CLIC Beam Delivery System:
New Beam parameters and optics

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- The new diagnostics section for ϵ_y=20nm:
  - Emittance measurement
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- Collimation for ϵ_y=20nm and 311 bunches/train
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- CSR in the BDS?
- News on BDS alignment

Goals & Requisites of Diagnostics

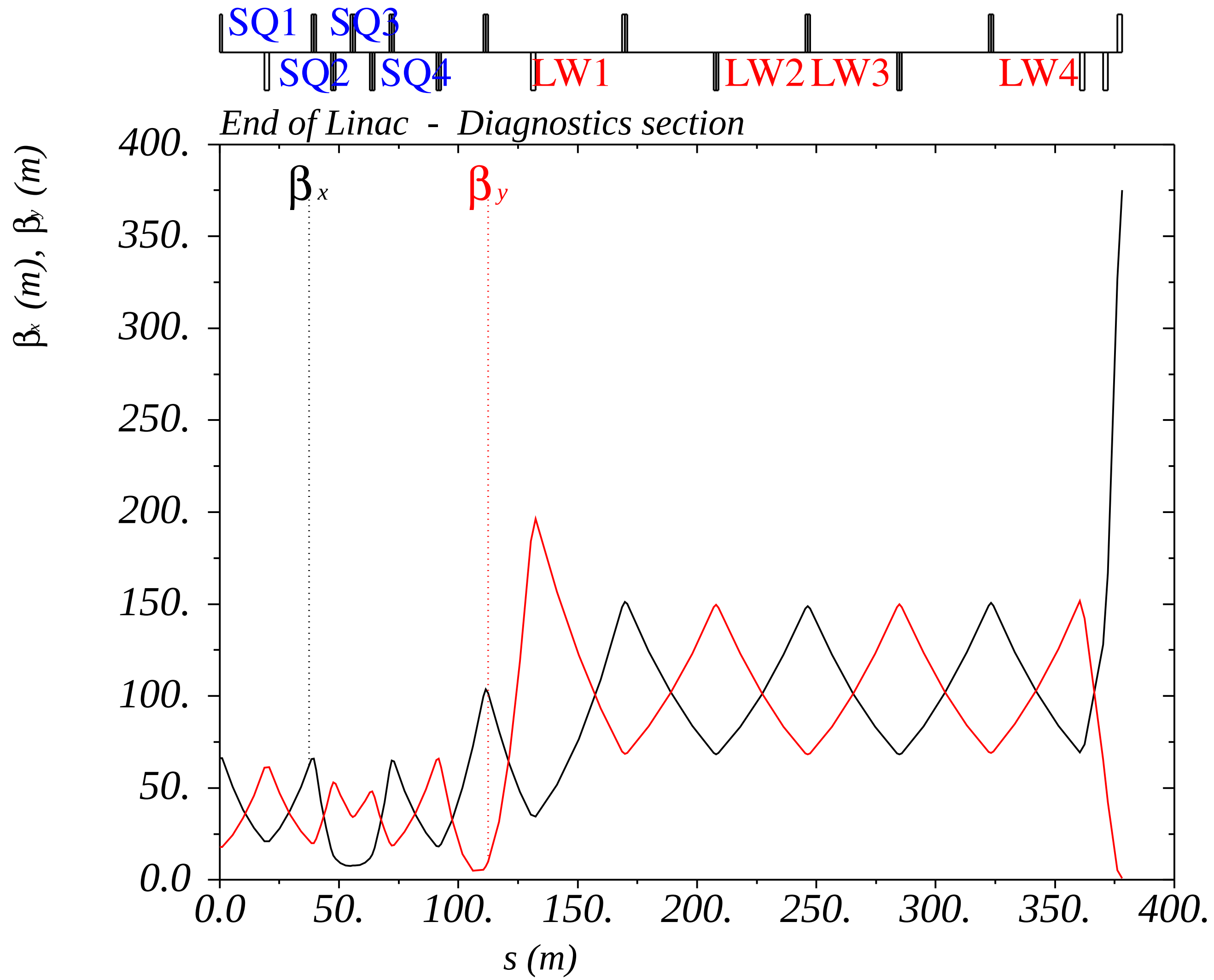
Goals:

- Coupling correction
- Emittance measurement
- Energy measurement (placed in collimation section to save space)

Requisites:

- 4 skew quadrupoles
- 4 laser wires
- Photon detector
- Precise dipole and BPMs

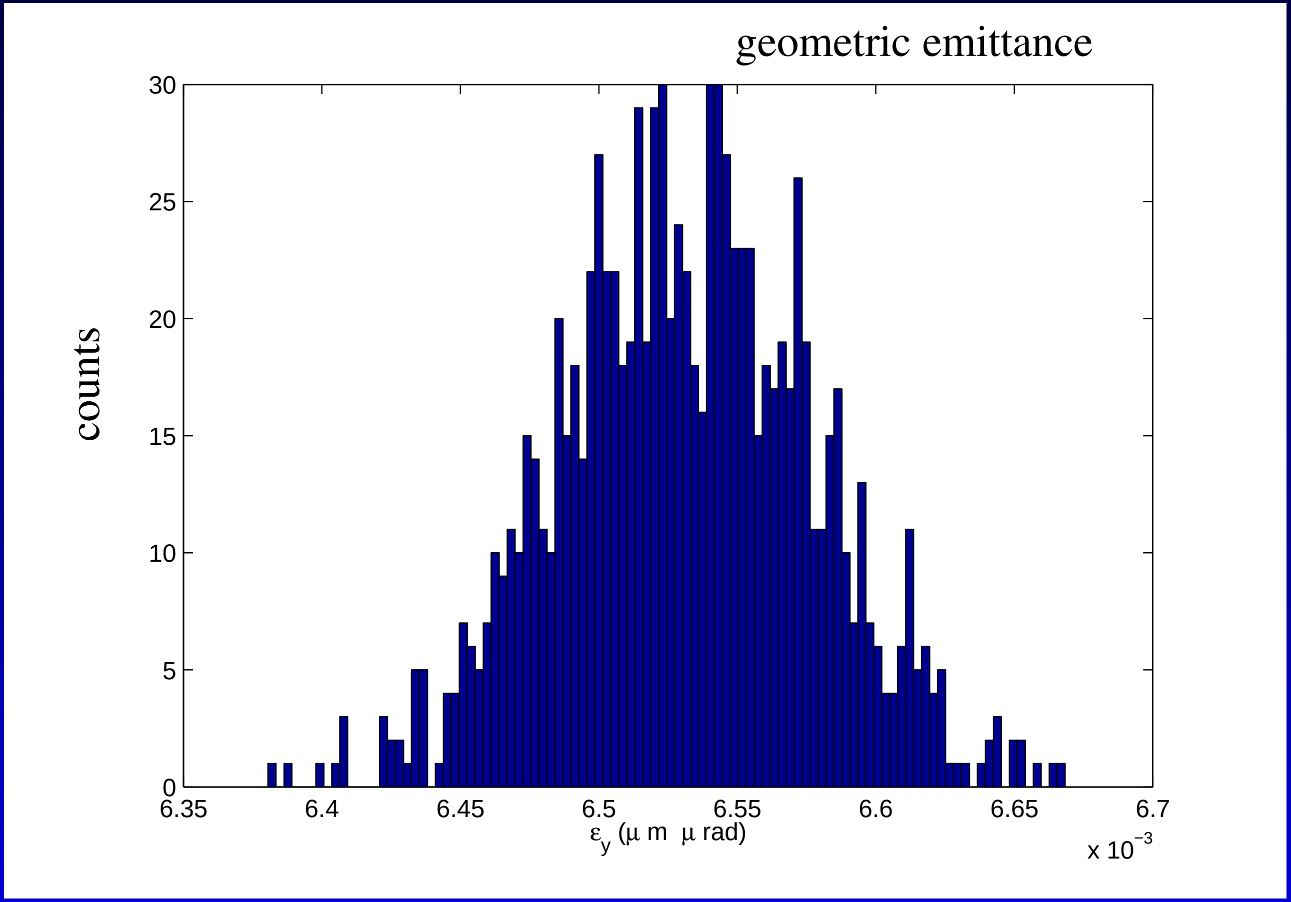
Diagnostics: emittance measurement



σ_y=1μm @ Laser wires (for ϵ_y=20nm)

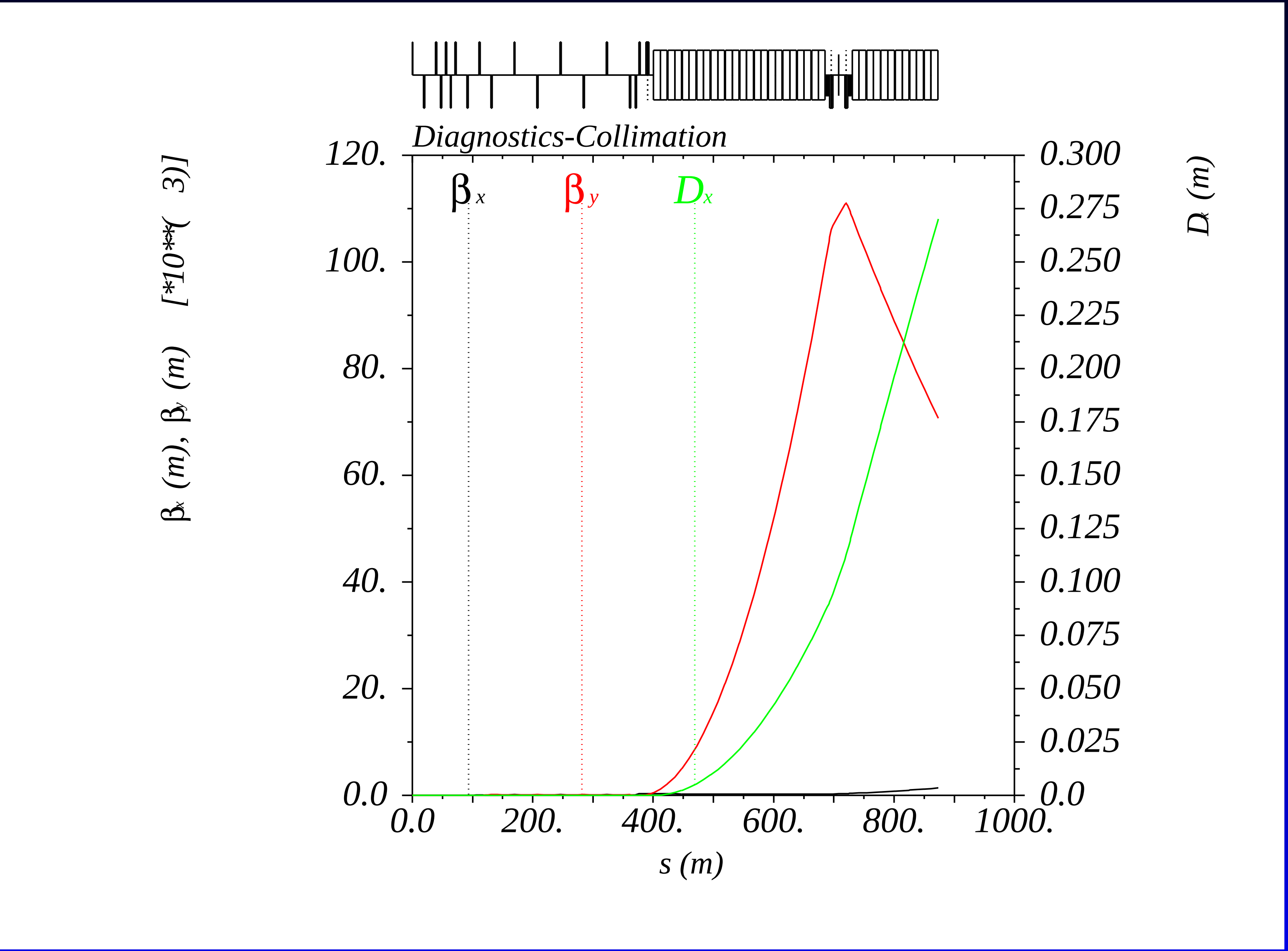
Emittance measurement

Simulations by I. Agapov: 3 trains, 3 wires and 10% error on beam size assumed.

