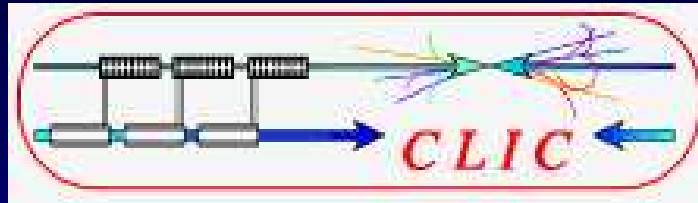


CLIC Beam Delivery System



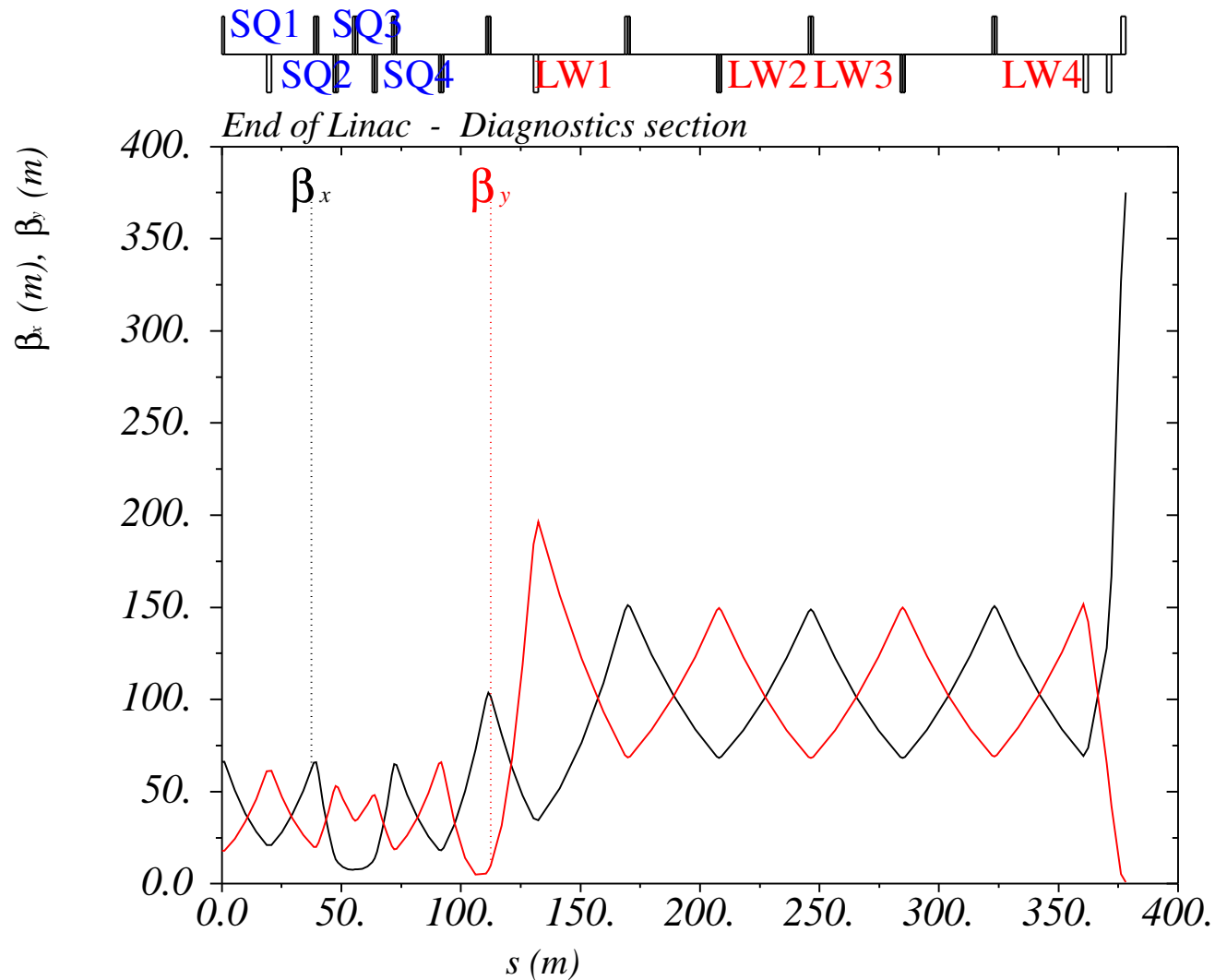
R. Tomás, H. Braun, A. Latina, G. Rumolo and
D. Schulte

September 2008

Contents

- The CLIC 3TeV BDS:
 - Beam diagnostics section
 - Collimation section
 - Final Focus System: 4.3m and 3.5m L*
 - ATF2 ultra-low betas
 - BDS Collective effects
- The CLIC 500GeV BDS
- Collaborators
- Workplan towards 2010

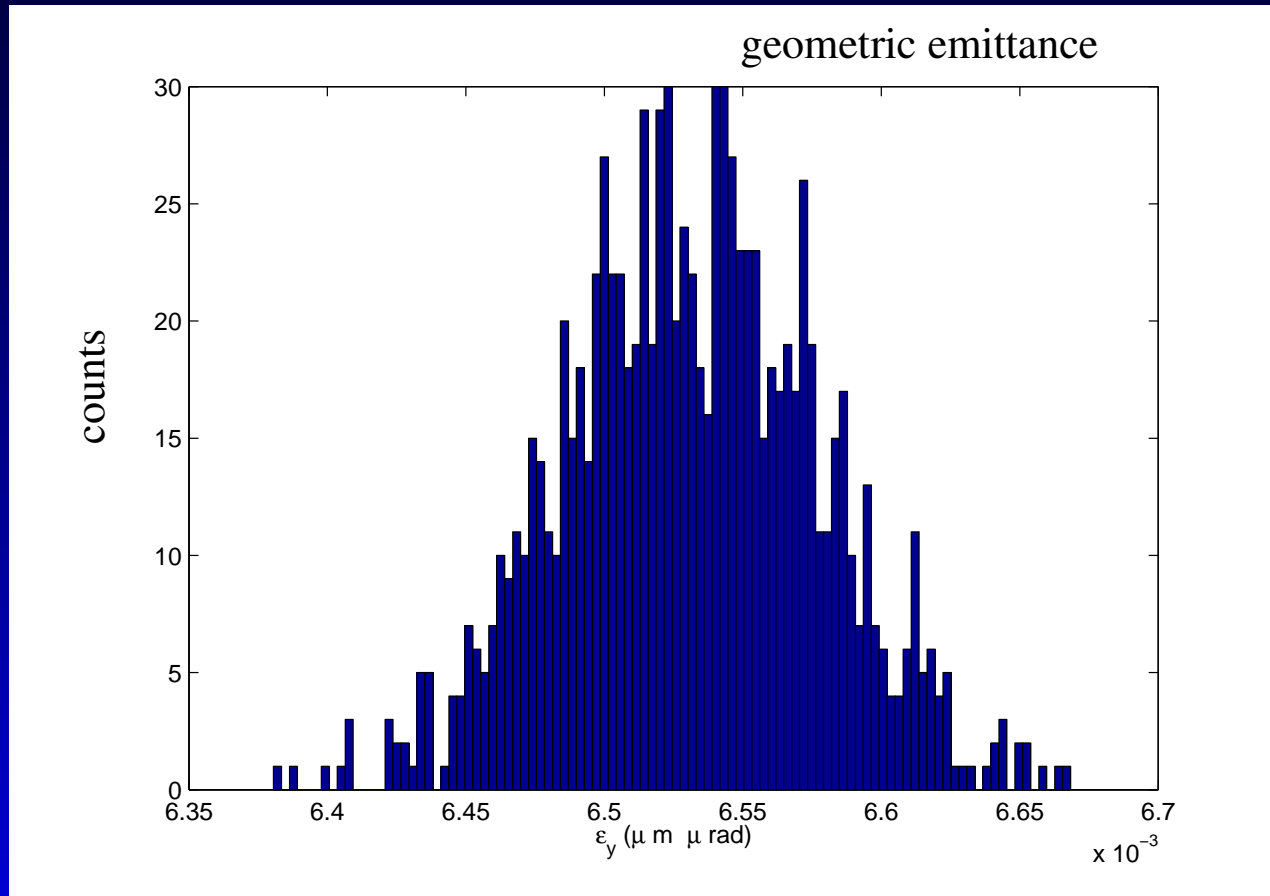
Diagnostics: emittance measurement



$\sigma_y = 1 \mu\text{m}$ @ Laser wires (for $\epsilon_y = 20 \text{nm}$)

