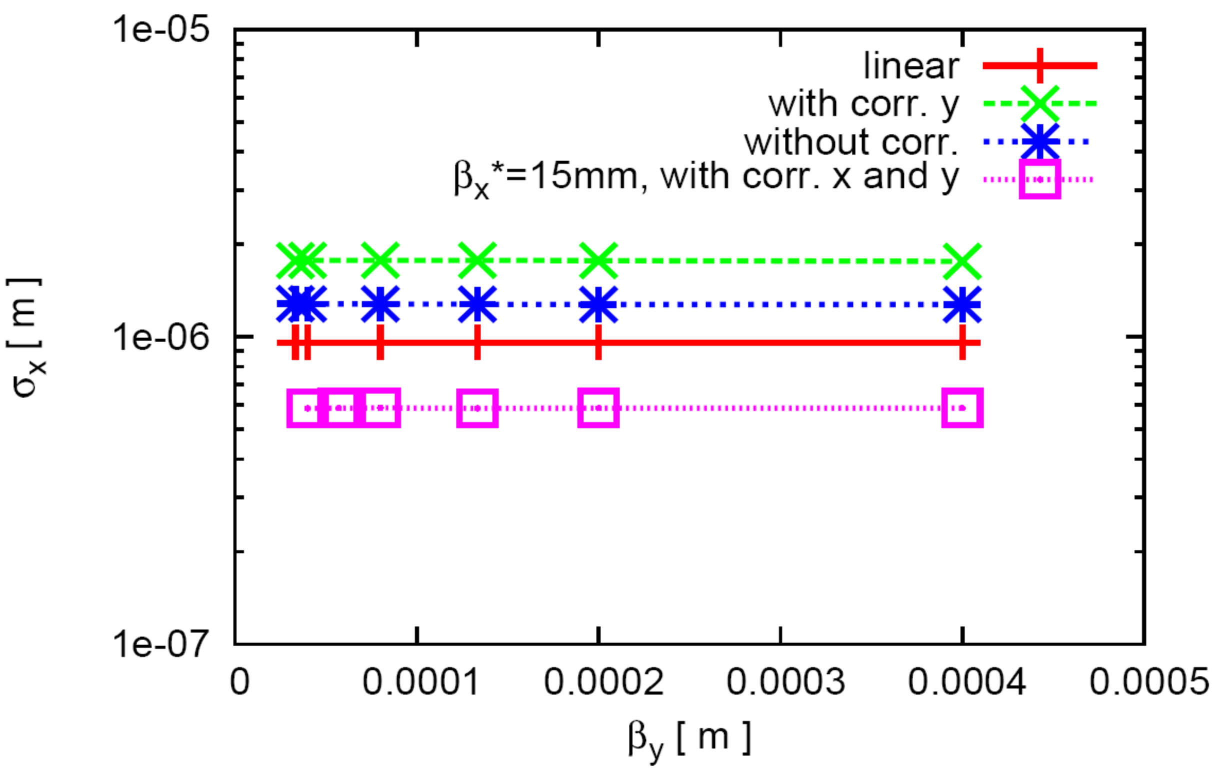
chromaticity correction mainly in the vertical plane

- enlarged βx*=45mm, variable βy*
  - choose βx*=45mm: as without chromaticity correction, σx* minimized
  - with chromaticity correction mainly in the vertical plane (green line): σy* minimized when βy*= 0.08mm
  - σy*=0.4·σy_nom* (σx*=3·σx_nom*)
  - It seems possible to get a smaller σy* and not decrease the luminosity with chromaticity correction mainly in the vertical plane. There's room for optimization.



chromaticity correction mainly in the vertical plane

- enlarged βx*=45mm, variable βy*
  - σx* increased as the horizontal chromaticity contributions from SD0, SD4



Conclusions

- With chromaticity correction in both plane
  - beam sizes minimized when β function are nominal values
- With chromaticity correction mainly in vertical plane
  - Turn off SF1, SF5 and SF6 ; fit SD0, SD4 to cancel T324, T346
  - with enlarged $\beta x^*=45mm$, beam sizes minimized when $\beta y^*=0.08mm$: $\sigma x^*=3\cdot\sigma x\_nom^*$, $\sigma y^*=0.4\cdot\sigma y\_nom^*$
  - It seems possible to get a smaller vertical beam size with chromaticity correction mainly in the vertical plane using fewer sextupoles and not decrease the luminosity.

- **Plan for further work** :
  - 1) optimization of sextupole fitting in present scheme without change to the linear optics (3 or 4 sextupoles, MAPCLASS)
  - 2) redesign of the linear optics to remove the upstream intermediate focus (no longer needed in this design), thereby reducing the vertical chrom-aticity; reduce the two remaining sextupole strengths by increasing the bend magnet angle (radiation effects not so important with larger horizontal beam size), thereby further reducing the remaining aberrations
  - 3) check of disruption conditions and confirmation of reduced beamstrahlung (e.g. using Guinea-Pig or CAIN)
  - 4) study as function of emittances and energy spread (suggested by Daniel and Pantaleo)
    5) application to ATF2 (both the schemes with unchanged and new linear optics)
  - 6) study of the tuning procedure with such an FFS with only 2 sextupoles
  - 7) consider these new proposed IP parameters in the context of overall ILC parameters optimization

Thanks for your attention!

Reserved

Concerning the energy spread

- 0.125%/0.07% for e-/e+ (to be published soon in TDR)
  - 0.06% we used
  - check the behaviour as a function of energy spread up to 0.2%

chromaticity correction in both plane

- nominal βx* and βy*:
- Sextupoles refitted
- Entrance :
  - betx= 86m, bety= 171m;
  - alfx=-2.6, alfy= -2.7;
  - dx=0,dpx=0;
  - emitxn=10um*rad, emityn=40nm*rad; (same with BDS entrance)
  - sigmaz=300um, sigmaE=0.06%;
- IP:
  - betx= 15mm, bety=0.4mm;
  - alfx=0, alfy=0;
  - dx=0 (original -0.002m; fit with QF1), dpx= 0.008;
  - emittx= 10.2um*rad, emitty= 47.5nm*rad;
  - sigmax=0.55um, sigmay= 5.7nm; (linear)
  - sigmax= 0.59um, sigmay=7.4nm; (track)