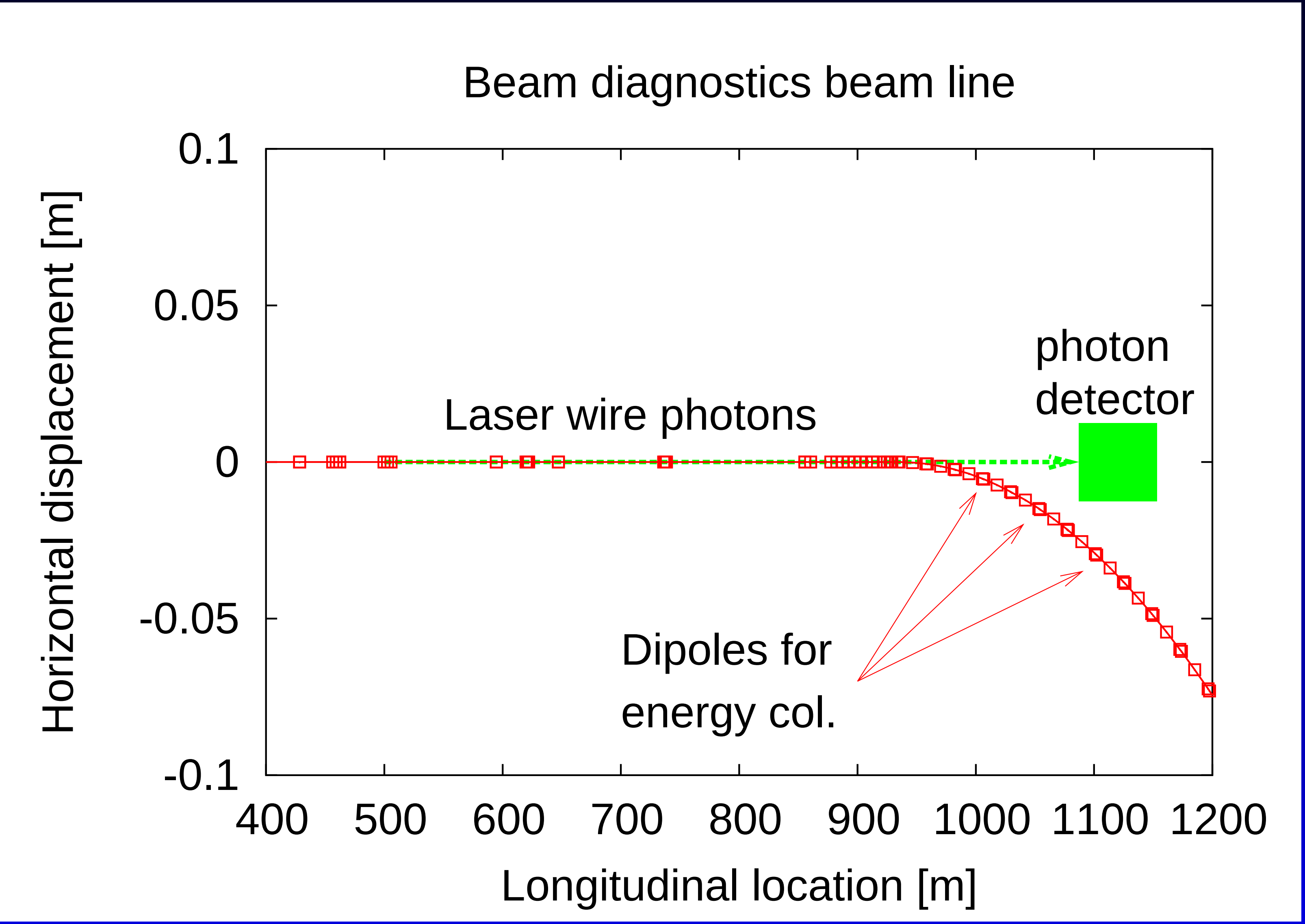


$$\Delta\epsilon_{x,y}/\epsilon_{x,y} \approx 7\%$$

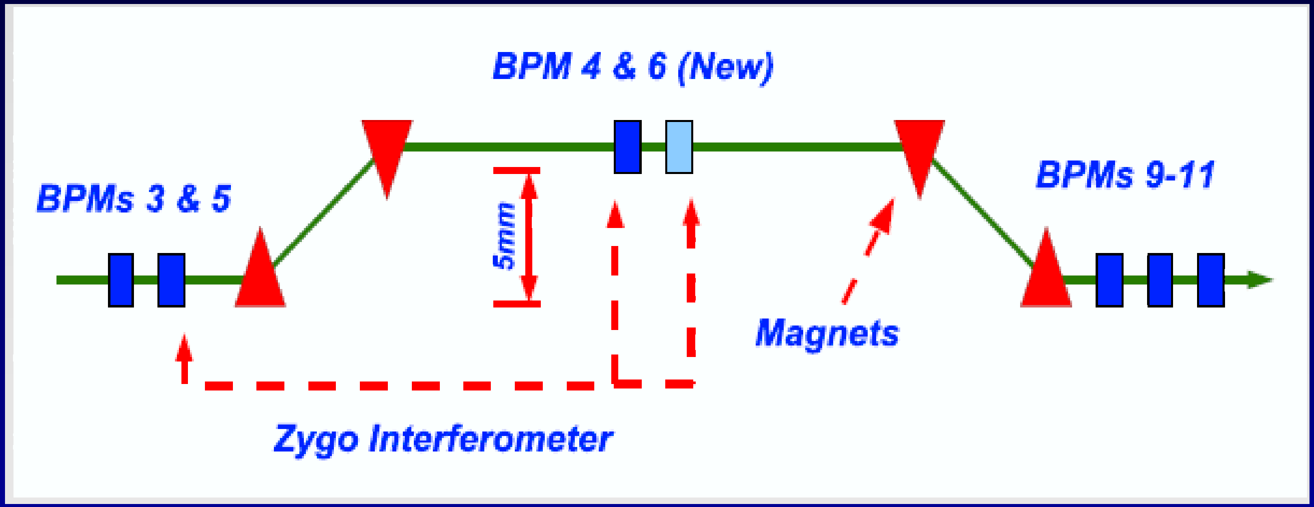
Diagnostics inside collimation



Layout & photon collection

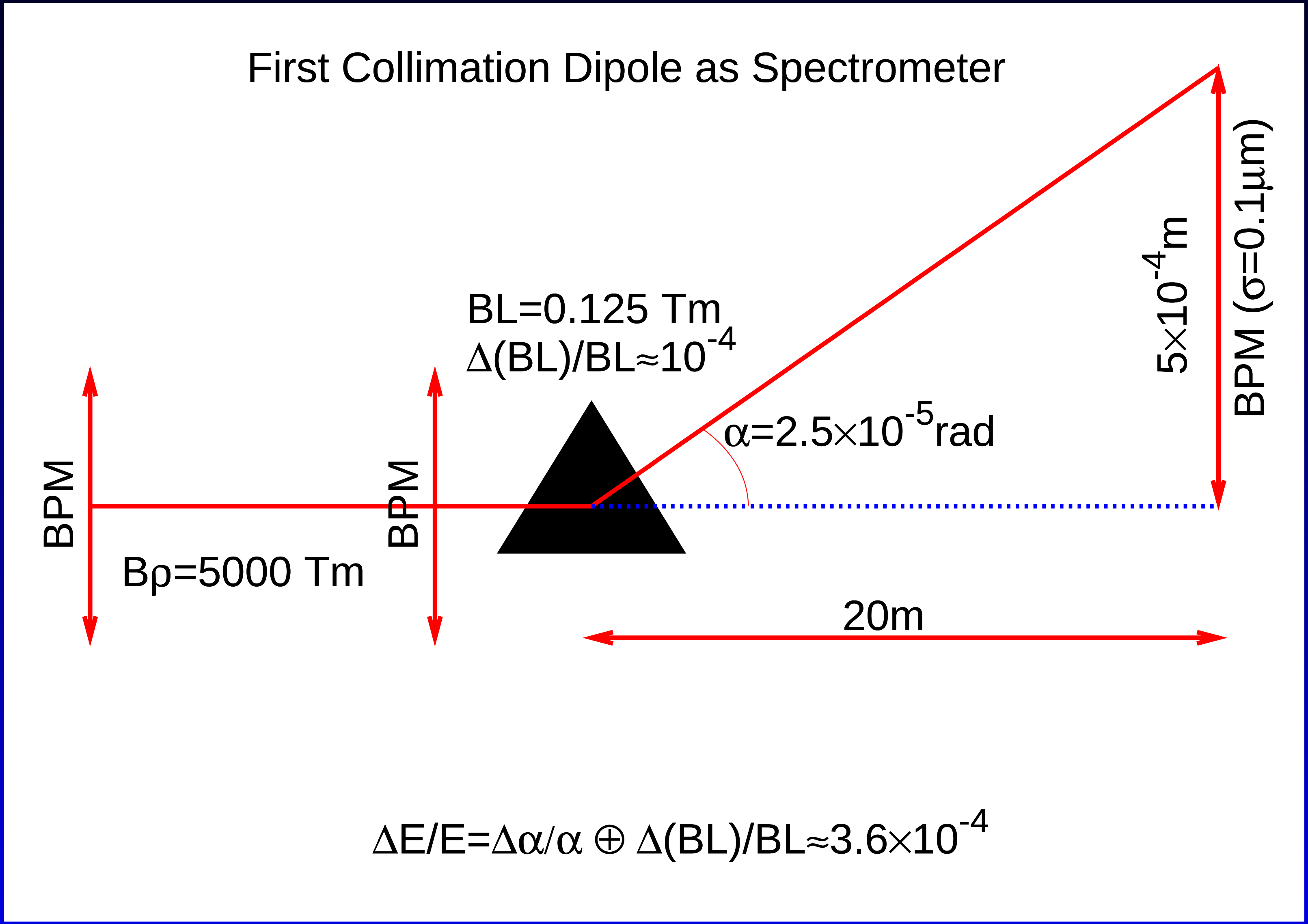


Traditional energy measurement (SLAC)