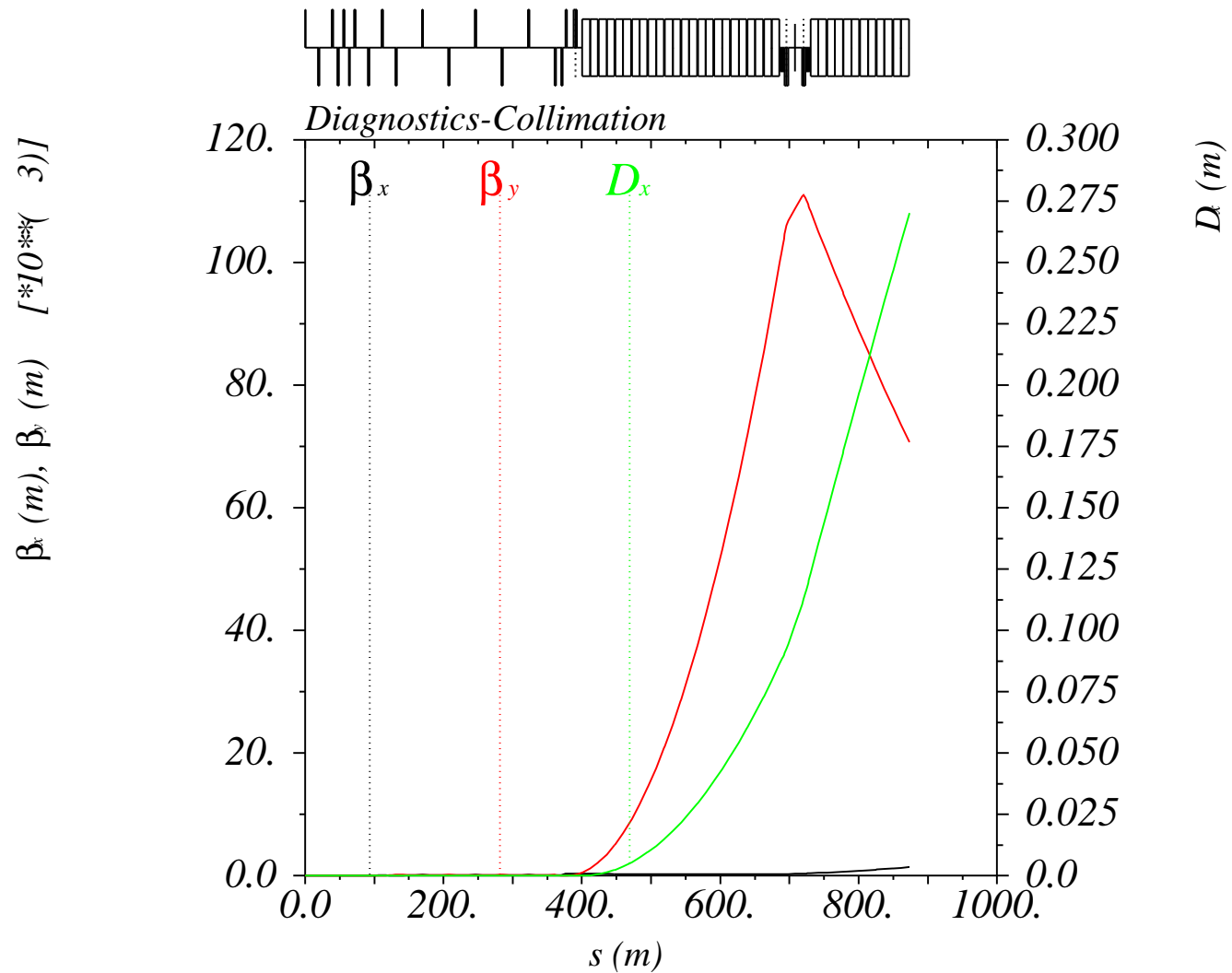
Emittance measurement

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

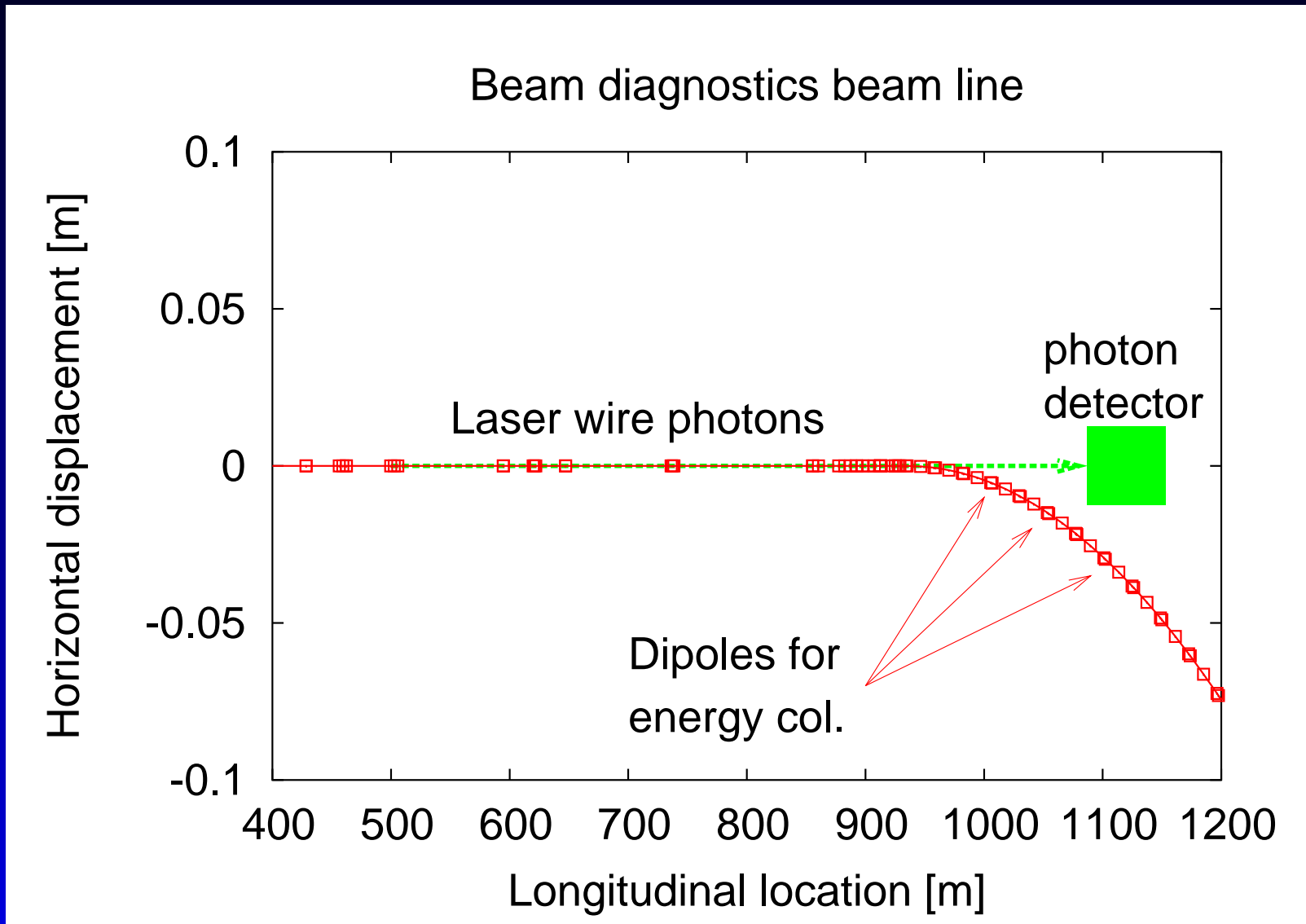


$$\Delta\epsilon_{x,y}/\epsilon_{x,y} \approx 7\%$$

Diagnosics inside collimation

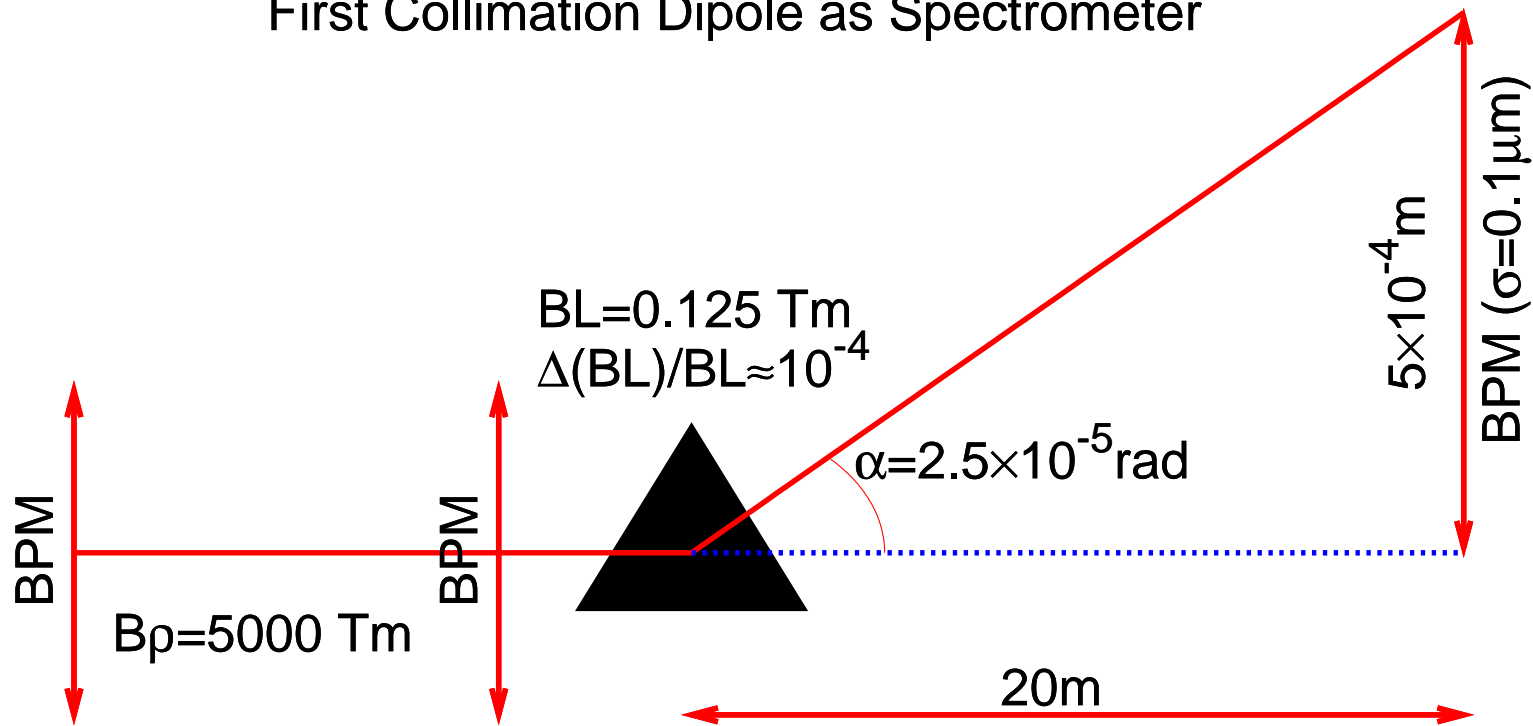


Layout & photon collection



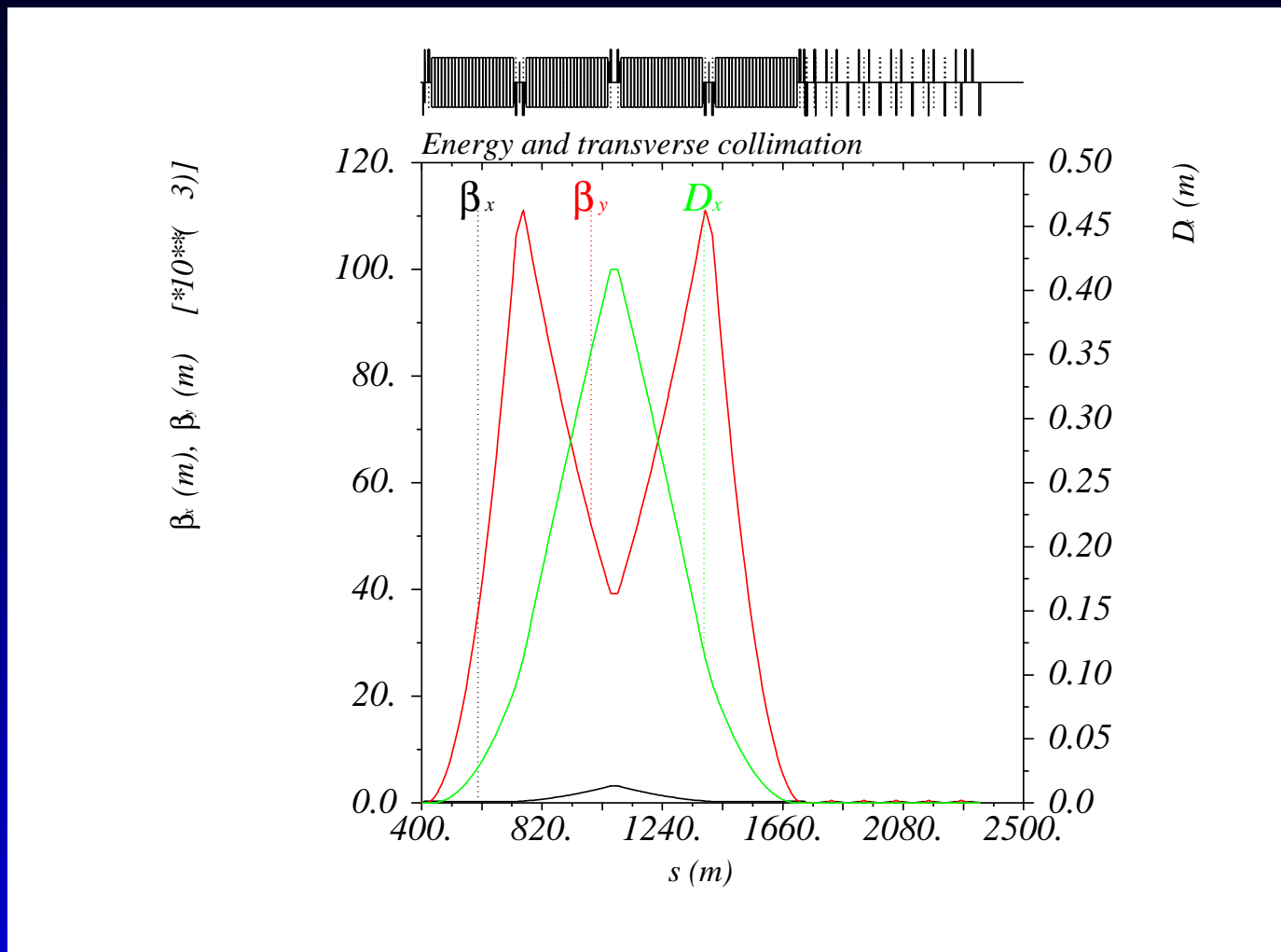
