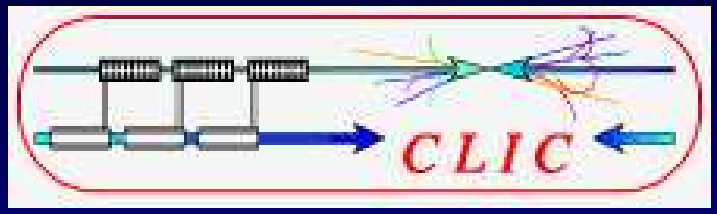
CLIC Beam Delivery System



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

Thanks to E. Adli, I. Agapov, S. Bai, P. Bambade, J.P. Delahaye, L. Fernandez, T. Markiewicz, K. Moffeit, P. Raimondi, Y. Renier, J. Resta, A. Seryi, P. Schuler, G. White, F. Zimmermann

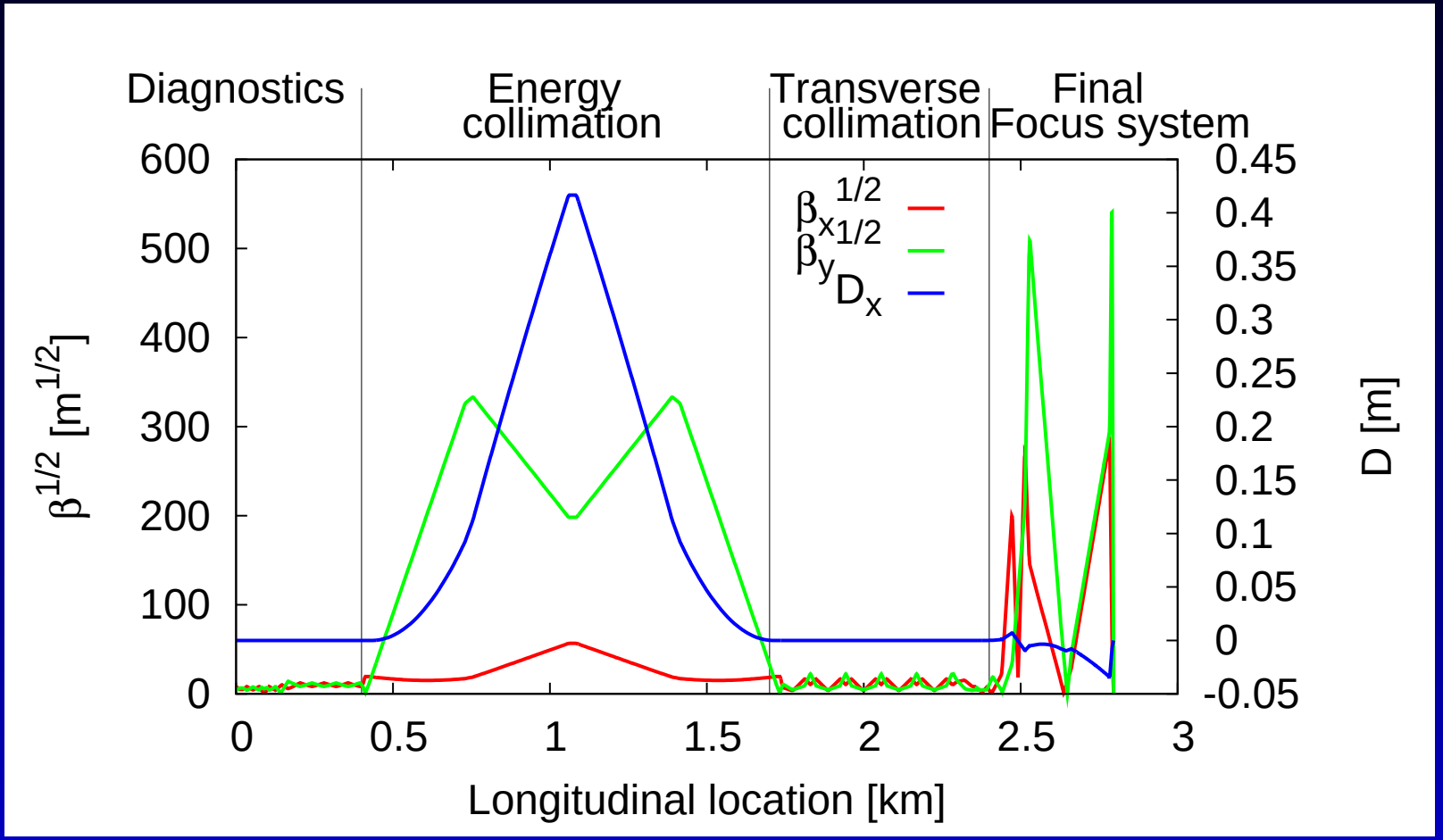
CLIC'08

Contents

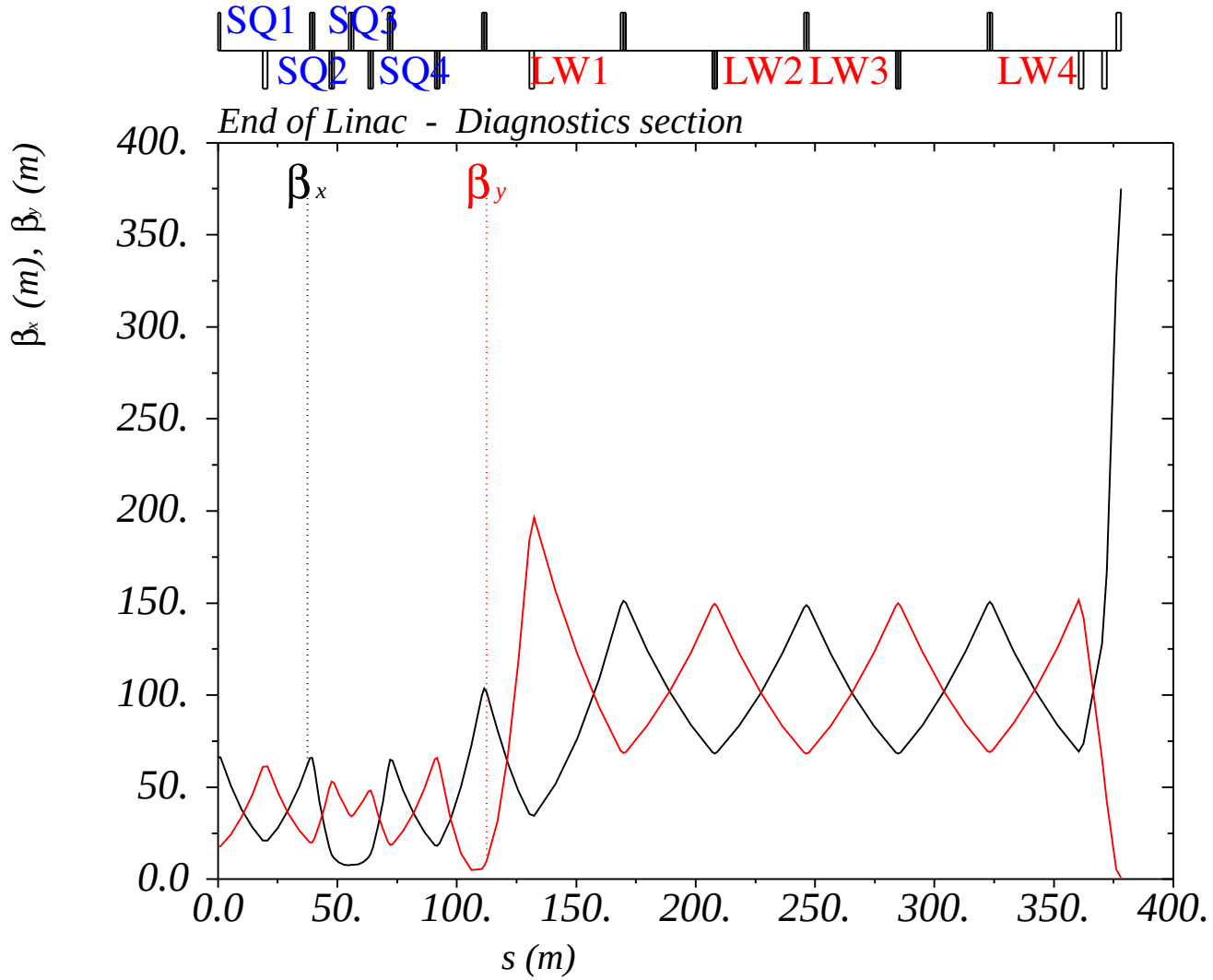
- The CLIC 3TeV BDS:
  - Beam diagnostics section
  - Collimation section
  - Final Focus System: 4.3m and 3.5m L*
  - ATF2 ultra-low betas proposal
  - BDS Collective effects
- The CLIC 500GeV BDS
- Summary