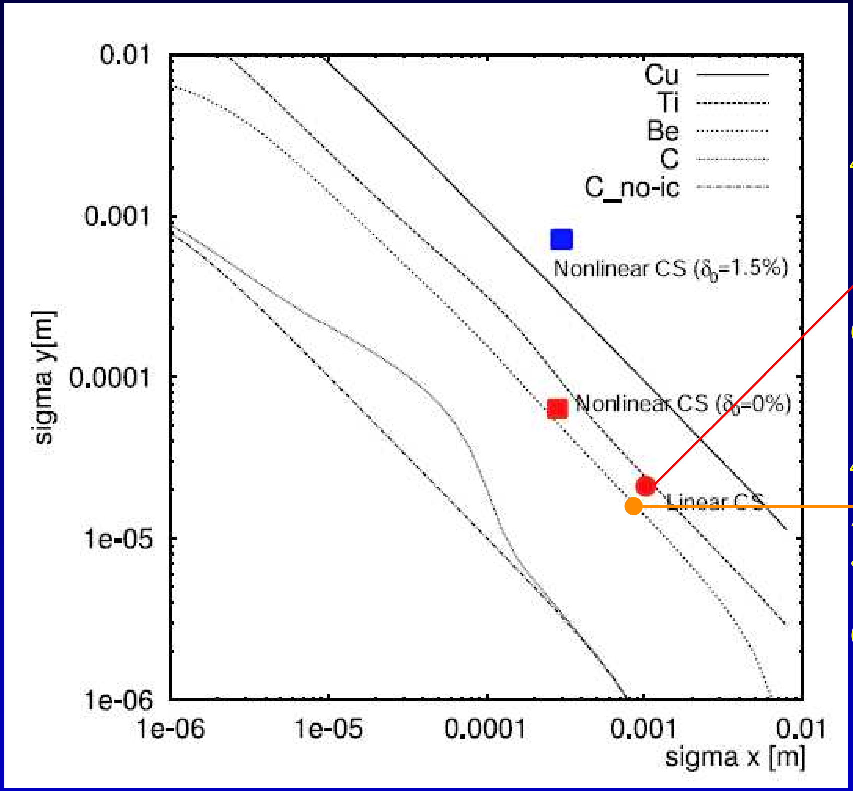
4 Bends chicane: The energy is inferred from BPMs.
Drawback for CLIC: too long!, alternatives:
$\rightarrow$ Compton backscattering (under study @ ILC)
$\rightarrow$ using a single bend?

CLIC compact energy measurement



New parameters and Collimation I

Survival plot from CLIC note 477 and J. Resta's thesis for different materials:



$4 \times 10^9\ e^-$
154 bunches/train
$\epsilon_y = 10nm$

$4 \times 10^9\ e^-$
311 bunches/train
$\epsilon_y = 20nm$

Be collimators on the edge! and now what?

New parameters and Collimation II

Studies to pursue:

- Simulation of energy deposition
- Failure modes analysis

Possible solutions:

- replaceable collimators
- larger betas → longer system
- non-linear collimation system → slightly lower luminosity
- Carbon collimator → Large wakefields

FFS shortening and optimization I

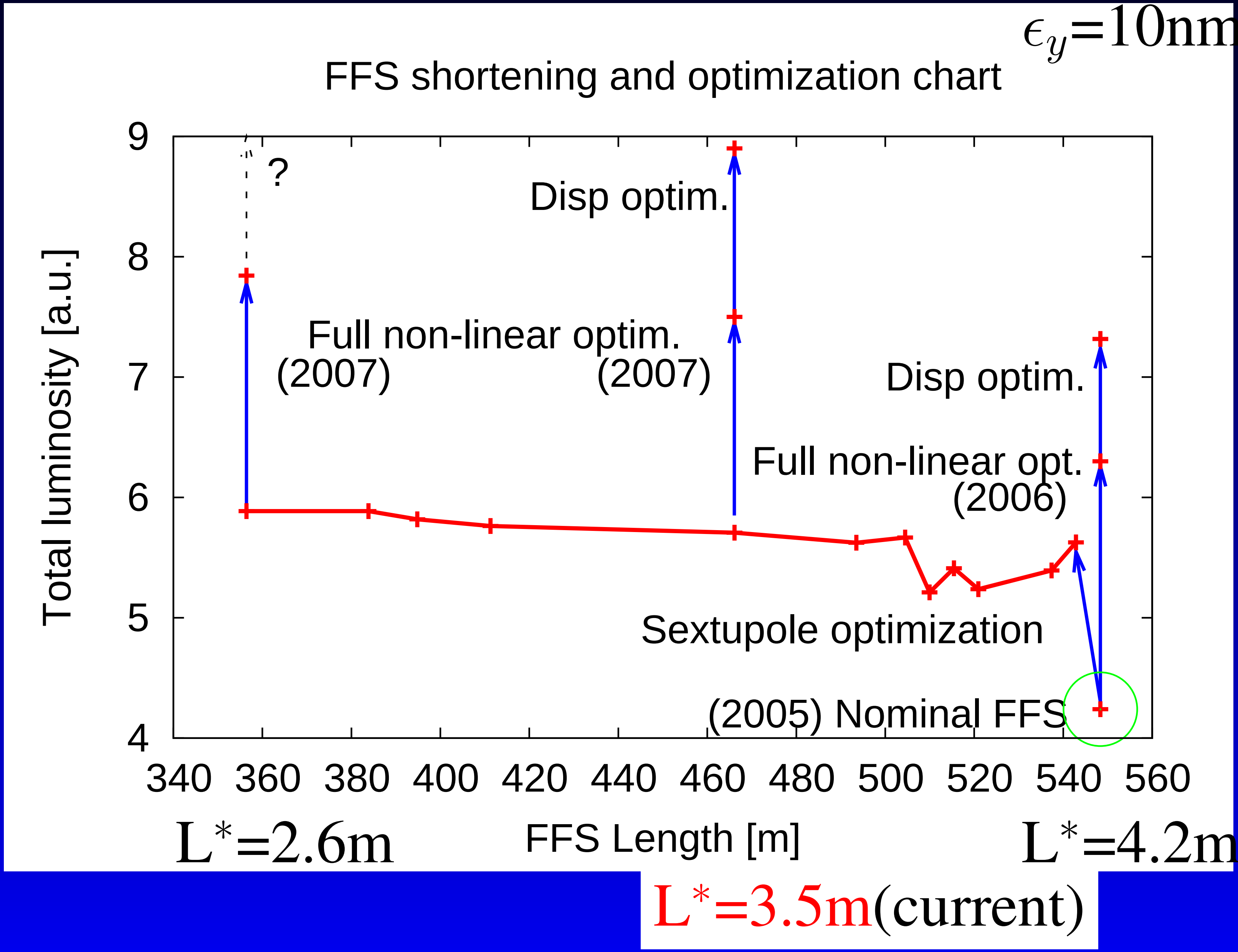
Advantages of a shorter FFS:

- Shorter tunnel
- Lower beta peak (better stability)
- Lower chromaticity (smaller aberrations)
- Shorter L^*

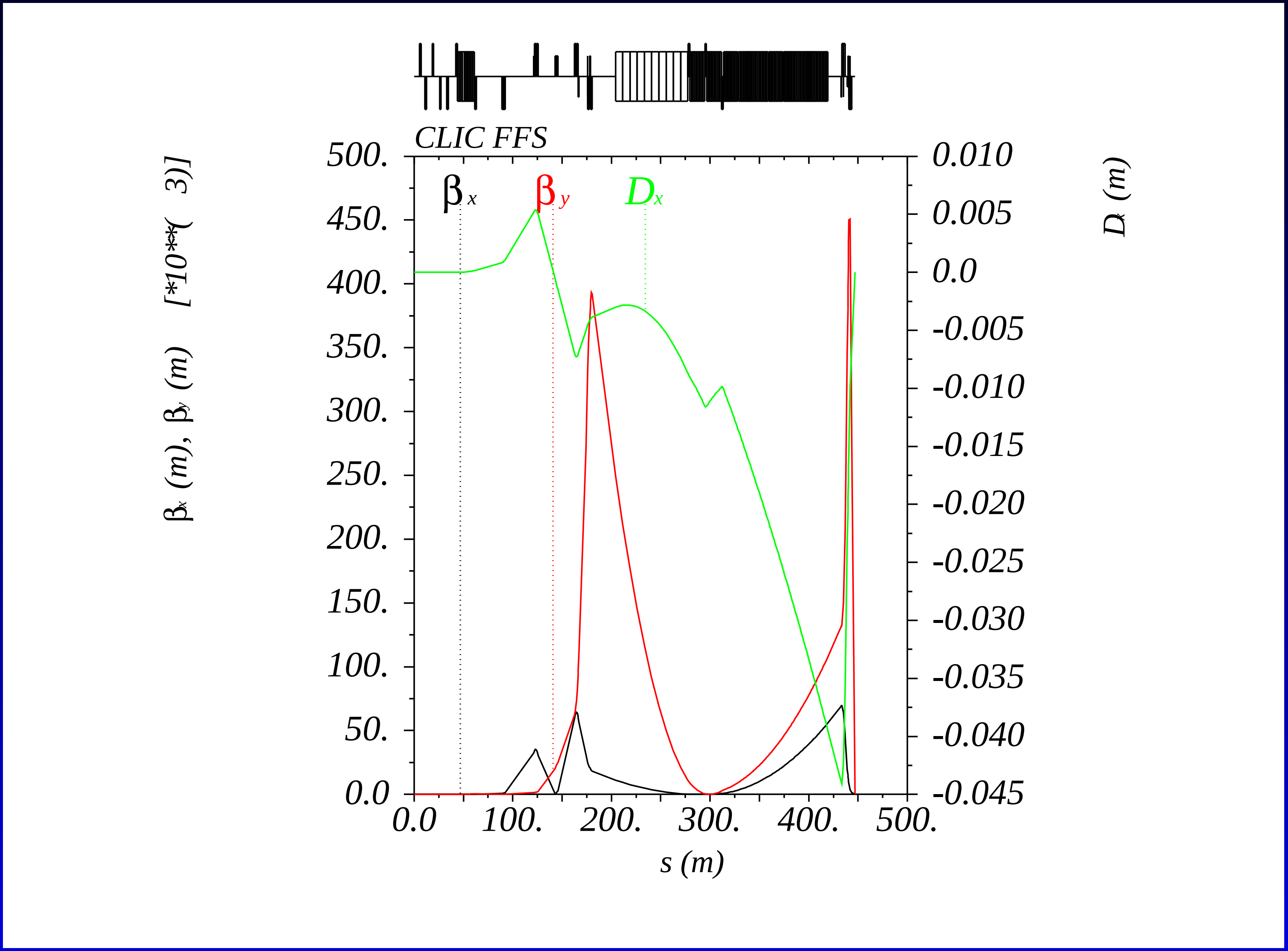
Disadvantages:

- Shorter L^* (detector and solenoid constrains)
- Stronger focusing (quad field)