CLIC compact energy measurement

First Collimation Dipole as Spectrometer



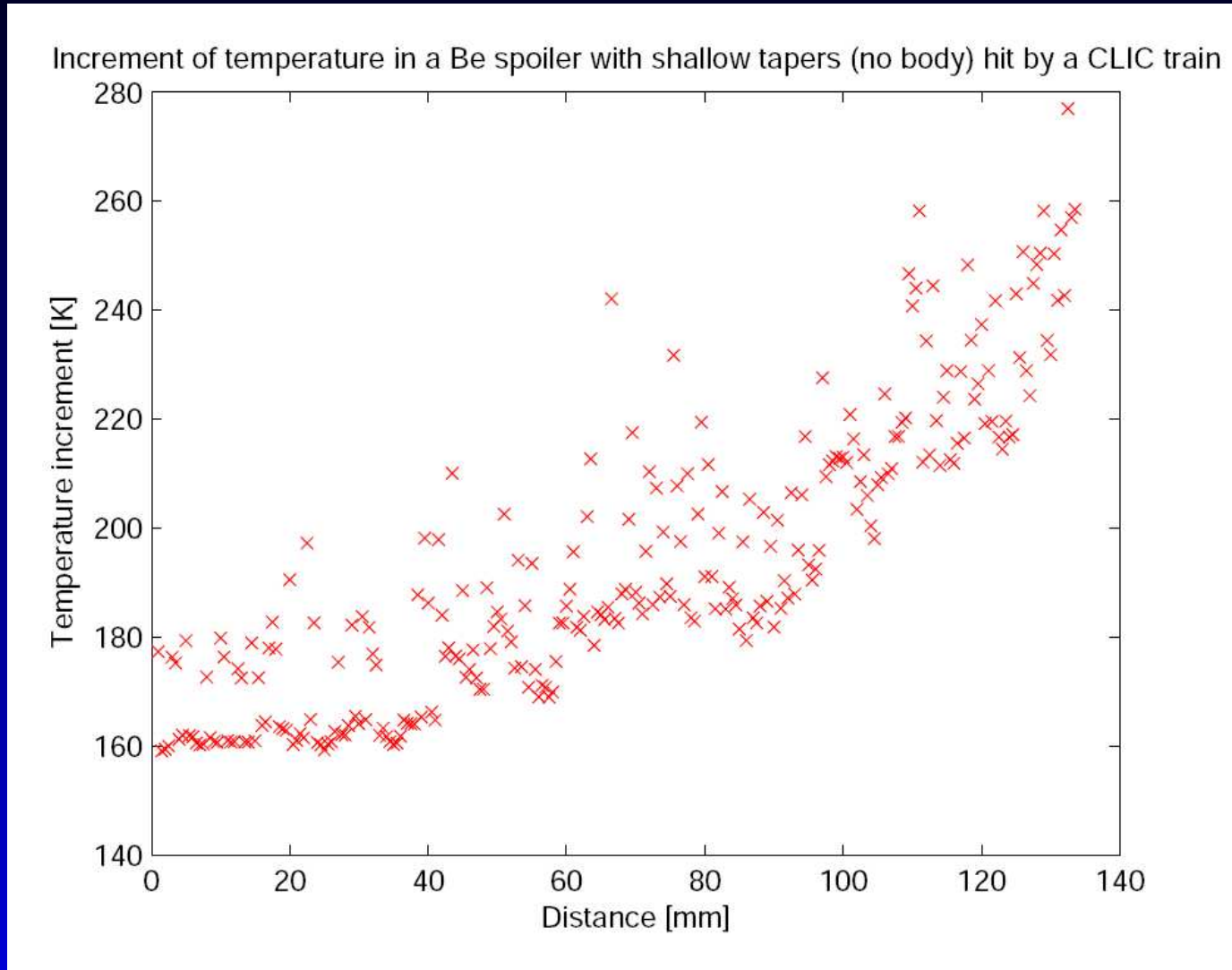
$$\Delta E/E = \Delta\alpha/\alpha \oplus \Delta(BL)/BL \approx 3.6 \times 10^{-4}$$

Collimation section



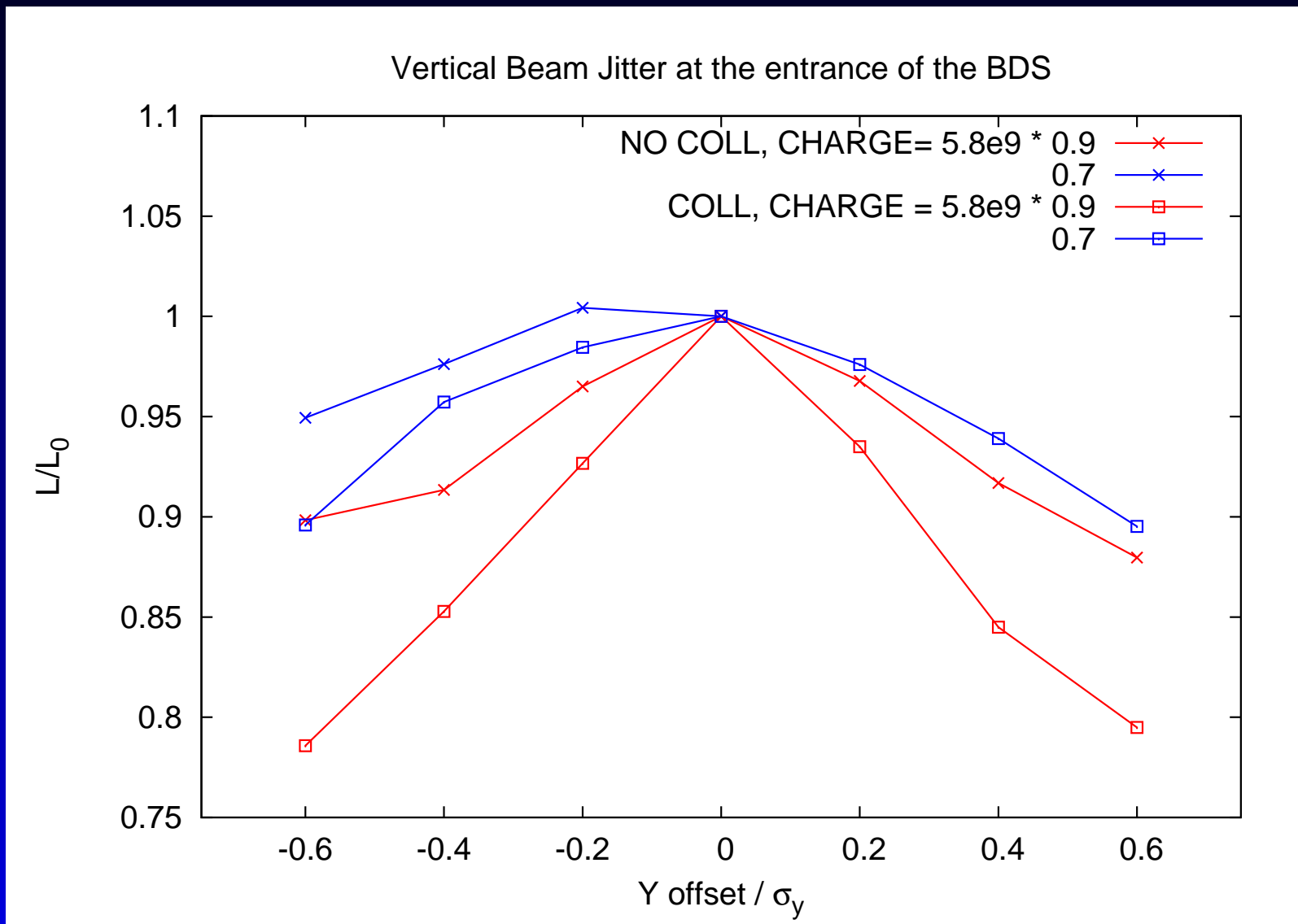
Cleaning inefficiency for new parameters under investigation by J. Resta.