Find the latest lattice at:
http://clicr.web.cern.ch/CLICr/MainBeam/BDS/v_07_09_25/

BDS lattice


Diagnostics
Energy collimation
Transverse collimation
Final Focus system
$\beta_x^{1/2}$
$\beta_y^{1/2}$
D_x
$\beta^{1/2}$ [$m^{1/2}$]
D [m]
Longitudinal location [km]
0
100
200
300
400
500
600
-0.05
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0
0.5
1
1.5
2
2.5
3

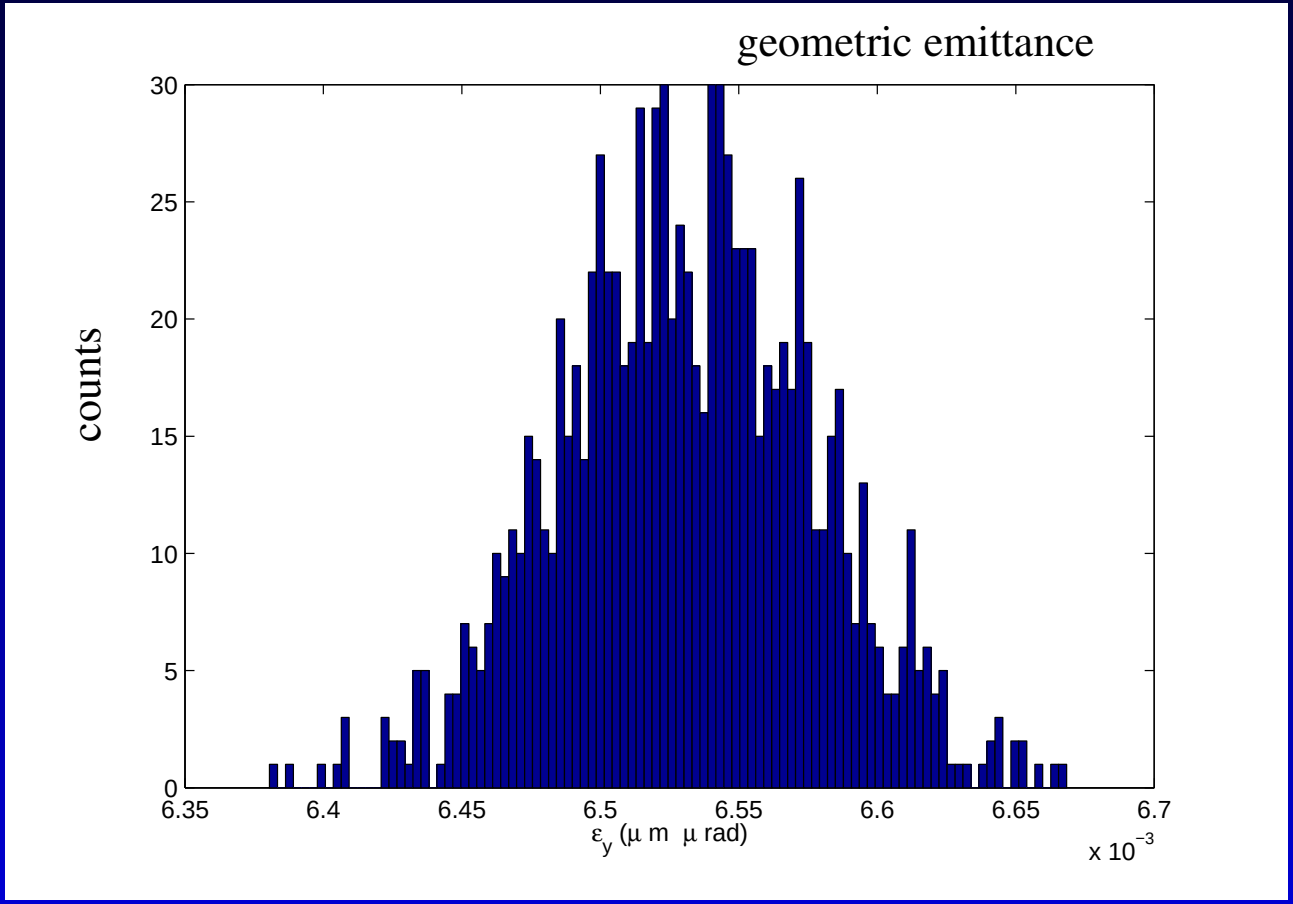
Diagnostics: emittance measurement



σ_y=1μm @ Laser wires (for ϵ_y=20nm)