FFS shortening and optimization II

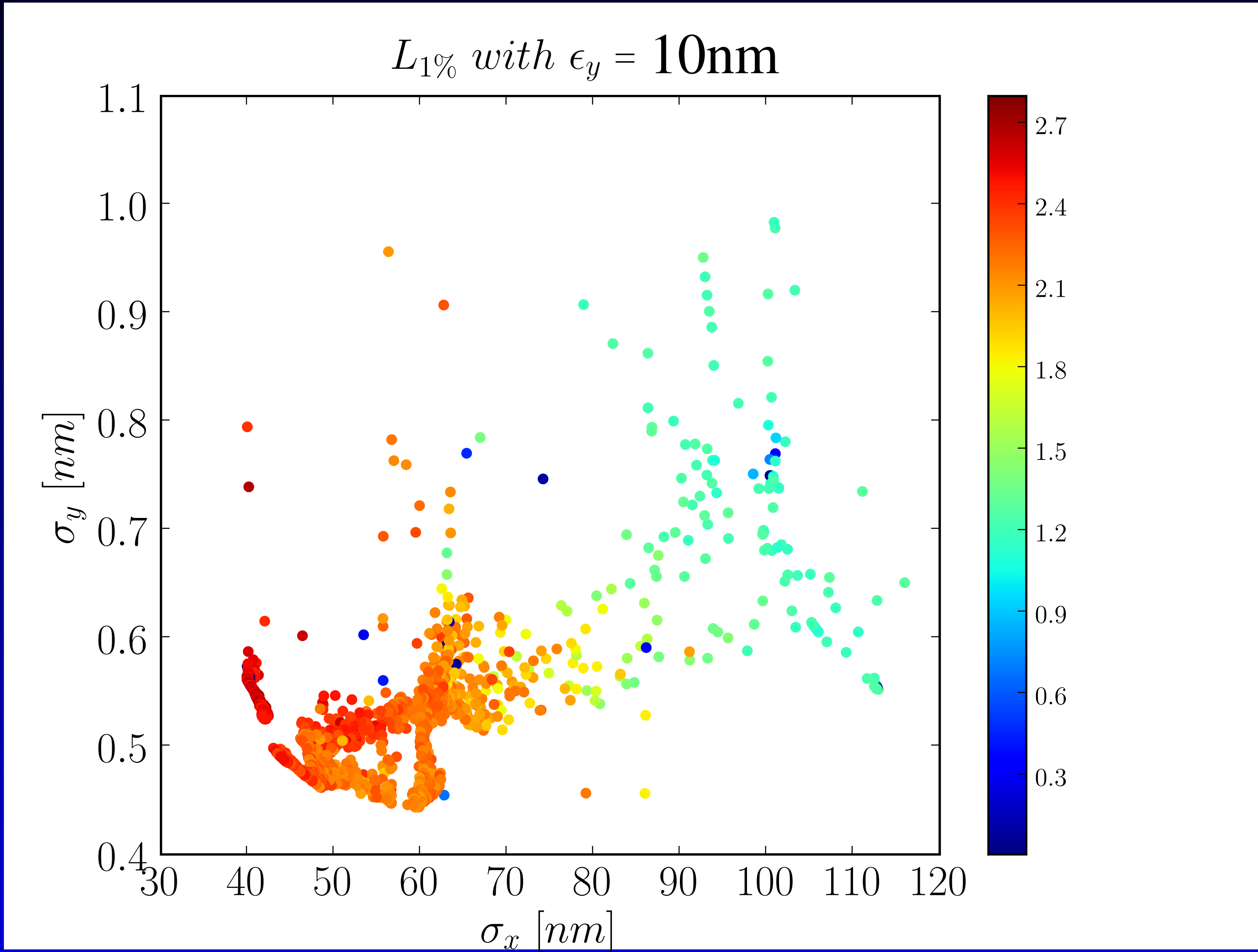


FFS optics for L^*=3.5m



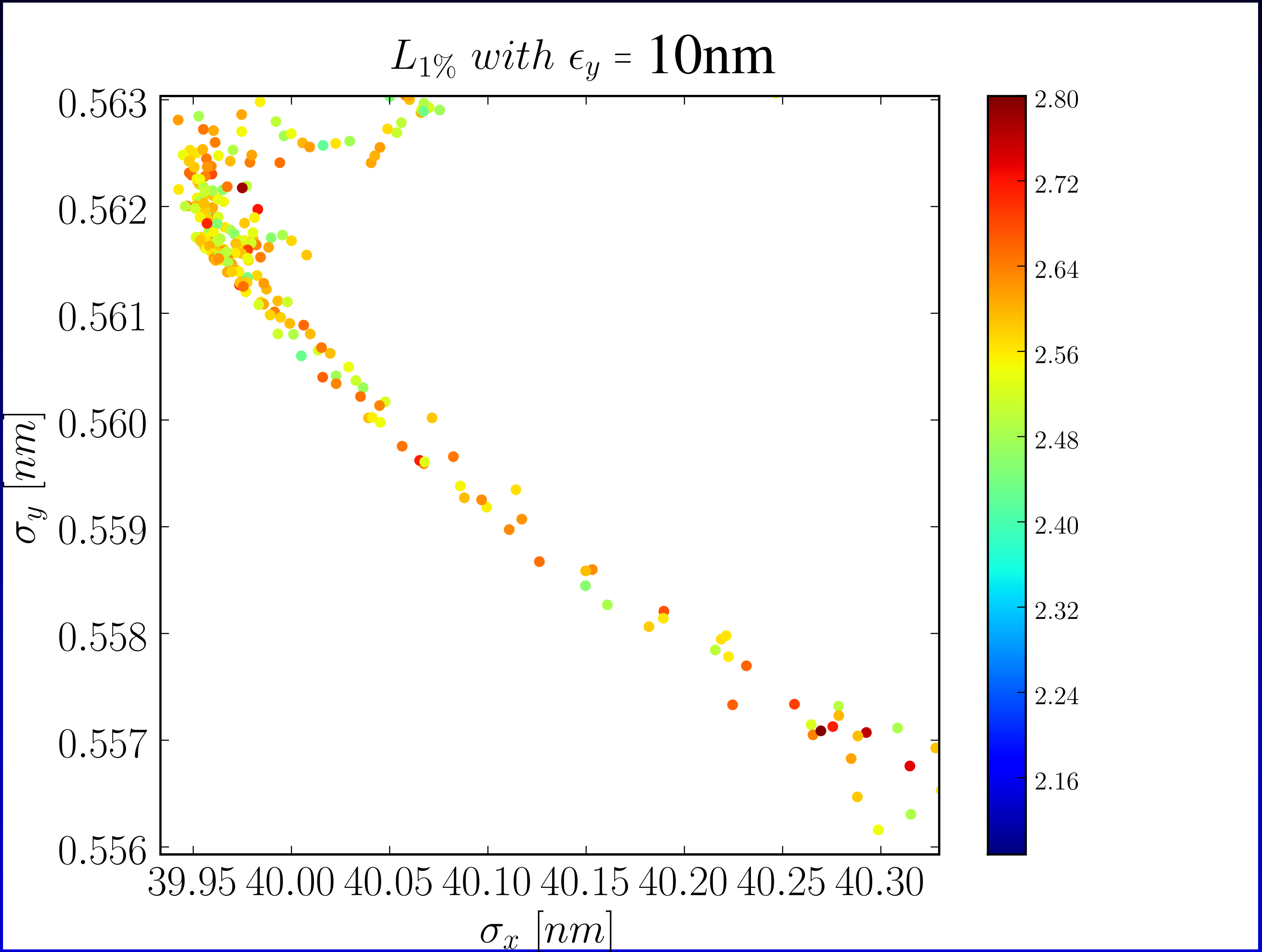
$$\beta_{IP,x} = 8\text{mm}, \beta_{IP,y} = 0.045\text{mm}$$