Collimator survival (J. Resta, L. Fernandez)



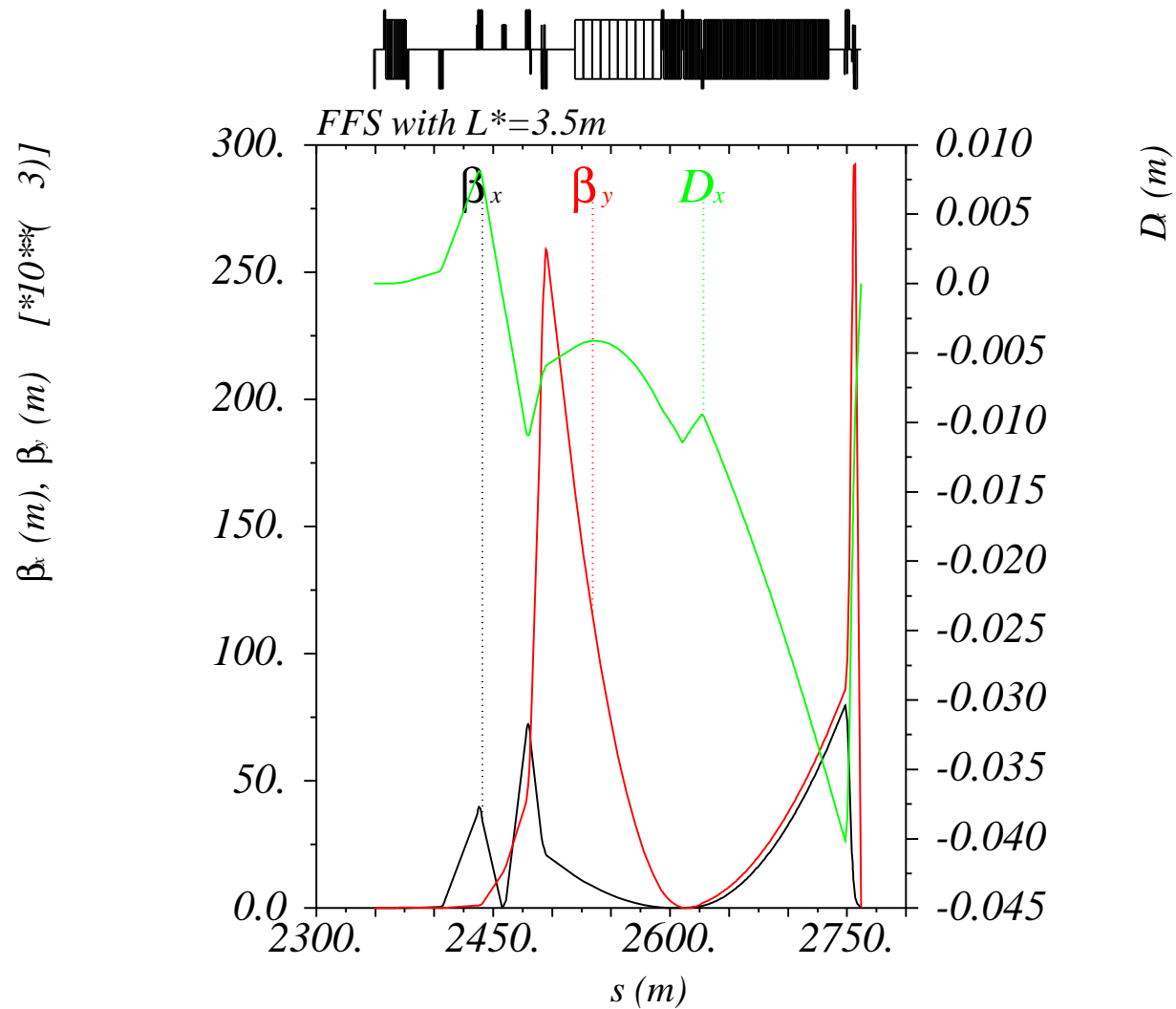
Be thermal fracture limit = 370K → Good!