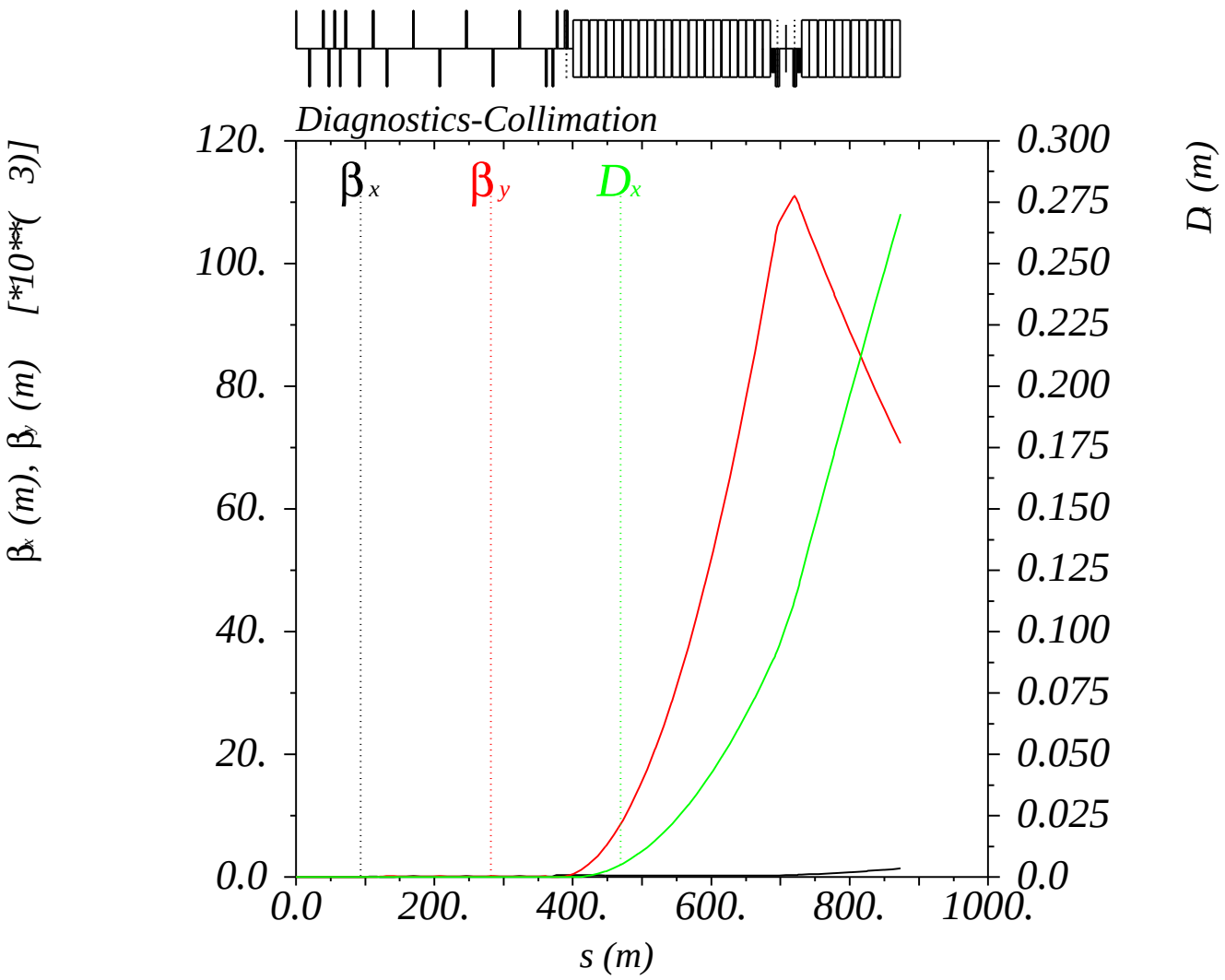
Emittance measurement

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

