σ_x^*, Limitations and Improvement Paths

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σ_x^* limitations from the BDS

Further focusing in the FFS faces:

- Quadrupole aperture
- Chromatic aberrations
- Synchrotron Radiation

Possible solutions:

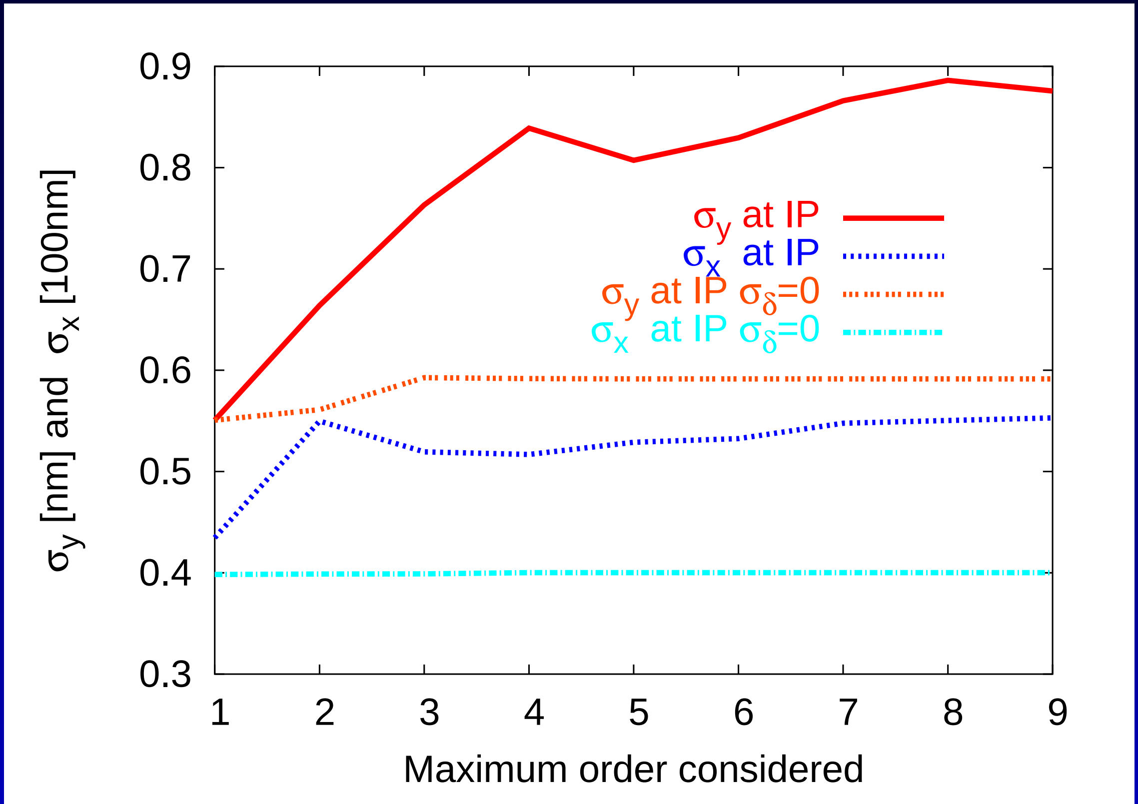
- Emittance reduction, dispersion reduction or larger aperture quadrupoles.
- Multipolar correctors to compensate aberrations.
- Dispersion reduction.

Quadrupole aperture

- Present design, permanent magnet, aperture=3.8mm
- Superconducting option is difficult due to small size (CLIC note 506)
- $10\sigma_x = 10\sqrt{\epsilon_x\beta_x + D^2\delta^2}$=3.1mm
- More focusing needs larger β_x.
- Doubling β_x implies $10\sigma_x =$3.5mm
- Doubling β_x and reducing D by 25% implies $10\sigma_x =$3.1mm

BDS chromatic aberrations

Optical rms beam sizes using MAPCLASS (no SR)