Non-linear optimization for L^*=3.5m



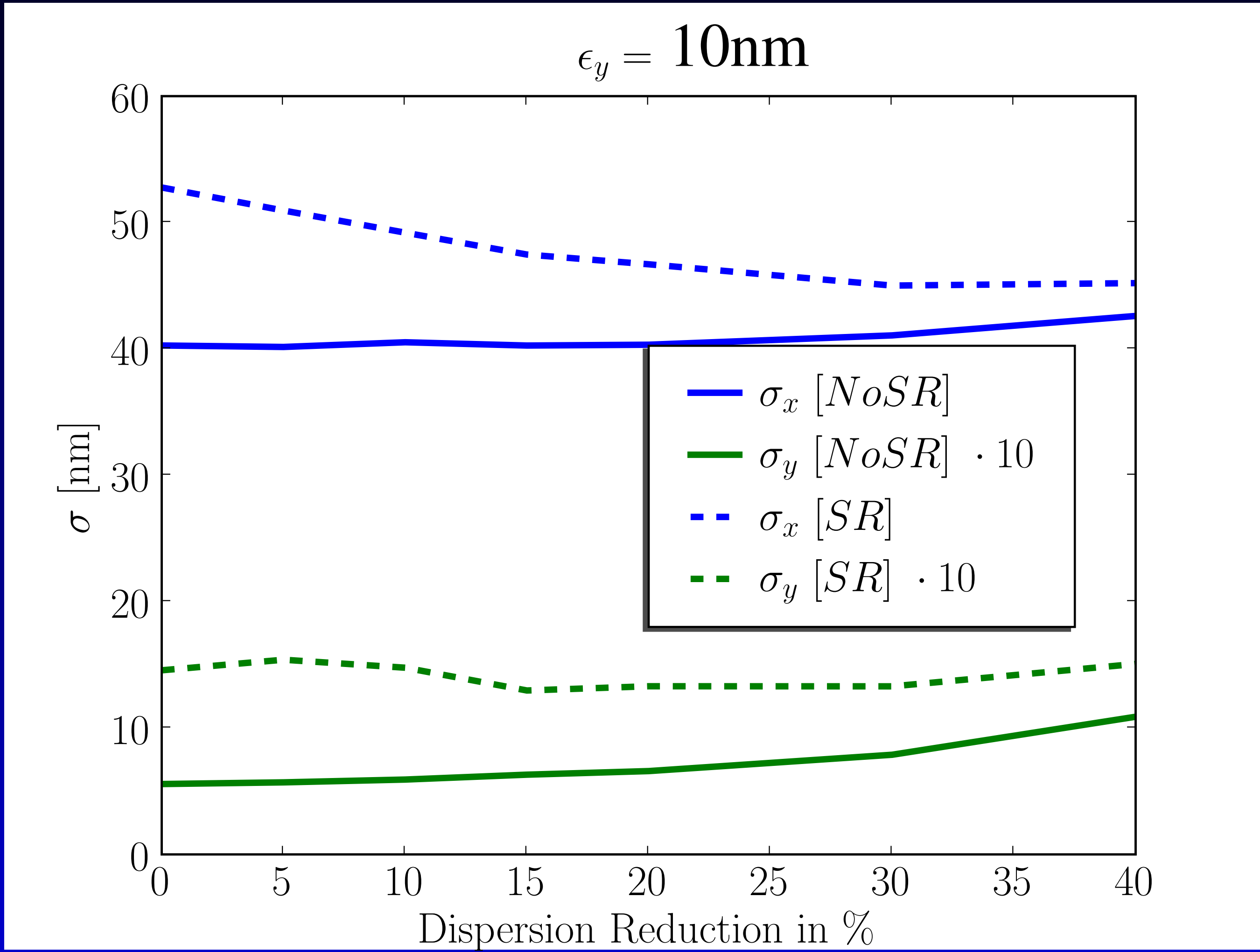
Strongest dependence is on σ_x

Zoom



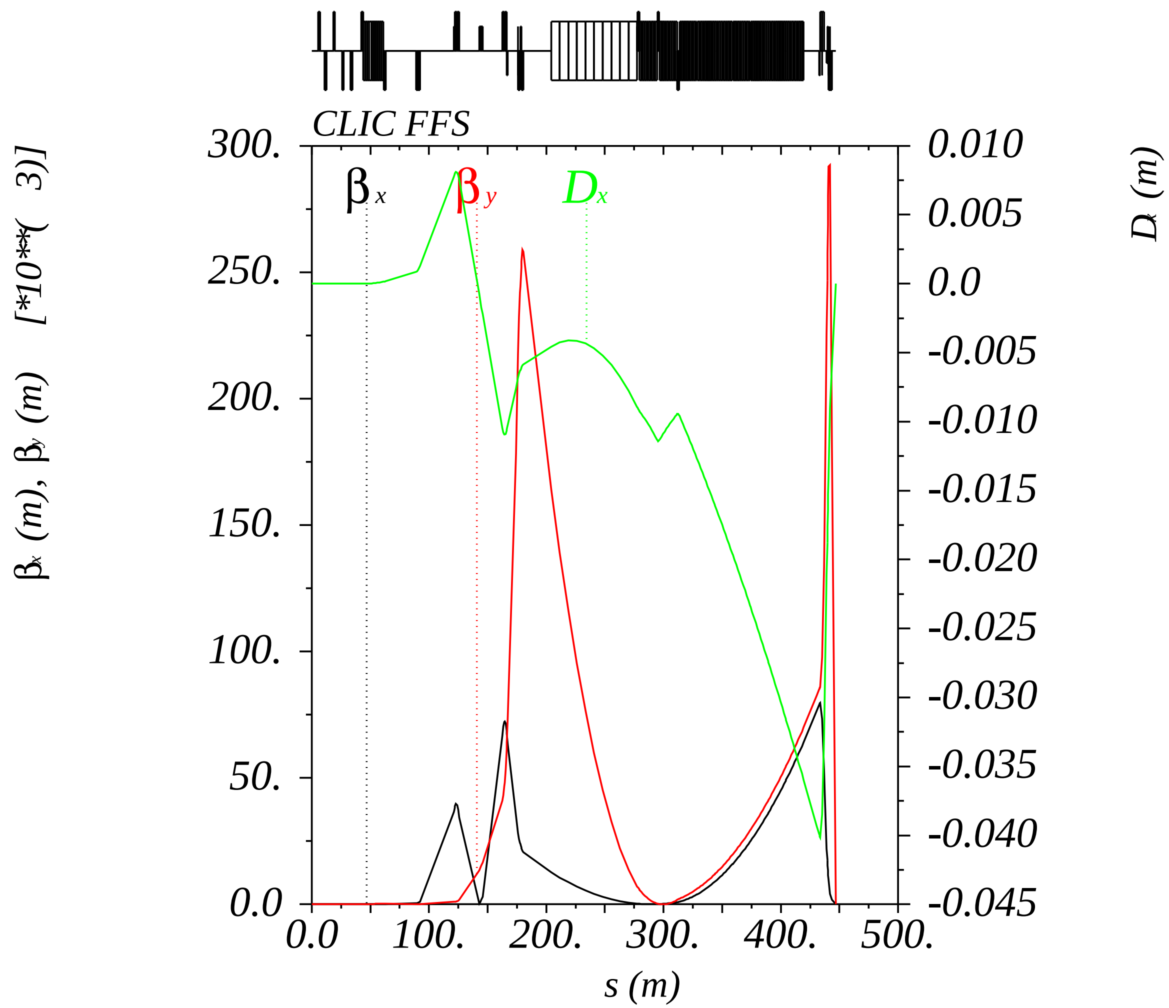
Clear border line. Lumi a bit erratic

Dispersion optimization: Beam sizes



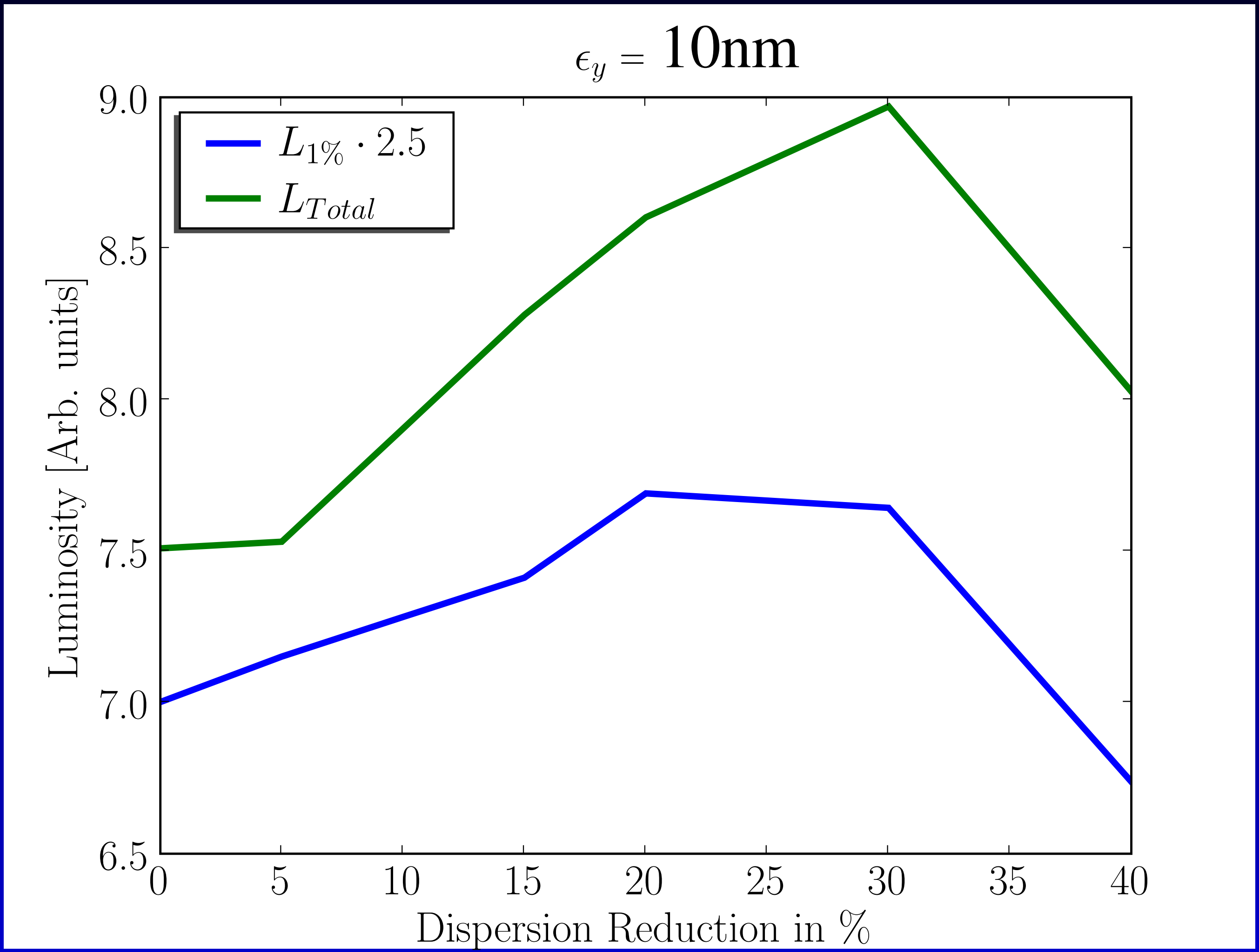
$\sigma_z = 35\mu\text{m}$

FFS optics for 20% disp. reduction



$\beta_{IP,x} = 7\text{mm}, \beta_{IP,y} = 0.067\text{mm}$

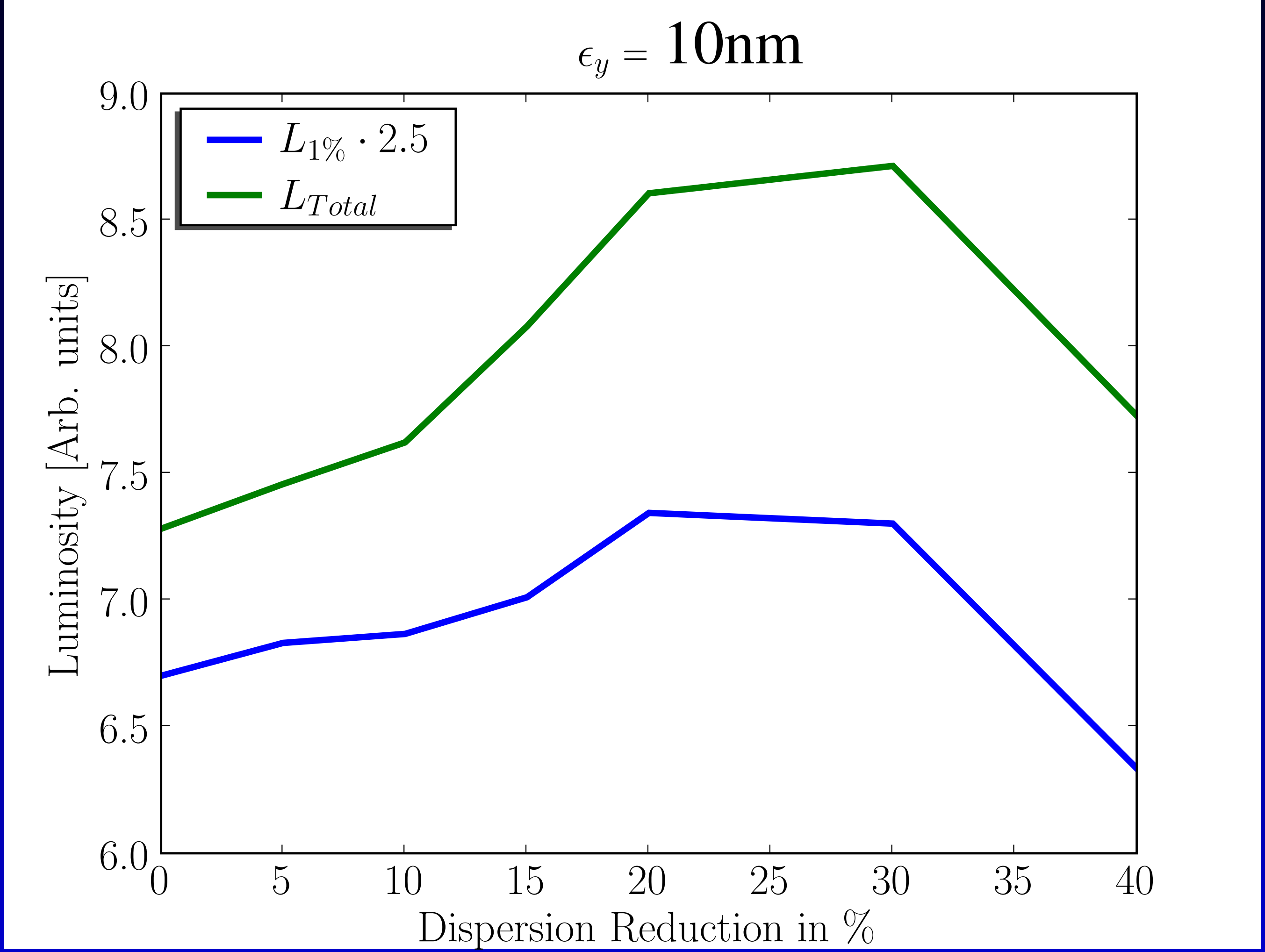
Dispersion optimization: old parameters



$\sigma_z = 35\mu\text{m}$

Optimum between 20-30% dispersion reduction.