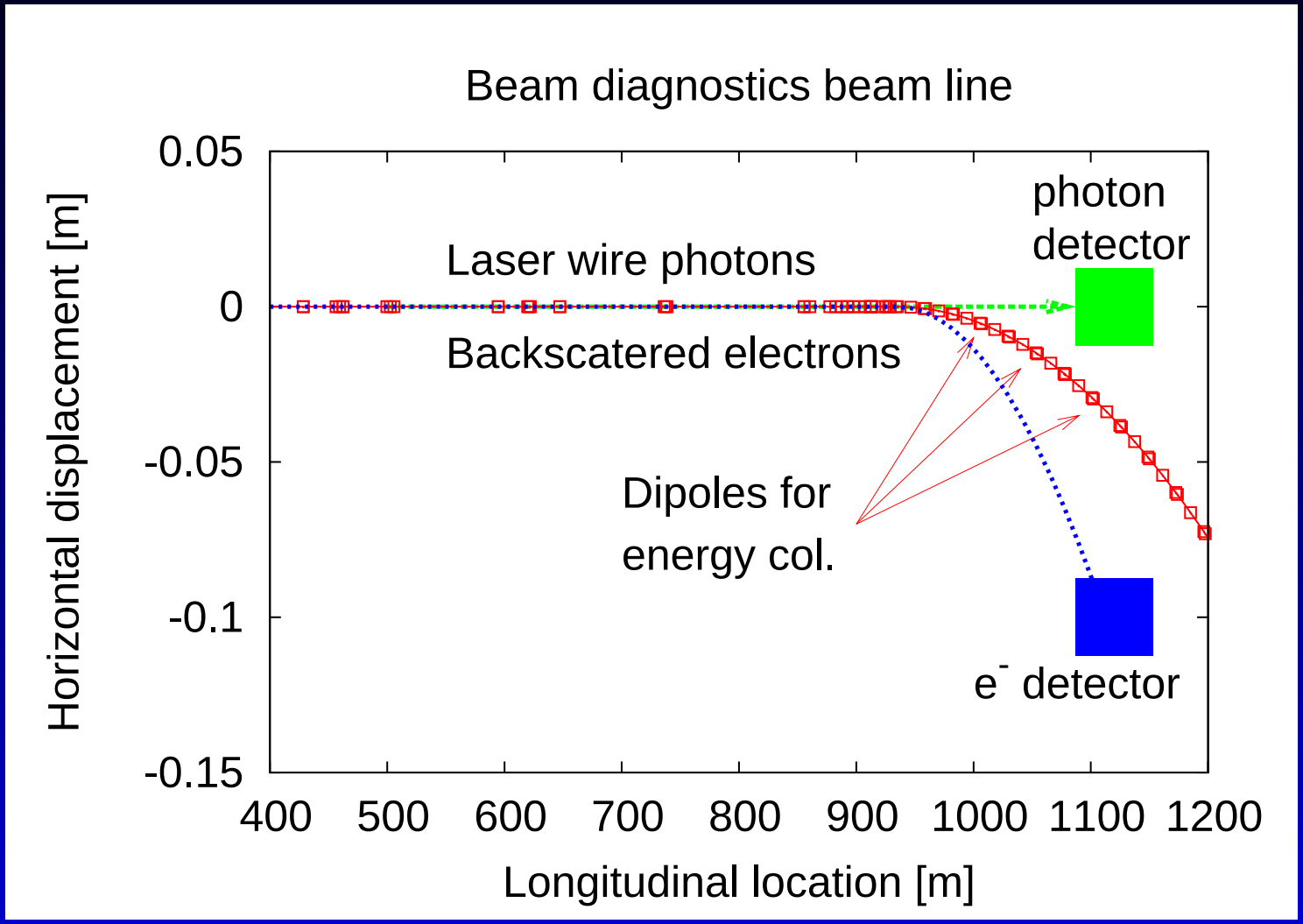


$$\Delta\epsilon_{x,y}/\epsilon_{x,y} \approx 7\%$$

Diagnostics inside collimation

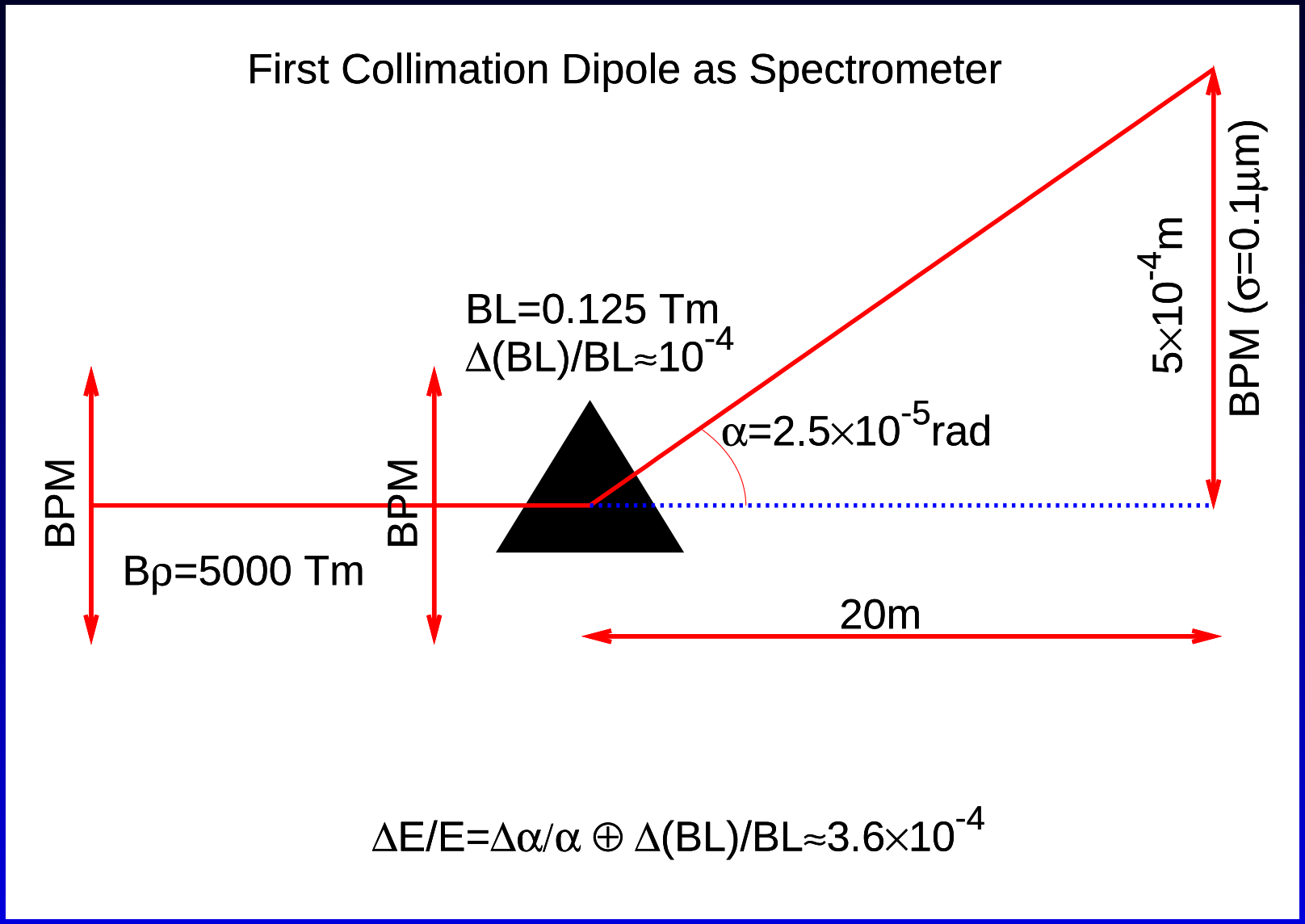


Conceptual layout & e^- collection



Backscatered e^- is the best signal (ILC-Note-2008-041). Need CLIC detailed studies.