Collimation wakefields

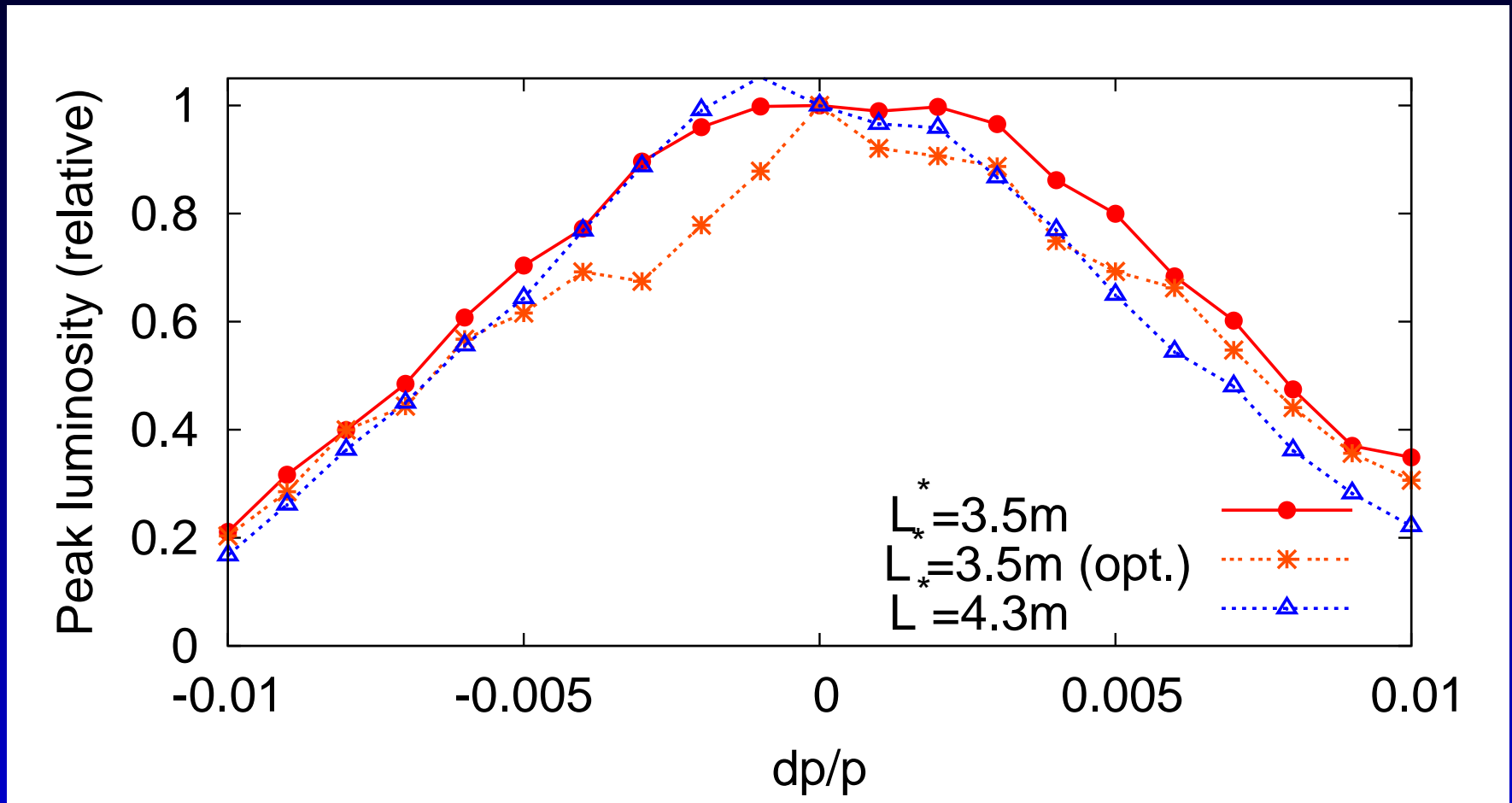


Tolerance in the level of the $0.1\sigma_y$

Final Focus System with $L^*=3.5\text{m}$

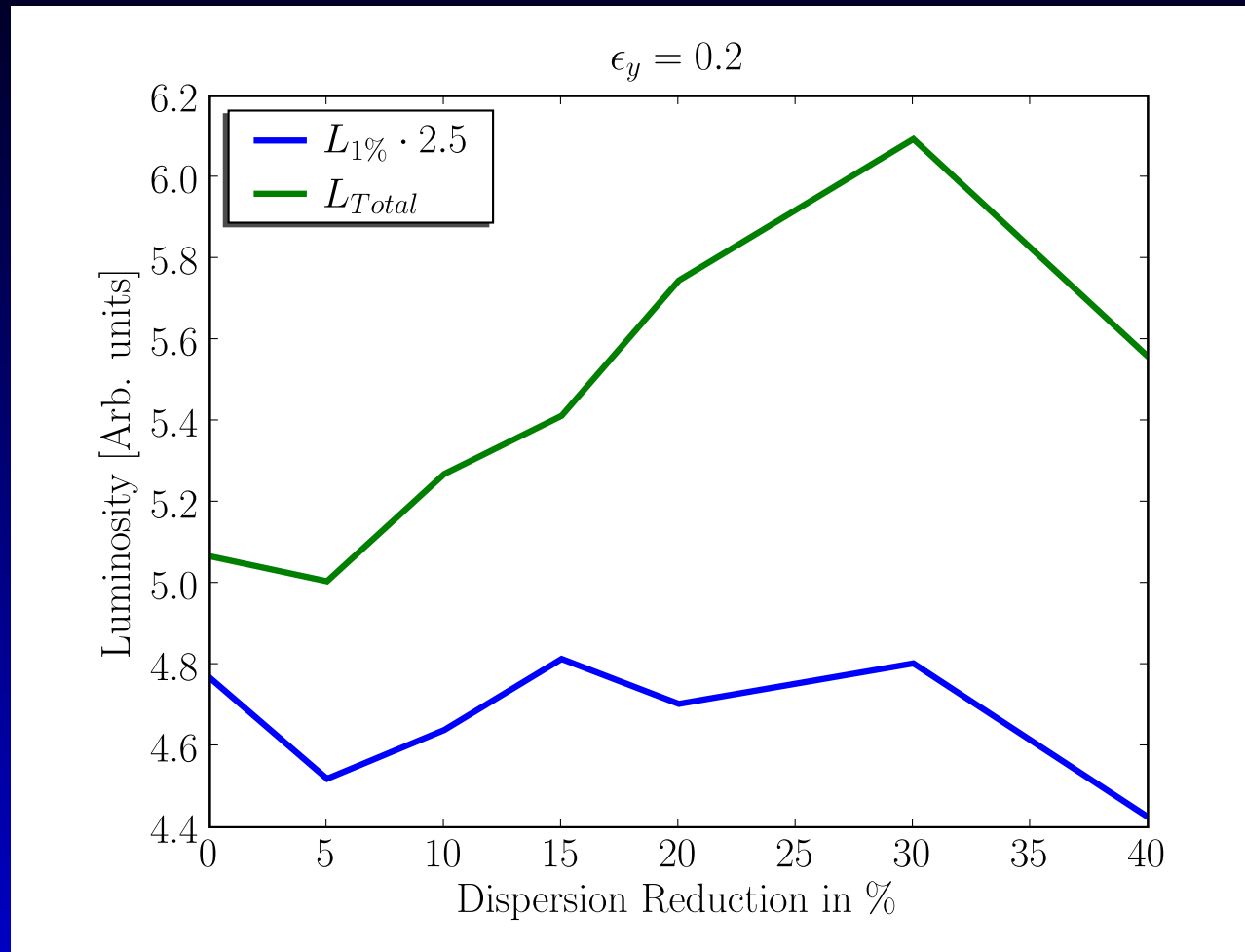


Final Focus Systems, 3.5m versus 4.3m L^*



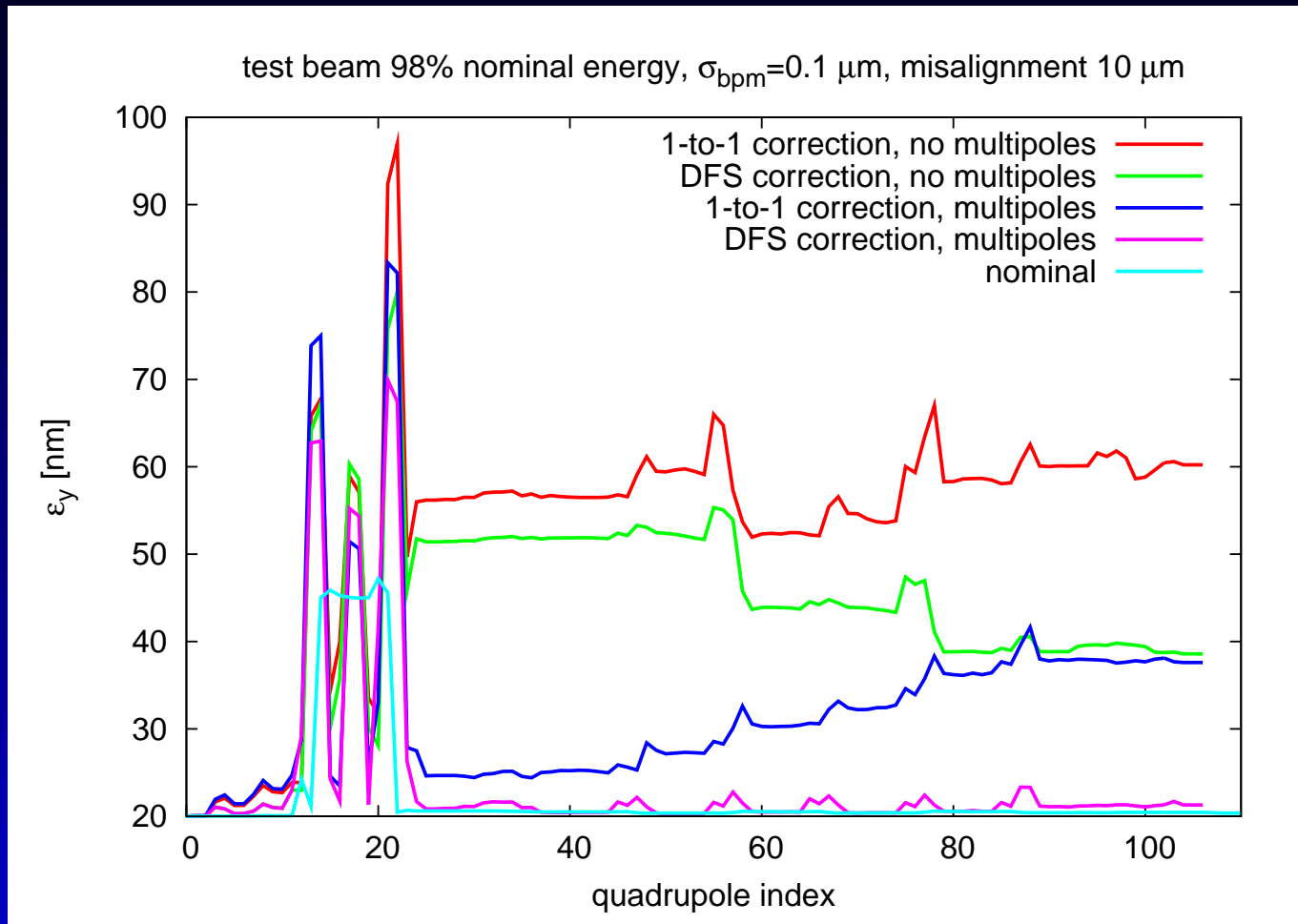
→ Slightly larger peak-lumi-bandwidth for the 3.5m L^* FFS

Saturation of the peak luminosity



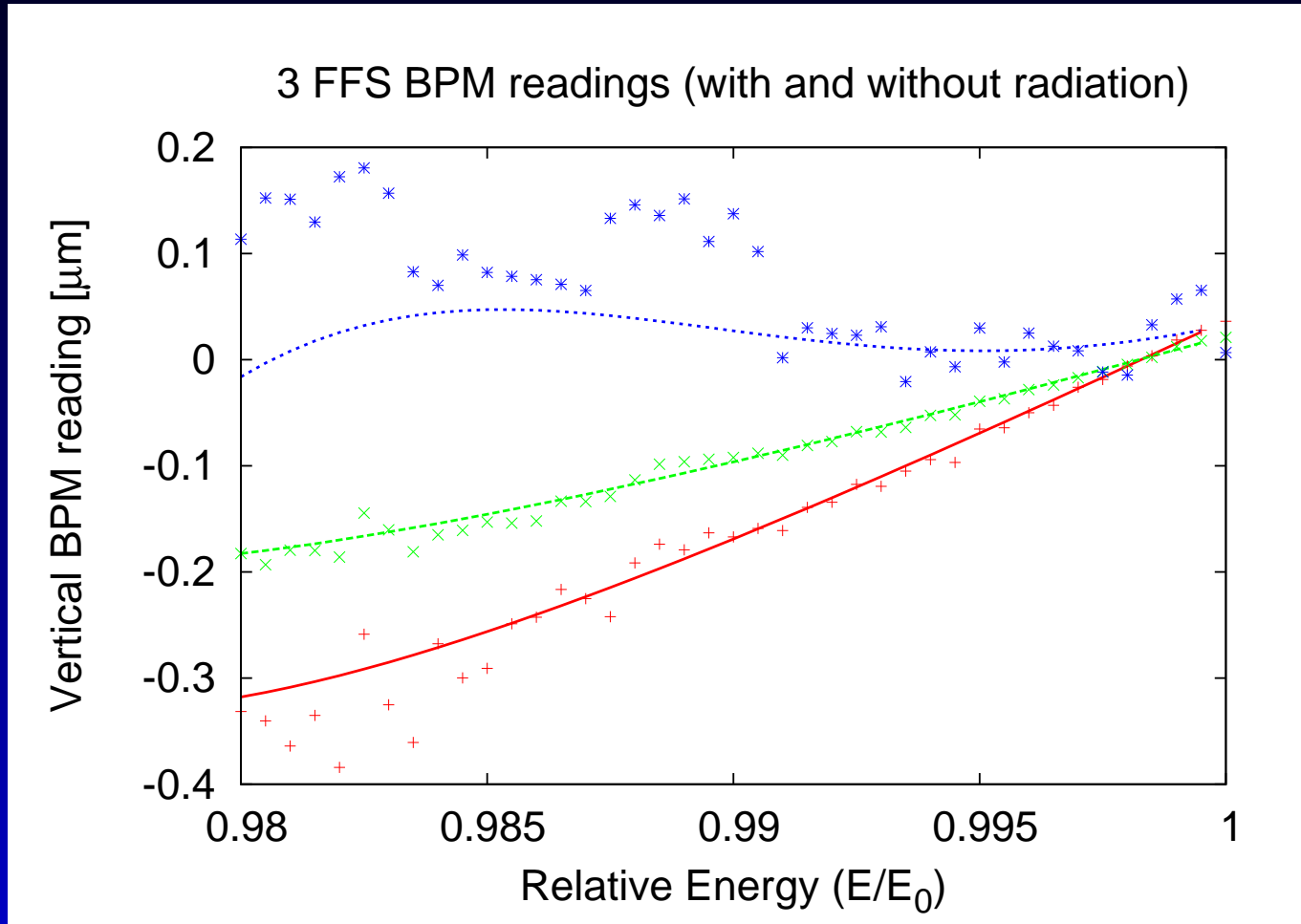
→ With the current beam parameters further reductions of IP beam size do not increase peak luminosity

Alignment of the collimation section



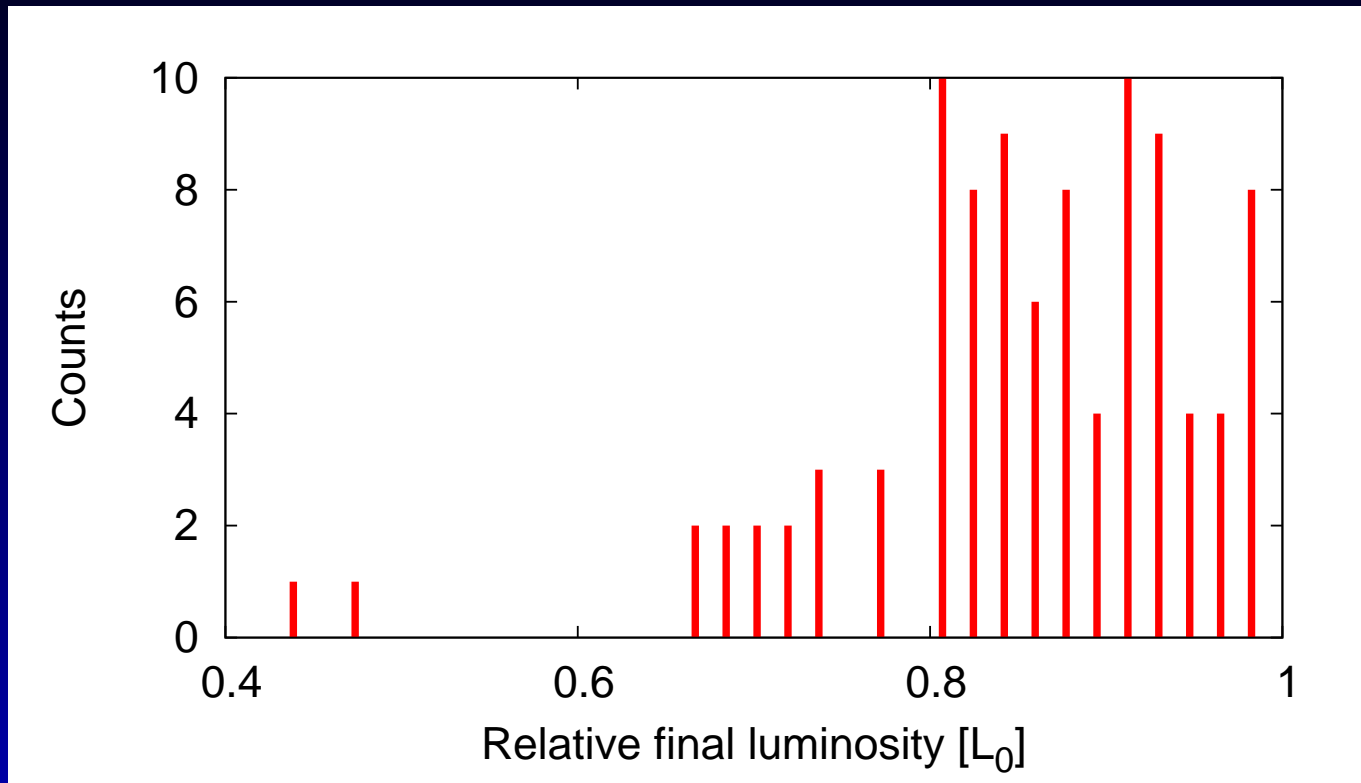
→ Dispersion Free Steering works in the collimation section.