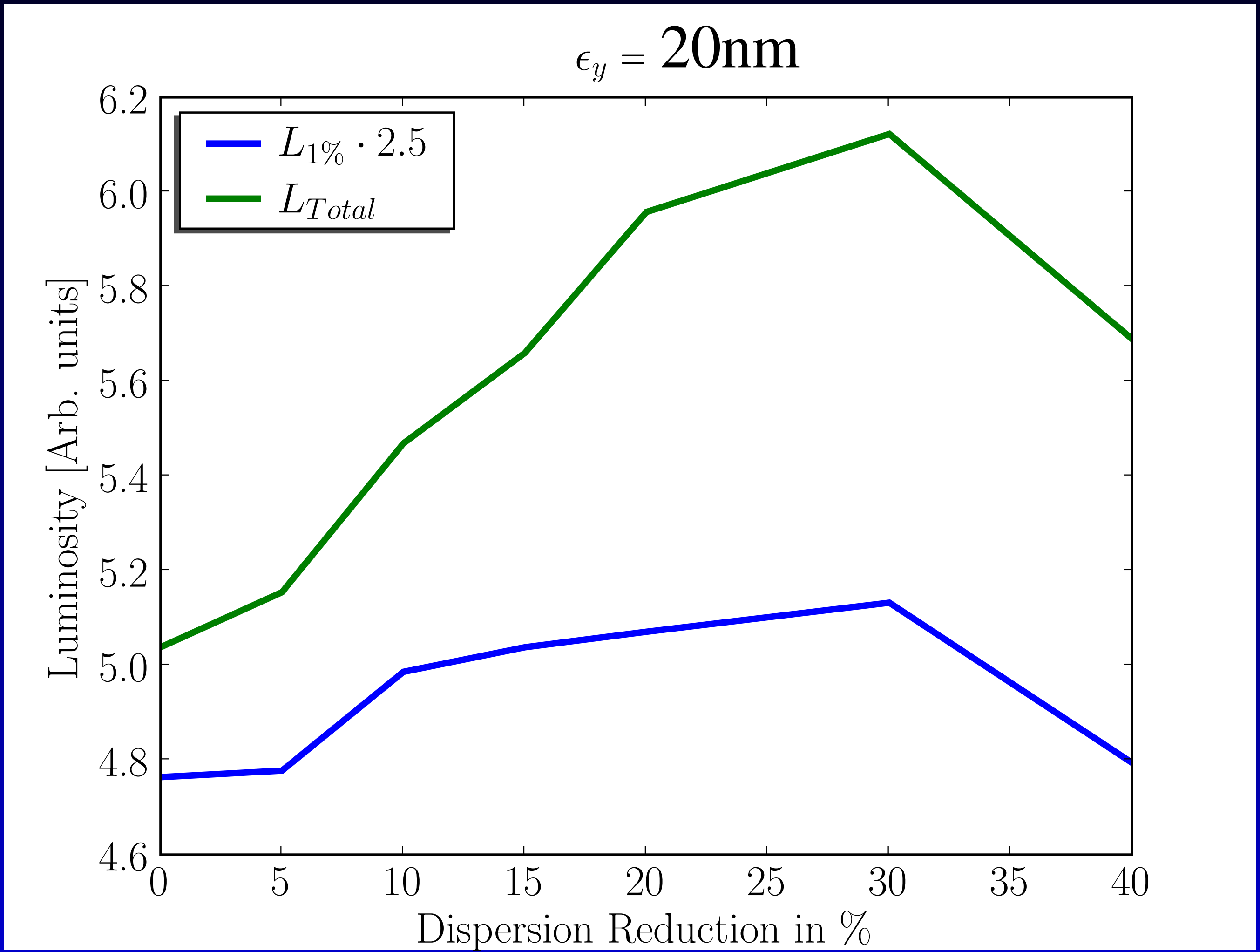
Dispersion optimization: longer bunch



$\sigma_z = 44\mu$m

Optimum still between 20-30% dispersion for longer bunch

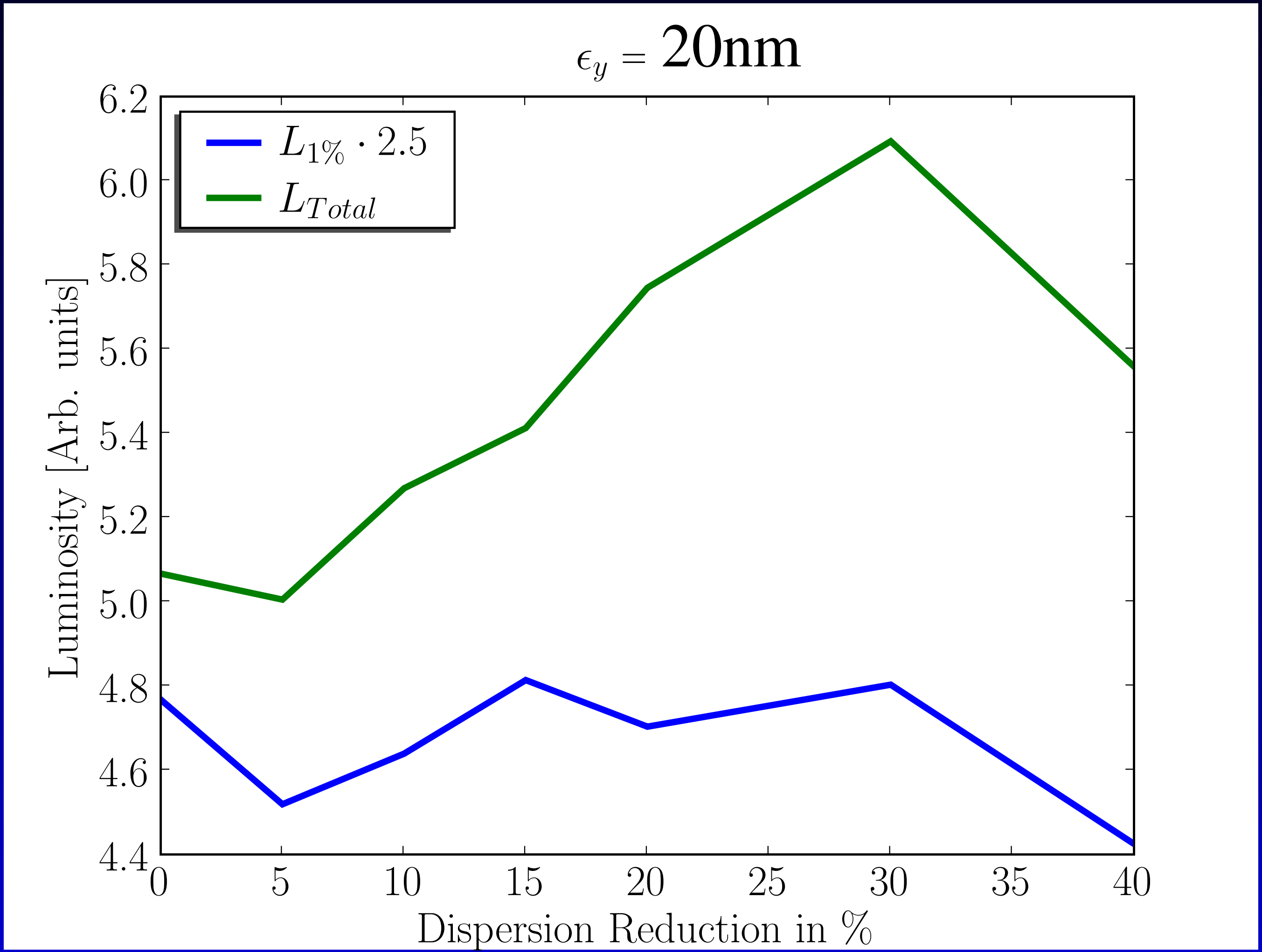
Dispersion optimization: larger bunch



$\sigma_z = 35\mu$m

Optimum still between 20-30% dispersion for larger bunch

Dispersion optimization: longer and larger



$\sigma_z = 44\mu$m

Peak Luminosity saturated?

From old to new parameters I

Cost of new parameters:

ϵ_y[nm]	$\sigma_s[\mu$m]	$\Delta L_{tot}[\%]$	$\Delta L_{1\%}[\%]$
10	35	0	0
10	44	-3	-5
20	35	-32	-33 *
20	44	-32	-37

(*doubling ϵ_y should cost 29%)