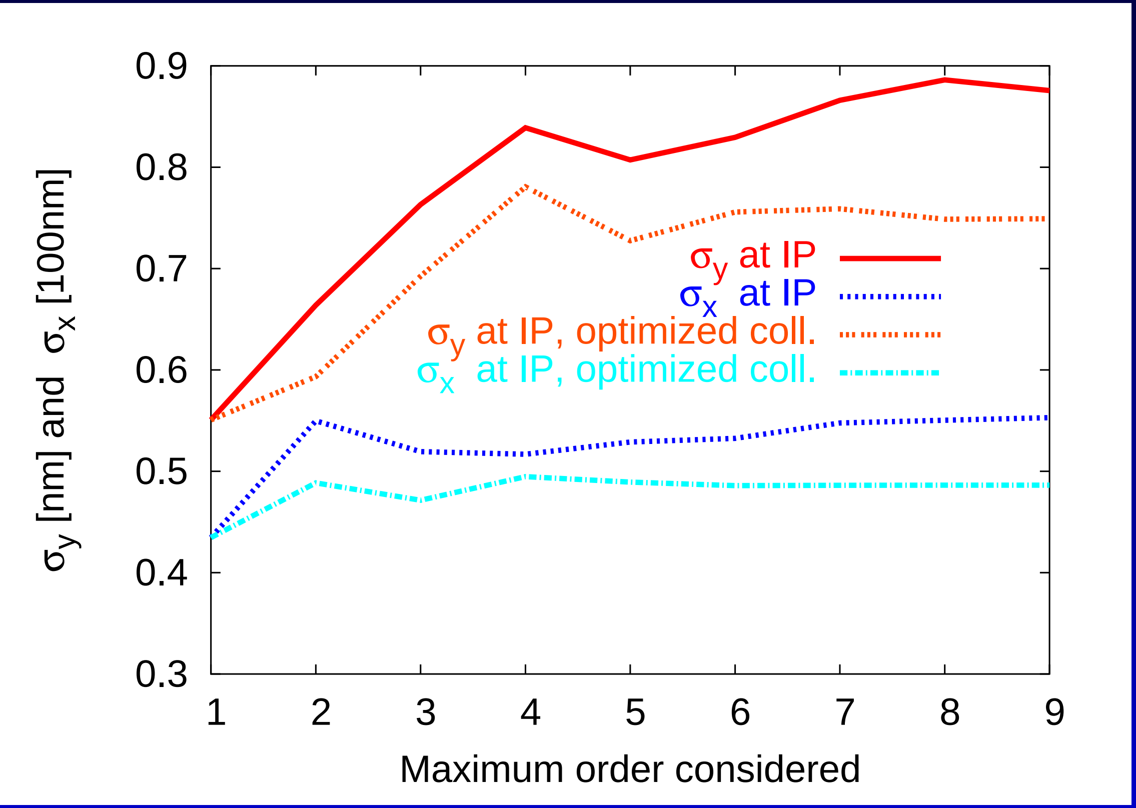


$\Rightarrow$ Almost pure chromatic aberrations

$\Rightarrow$ Correctable with appropiate multipolar magnets

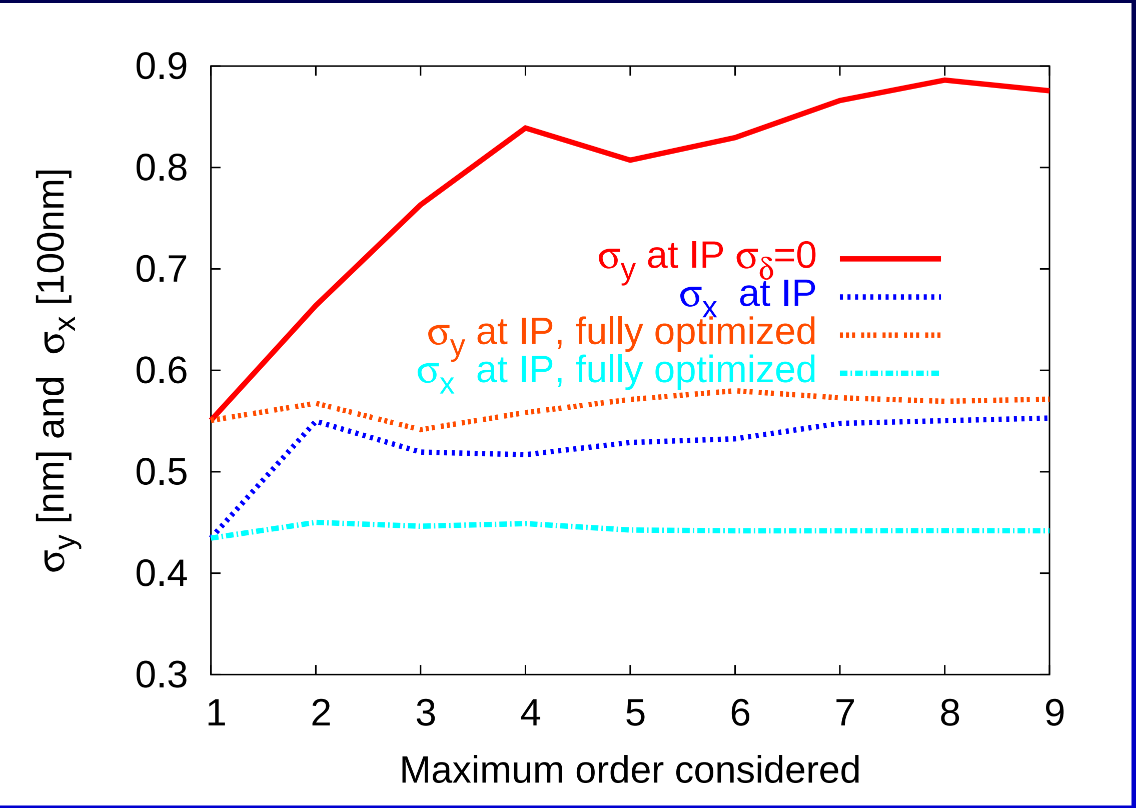
Collimation section chromatic aberrations

Sextupoles of the collimation section were overpowered!



FFS aberrations correction

The FFS sextupoles are assumed to be combined magnets with sextupolar, octupolar and decapolar fields used for correction