The more complex FFS



The FFS is the most complex section. Rather than align the FFS more general tuning algorithms must be

Luminosity after tuning



80% of the seeds give more than 80% of the design luminosity \rightarrow 20% fail.

ATF2 ultra low betas: Chromaticity

Project	Status	β_y^* [mm]	L^* [m]	L^*/β_y^*	ξ_y
FFTB	Design	0.1	0.4	4000	17000
FFTB	Measured	0.167	0.4	2400	10000
ATF2	Design	0.1	1.0	10000	19000
ATF2 pushed	Proposed	0.05	1.0	20000	38000
CLIC 500GeV	Design	0.2	4.3	21500	35000
CLIC 3TeV	Design	0.09	3.5	39000	63000
ILC	Design	0.4	3.5	8750	15000
ILC pushed	Design	0.2	3.5	17500	30000

ATF2 ultra low betas: Tuning difficulty

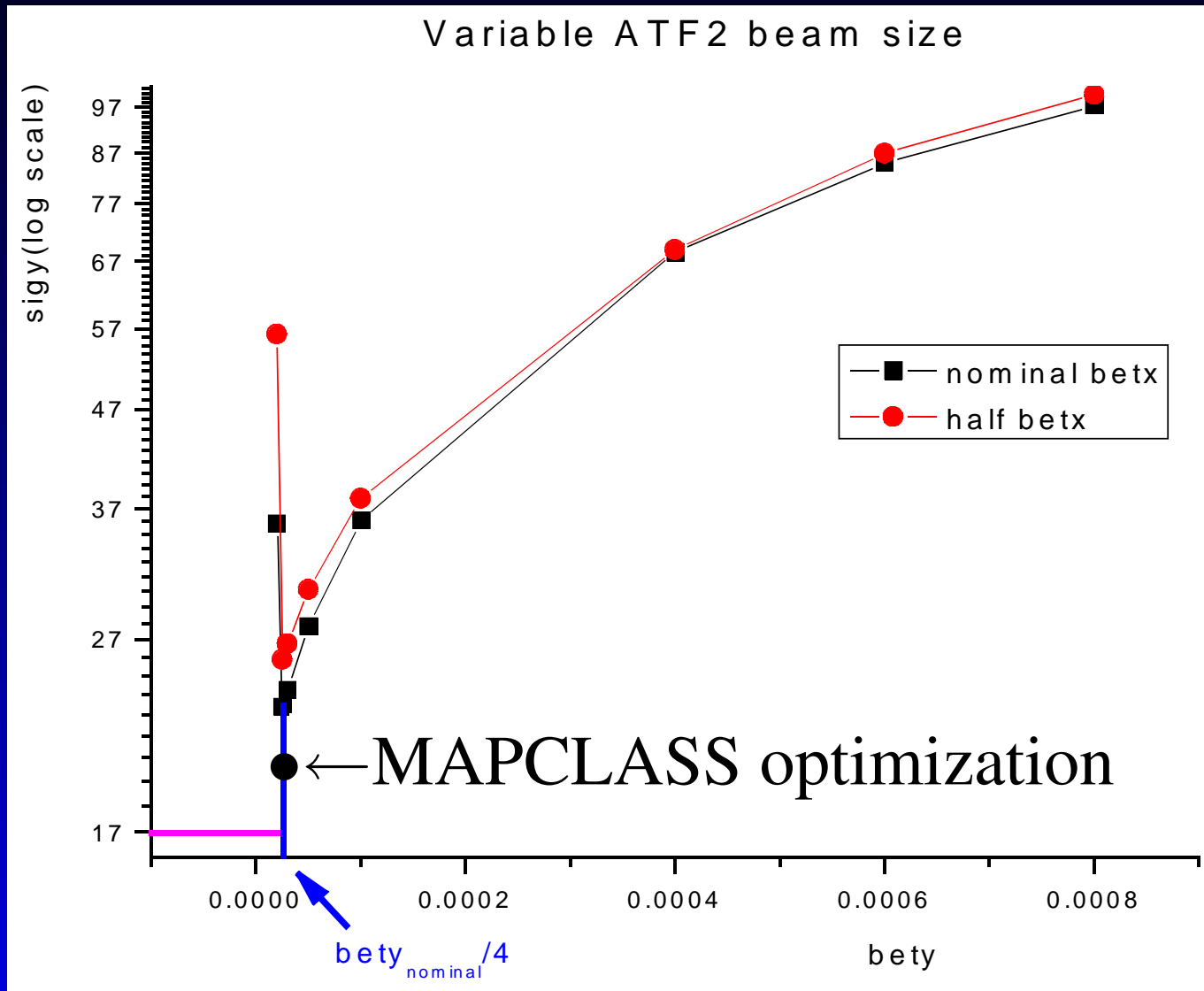
Project	Status	σ_y^* [nm]
FFTB	Measured	70
ATF2	Design	37
ATF2 pushed	Proposed	<26
ILC	Design	6
CLIC 500GeV	Design	3

Does tuning difficulty scale as σ_y^{*-1} ?

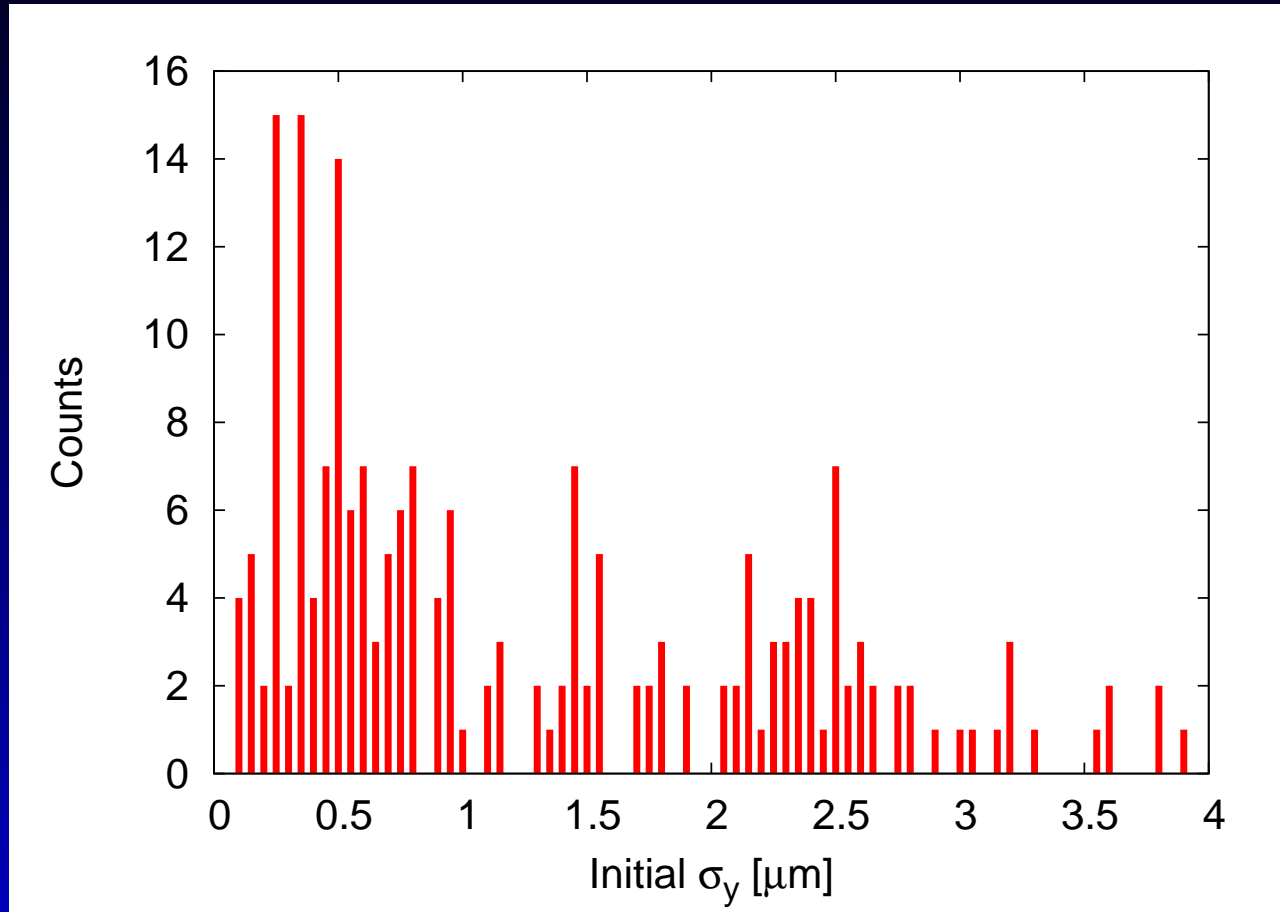
Both ILC and CLIC need as low ATF2 σ_y^* as possible.

What is the minimum achievable σ_y^* in ATF2?