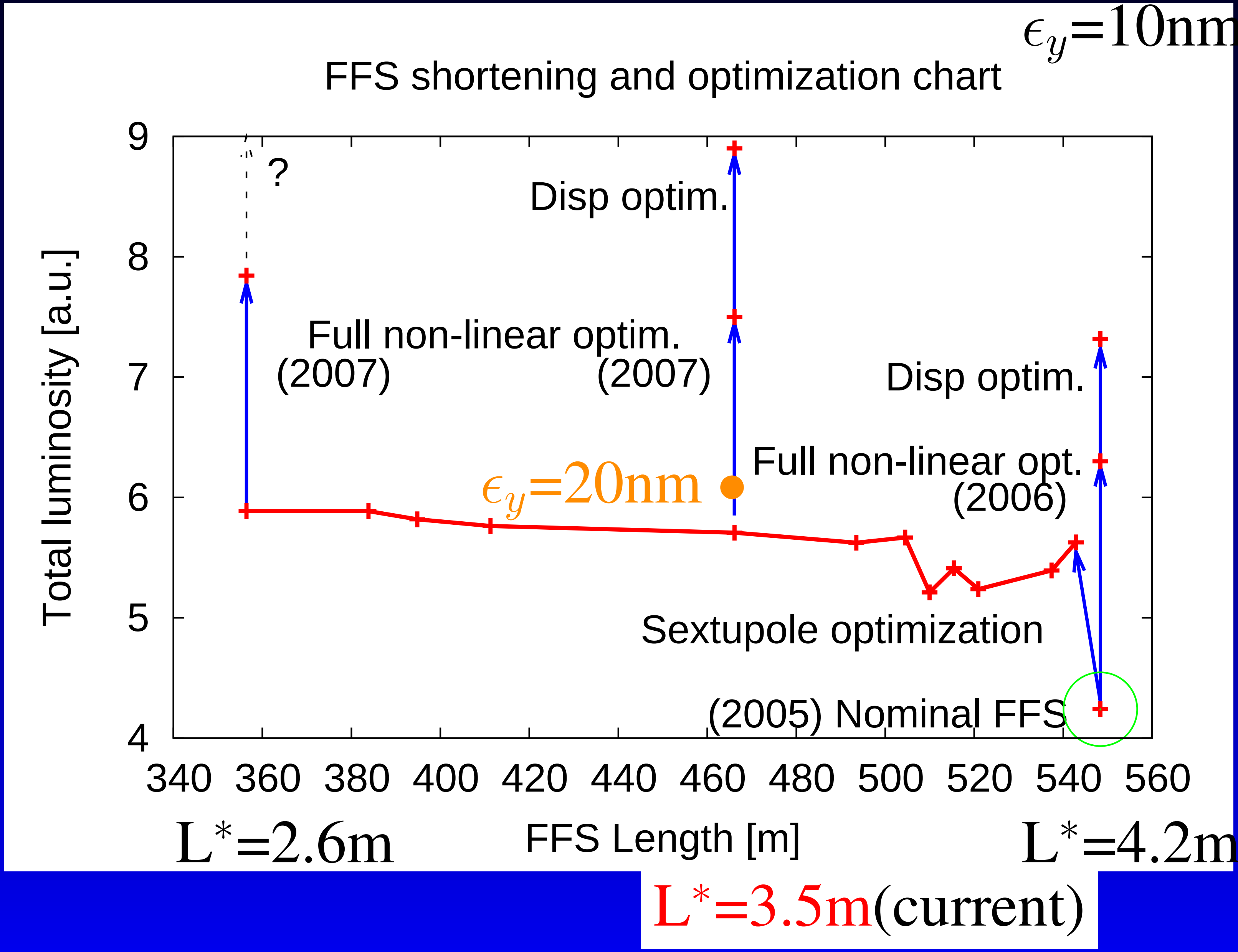
Bremsstrahlung: $n_\gamma \propto \sigma_s^{1/3}/\sigma_x^{2/3}$ (for CLIC)

V Disruption: $D_y \propto \sigma_s/(\sigma_y \sigma_x)$

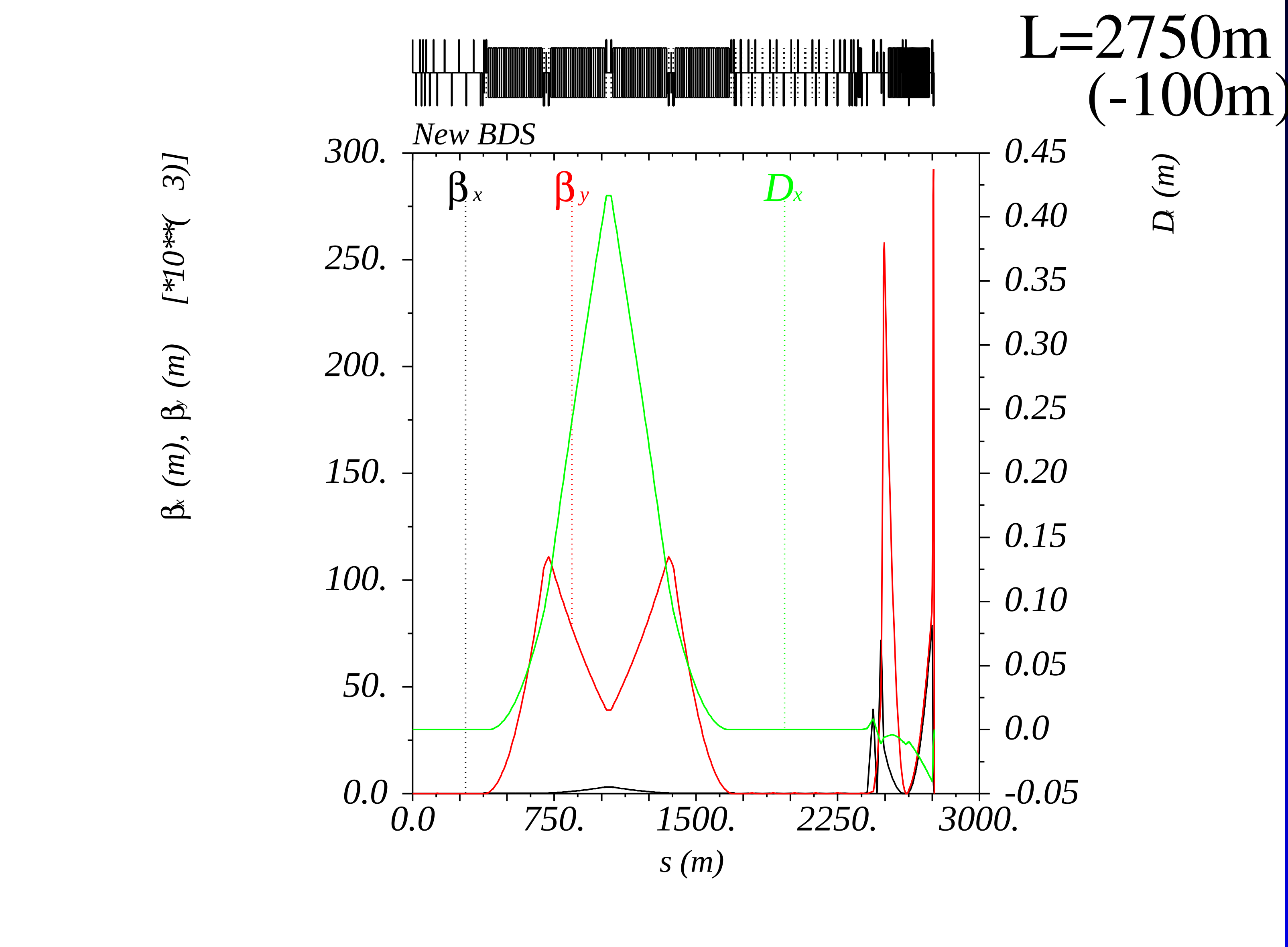
H Disruption: $D_x \propto \sigma_s/\sigma_x^2$

$\rightarrow$ Trends roughly in agreement

From old to new parameters II

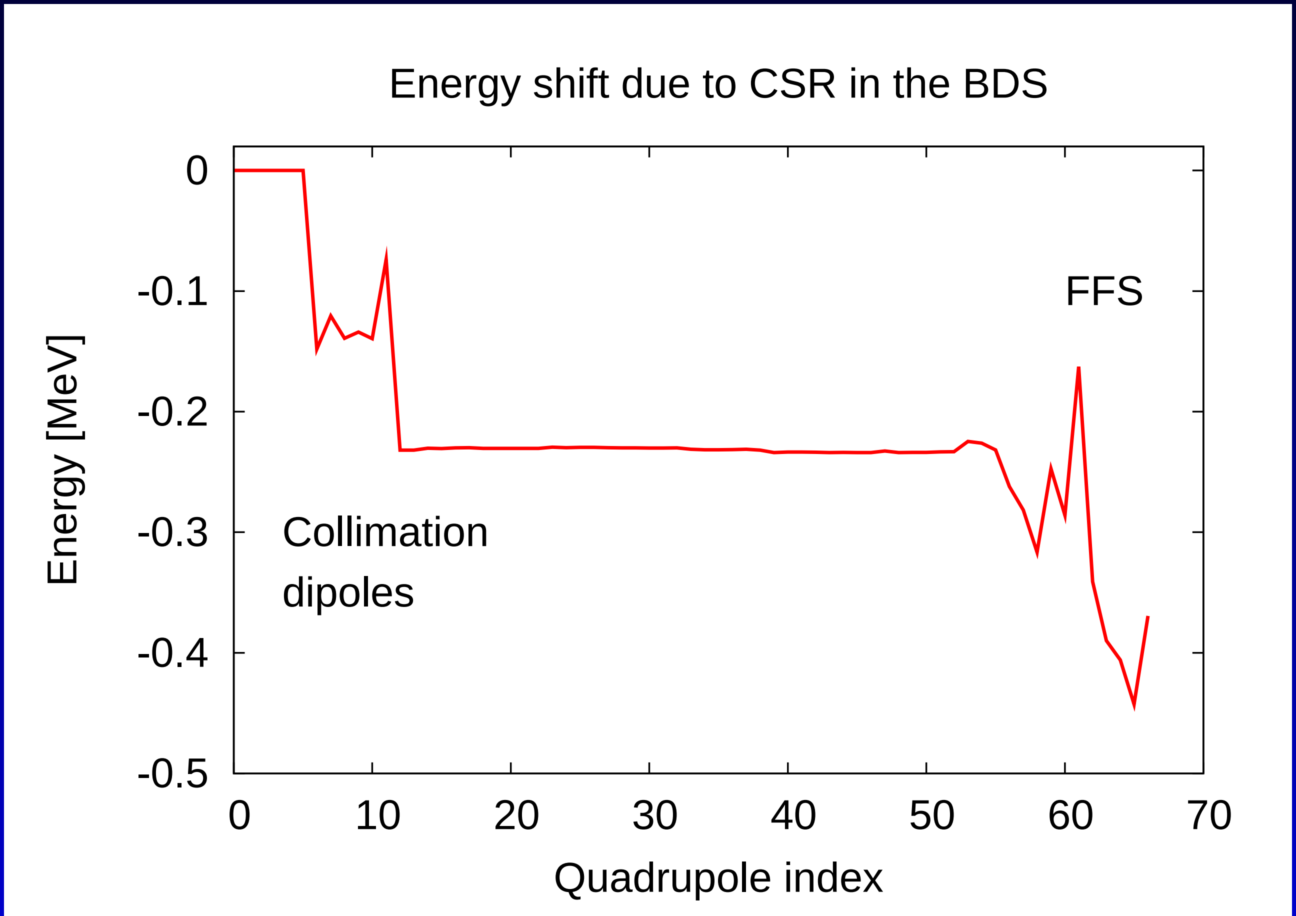


New BDS optics



CSR in the BDS?

New CSR module in PLACET by E. Adli.