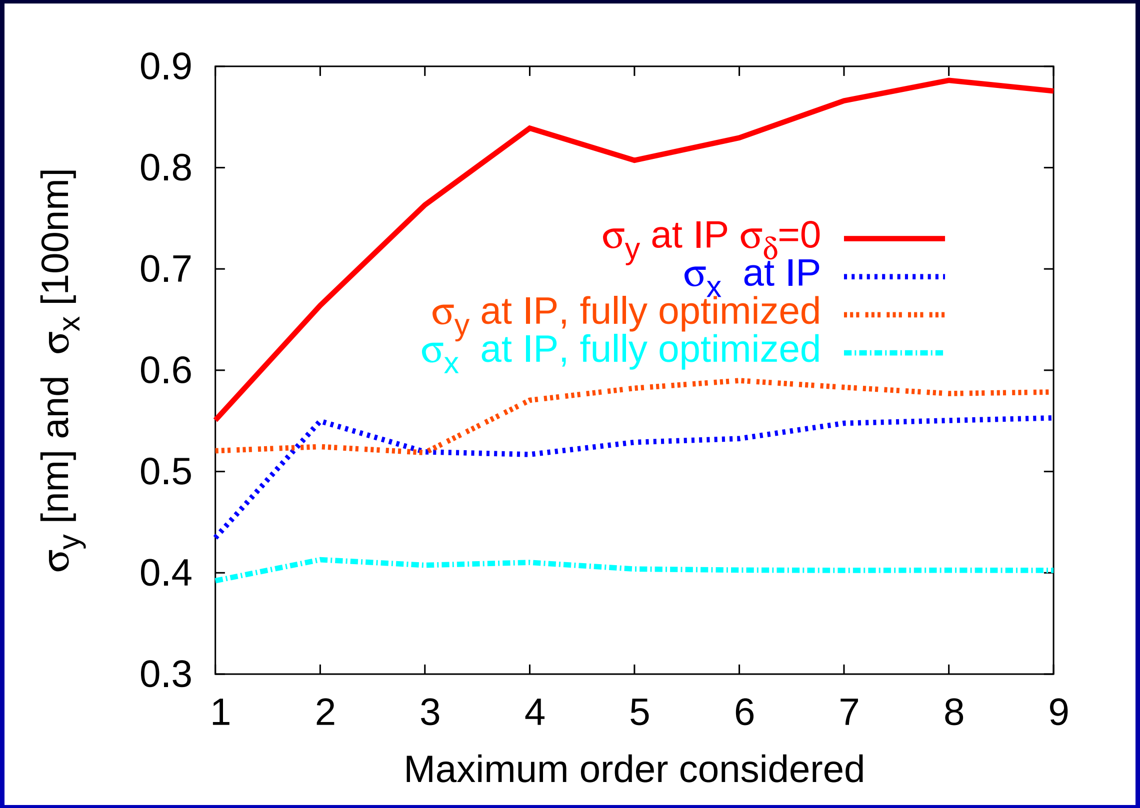


⇒ Almost total correction of aberrations

⇒ Now it is possible to focus more

More focusing

The FFS quadrupoles are used to focus more



$\Rightarrow$ Need to stop focusing when aberrations arise

$$\Rightarrow \Delta\beta_x^{QF}/\beta_x^{QF} = +42\%\ ,\ \Delta\beta_x^{IP}/\beta_x^{IP} = -19\%$$

σ_x^*, synchrotron radiation & luminosity

Nominal Total Luminsoty=6.15 10^{34} cm^{-2}s^{-1}

Luminosity in energy peak (1%)=2.65 10^{34} cm^{-2}s^{-1}

σ_x^{rms}=88 nm, σ_x^{gauss}=57 nm

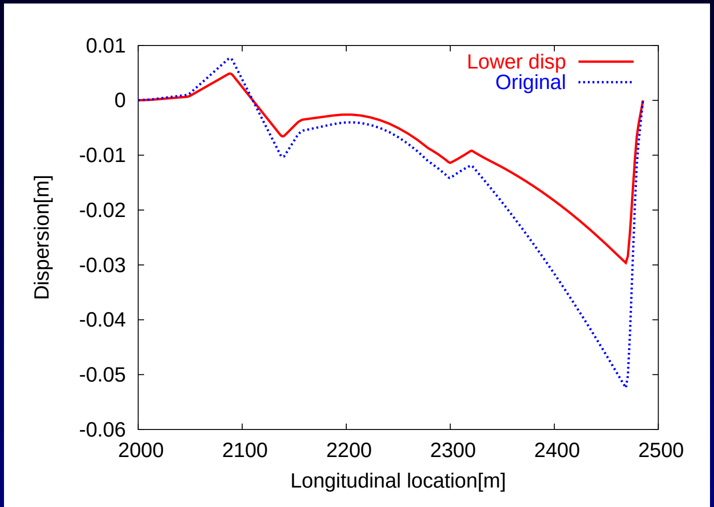
$Case$	$-\frac{\Delta\sigma_x}{\sigma_x^{rms}}$	$-\frac{\Delta\sigma_x}{\sigma_x^{gauss}}$	$\frac{\Delta L_{tot}}{L_{tot}}$	$\frac{\Delta L_{1\%}}{L_{1\%}}$	$\frac{L_{1\%}}{L_{tot}}$
Nominal	0	0	0	0	43
Coll corrected	30	6	9	6	42
Sexts, oct & decs	35	7	31	19	39
More focusing	37	14	45	29	38

(All numbers are percent)(Tracking with PLACET including SR)

Conclussions and outlook I

- σ_x^{gauss}=49 nm has been achieved with 45% luminosity increase
- Further focusing will require more optimization iterations and probably more corrector magnets
- Reduction of dispersion in the FFS quads could relax aperture constrains and increase luminosity due to the reduction of SR. Steps to take:
  1. Match the dispersion to a lower value
  2. Match multipolar correctors to compensate aberrations
  3. Check beam sizes, SR, luminosity

Conclussions and outlook II



$Case$	$-\frac{\Delta\sigma_x}{\sigma_x^{rms}}$	$-\frac{\Delta\sigma_x}{\sigma_x^{gauss}}$	$\frac{\Delta L_{tot}}{L_{tot}}$	$\frac{\Delta L_{1\%}}{L_{1\%}}$	$\frac{L_{1\%}}{L_{tot}}$
More focusing	37	14	45	29	38
Lower disp	22	16	47	32	38

$\Rightarrow$ Preliminary luminosity results support the reduction of the dispersion in the FFS.