On-going optimization with MAPCLASS

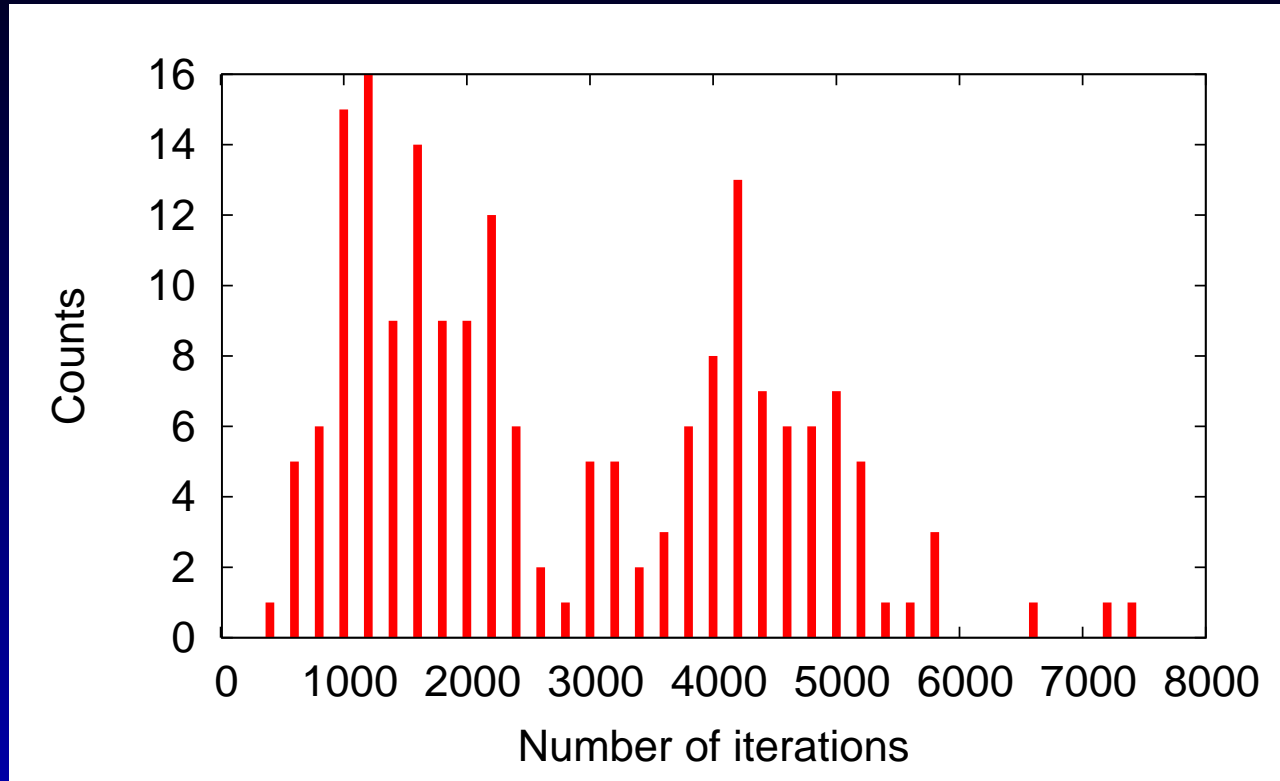


Initial σ_y for 150 seeds



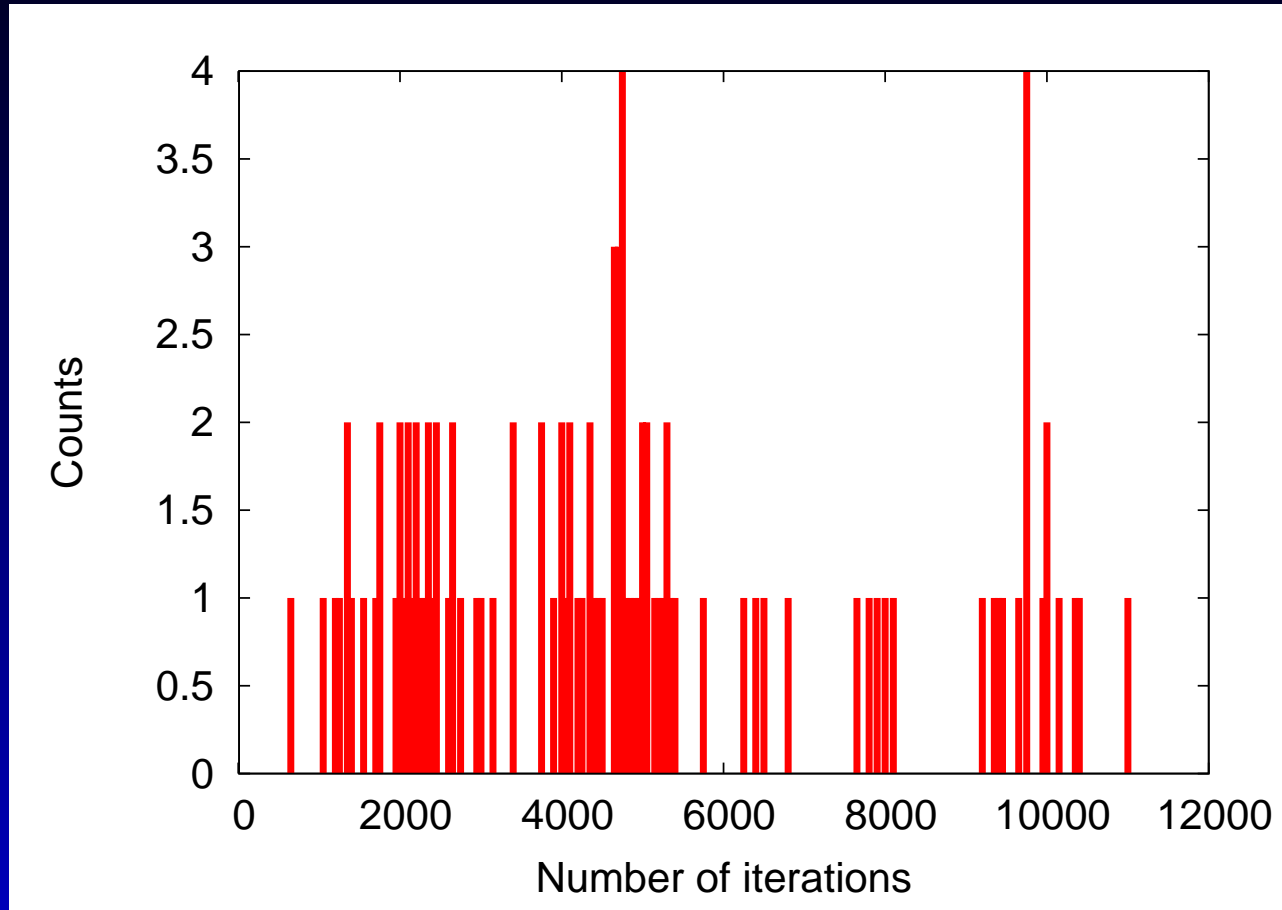
Up to $4\mu\text{m}$ of initial σ_y .

Number of iterations for $\beta_y=0.1\text{mm}$



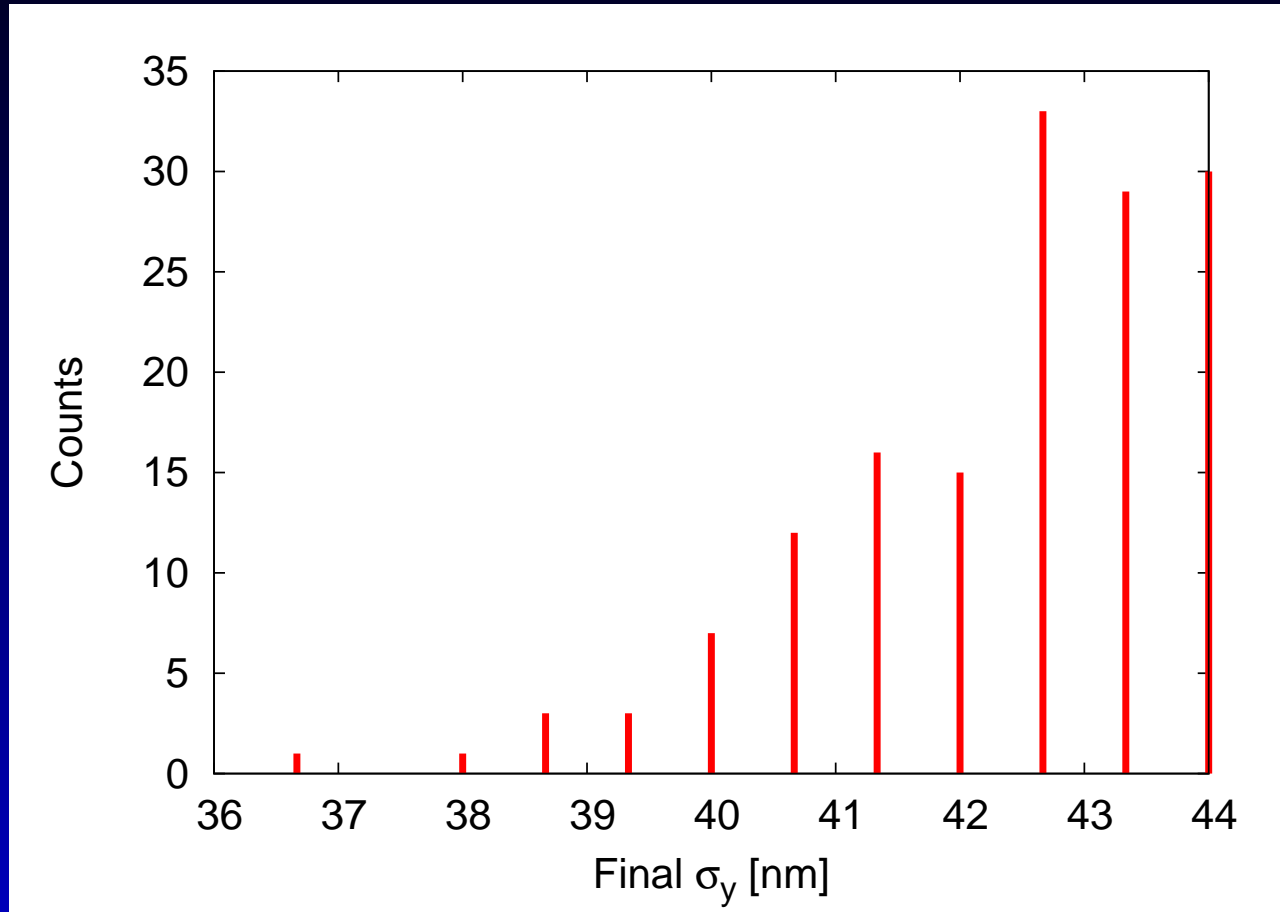
Below 8000 iterations required.

Number of iterations for $\beta_y=0.05\text{mm}$



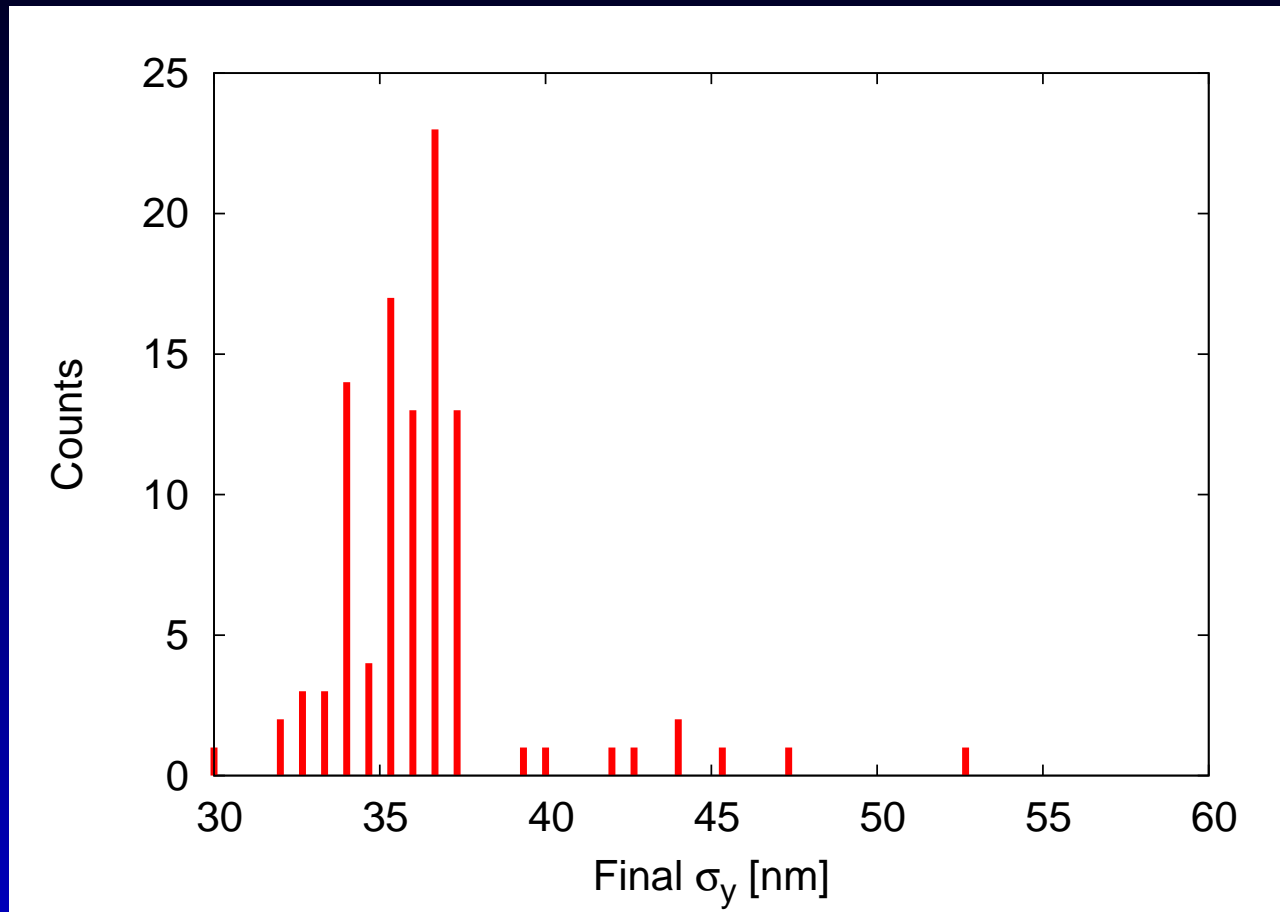
Below 12000 iterations required but maximum is hit.
More iterations are required for lower β !