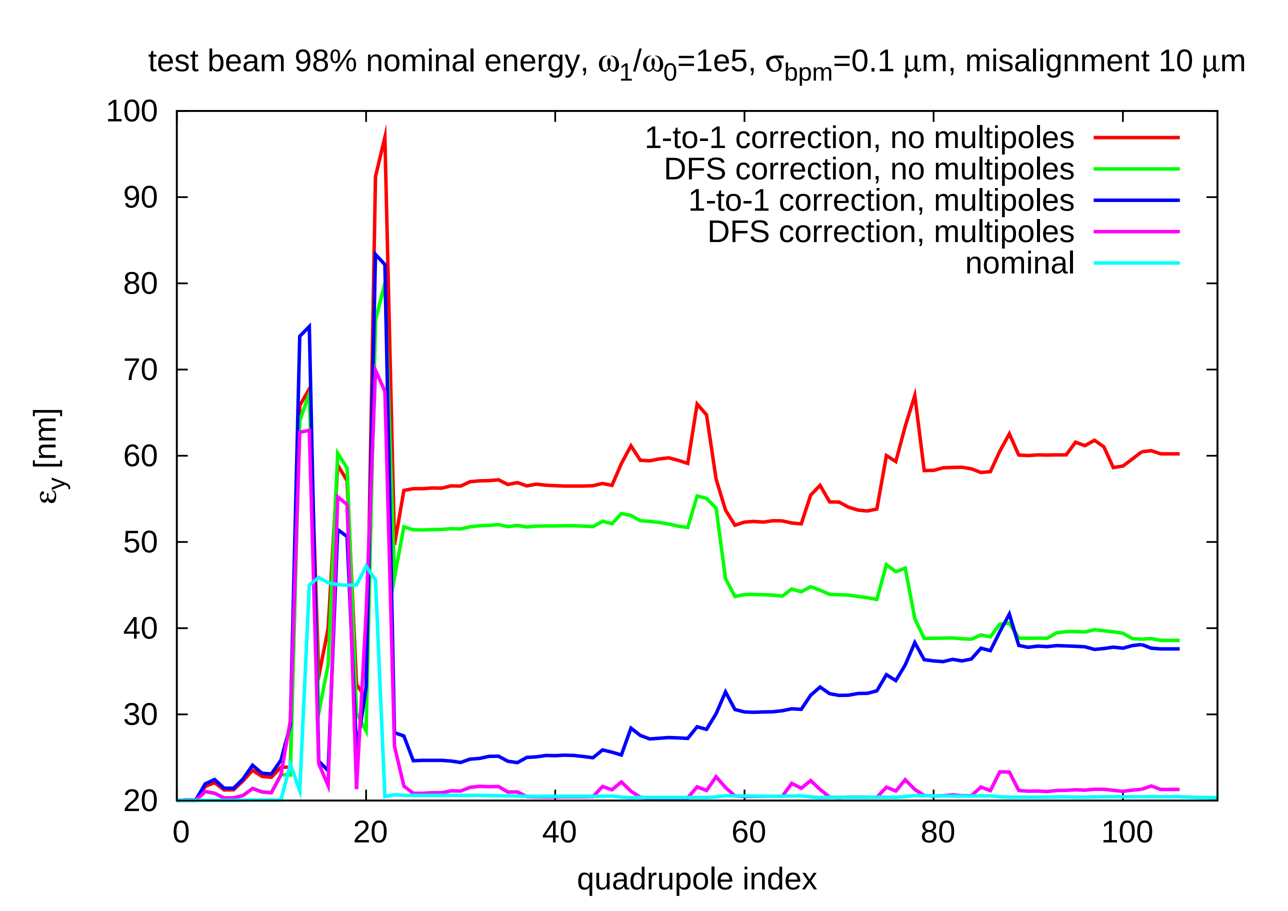
Negligible effect, also from formula:

$$< \delta E > \propto \frac{r_e q L E_0}{e\gamma(R^2\sigma_s^4)^{1/3}} \approx 1\ MeV$$

News on the BDS alignment

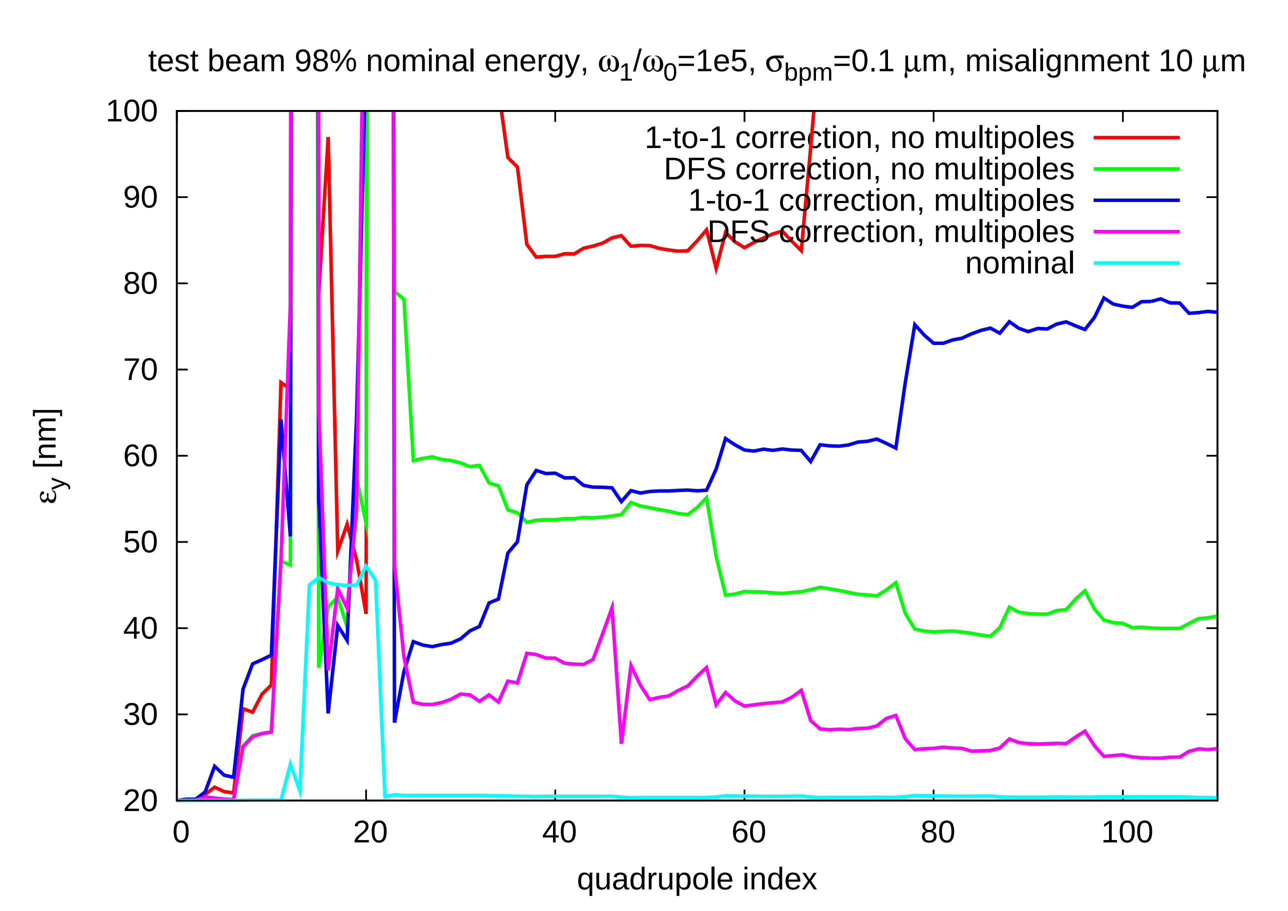
- Task force by A. Latina, D. Schulte and R. Tomás
- Full use of Placet-octave
- Use real Dispersion Free Steering
- Collimation octupoles found disturbing
- Aligning the BDS by subsystems

Aligning the Collimation section



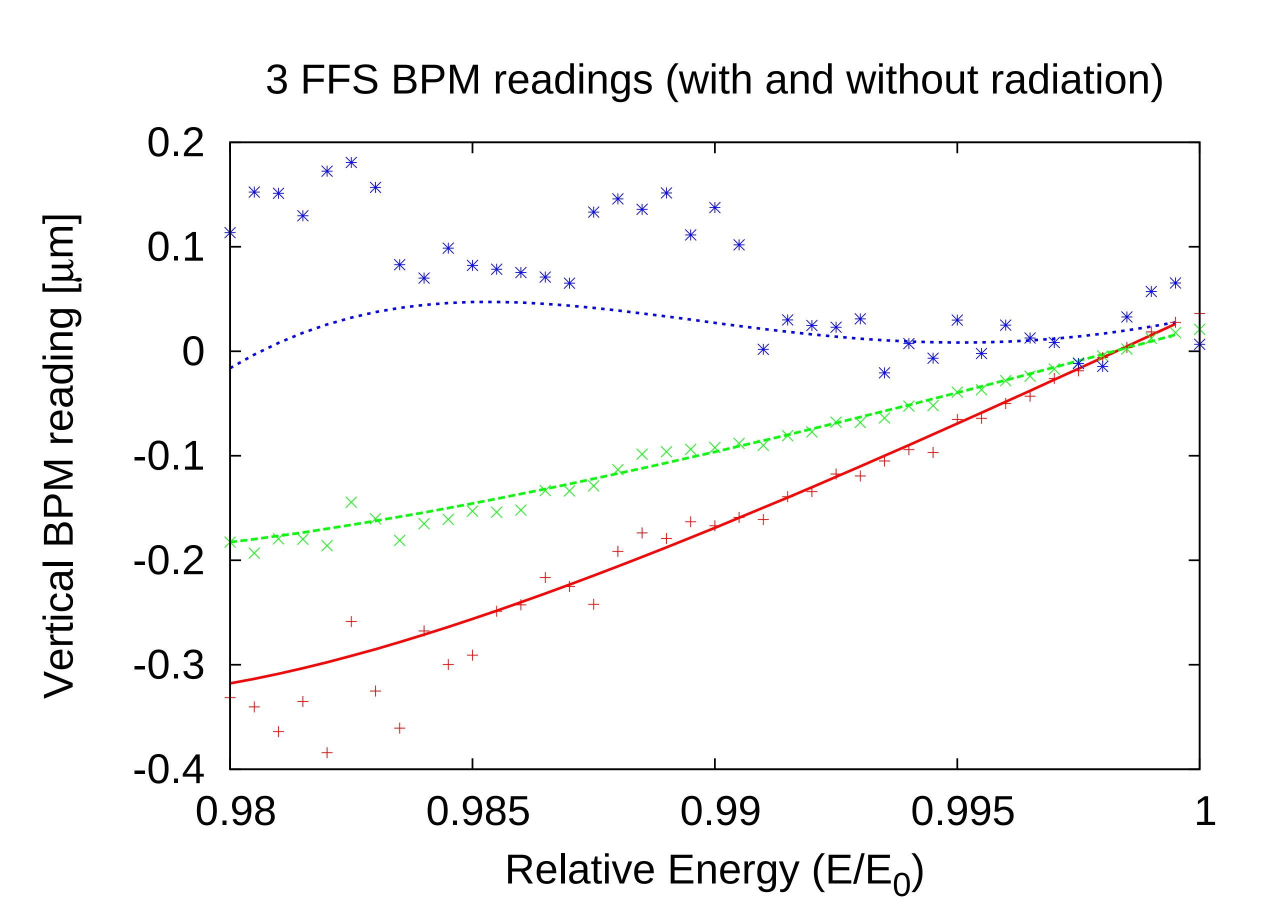
5% emittance growth after aligning only the collimation section.

Aligning the full BDS?



Does not work. The FFS corrupts the correction in the collimation section.

Looking into the FFS



Large error due to radiation

Apparent linear and non-linear dispersion

Summary and such

- Diagnostics section ready for $\epsilon_x = 20$nm:
  - Emittance measurement $\leq$7% accuracy
  - Energy measurement $\approx$0.04% accuracy
- Be collimators on the edge
- Shorter L^*=3.5m excellent choice for lumi.
- Peak luminosity saturated with new parameters
- Negligible CSR in the BDS
- DFS works for the collimation section
- FFS alignment under investigation
- New CLIC lattices web repository: http://cern.ch/CLICr/