Final σ_y for $\beta_y=0.1\text{mm}$



Final σ_y between 37 and 44nm.

Final σ_y for $\beta_y=0.05\text{mm}$



Some seeds fail to finish between 30 and 37nm and one seed even stops at 53nm!!

More sophisticated tuning algorithms are required for lower β ! \rightarrow Same problem as in CLIC

Fast ion instability in the CLIC BDS

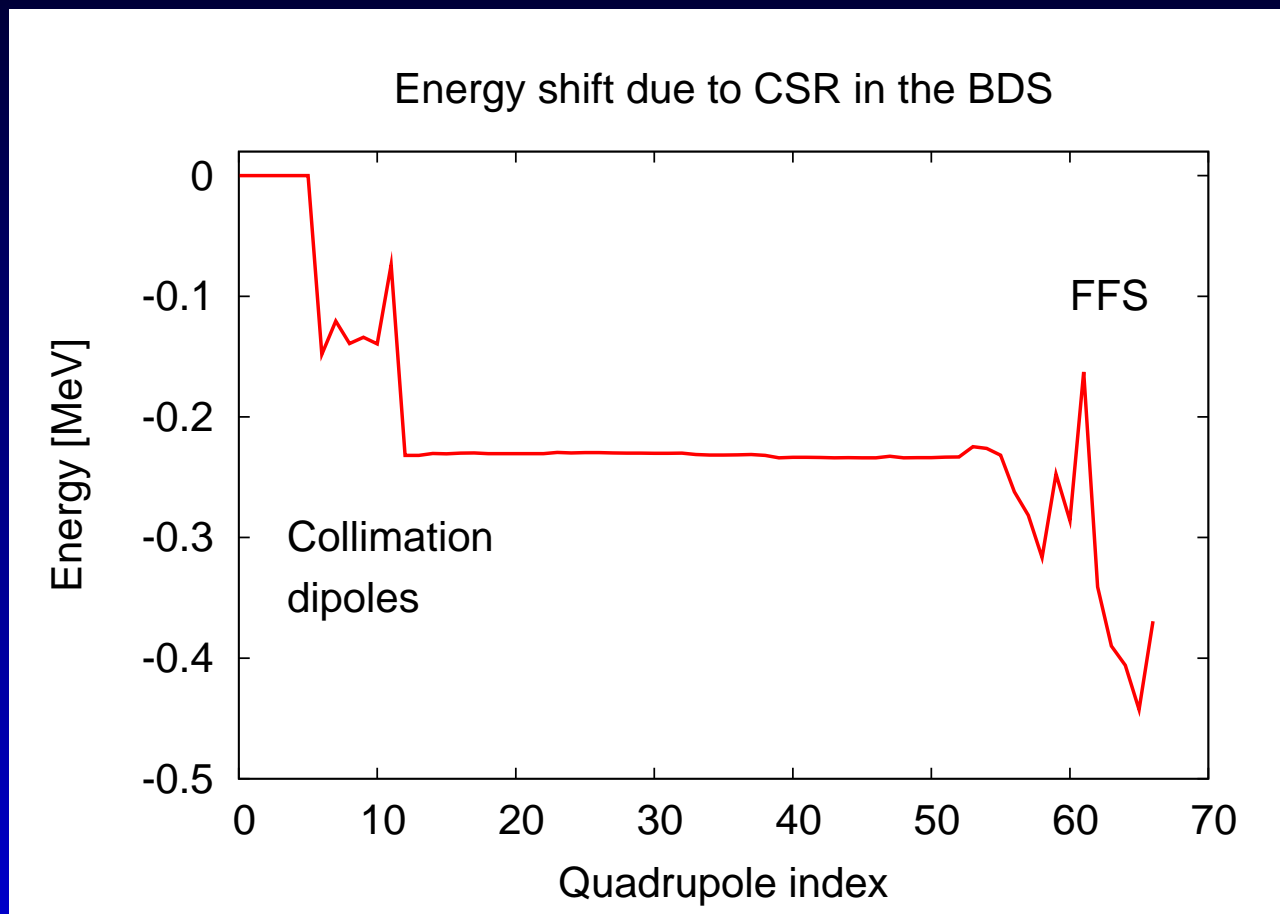
→ Not a problem

Resistive wall in the BDS

- It amplifies the incoming jitter of the beam
- and it decreases for larger beam pipes ($\propto \frac{1}{r^3}$)
- Conservative estimates by D. Shulte and G. Rumolo suggest $r=8\text{mm}$

CSR in the BDS?

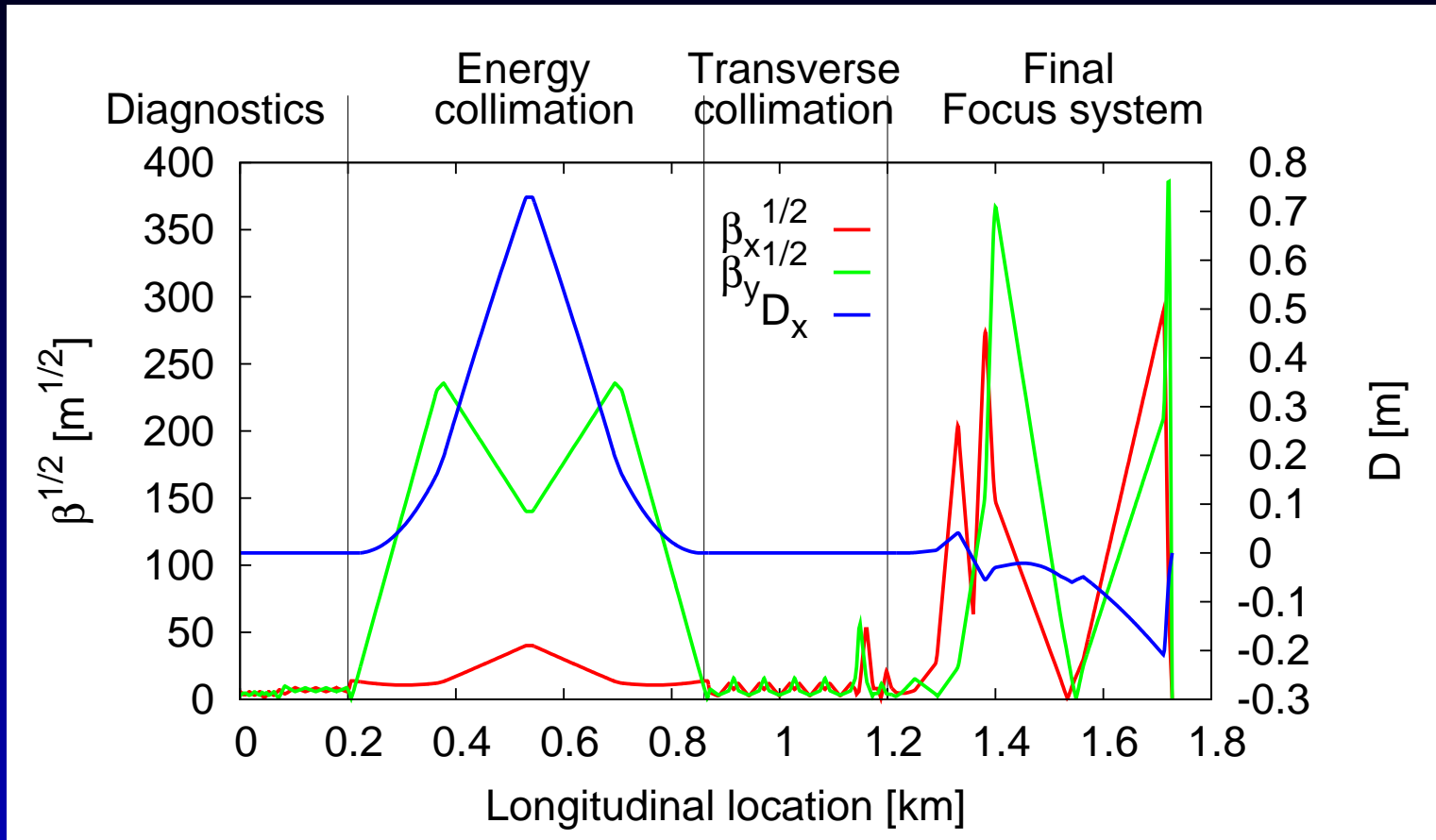
CSR module in PLACET by E. Adli.



Negligible effect, also from formula:

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

CLIC 500GeV BDS: a proposal



Collimation section can be scaled by a factor 2.

Dispersion and efficiency still to be optimized.

Summary

- Convergence to an optimized BDS design
- The challenge remains to verify tuning in realistic simulations with dynamic effects
- Lots to learn from ATF2 experience
- and many details to address...

Workplan towards 2010 & collaborators

- FFS tuning and dynamic effects simulations: lots of work and need of new ideas (2010)
 - * Interest from CI, SLAC and LAL but shortage of manpower
- ATF2 regular experience (2010) and ultra-low β s (2011)
 - * KEK, LAL, LAPP, SLAC, CI, Oxford
- Collimation efficiency validation for new parameters at 3TeV (end 2008) and for 500GeV (2009)
 - * Oxford and CI
- Final quadrupole design validation (2009)
 - * ?

Workplan towards 2010 & collaborators

- Polarization measurement design (2009)
 - * SLAC may express interest
- Post-collision line and dump design (2010)
 - * Upsala, ?
- Collective effects review (2009)