CLIC compact energy measurement

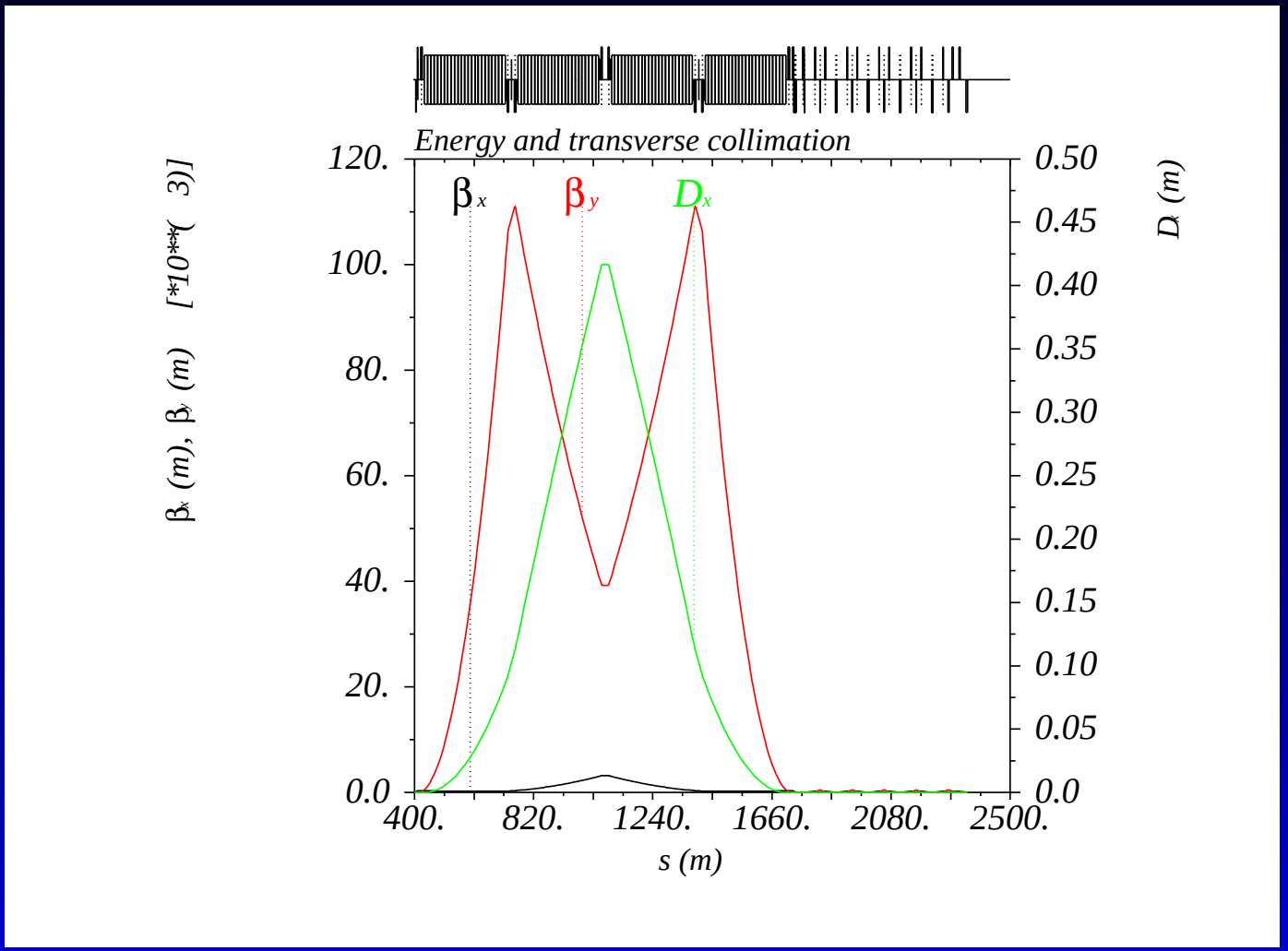


Polarization measurement

What is polarization?

Thanks to the ILC experts for looking into CLIC case

Collimation section



CLIC collimators must survive the impact of a full train (312 bunches)

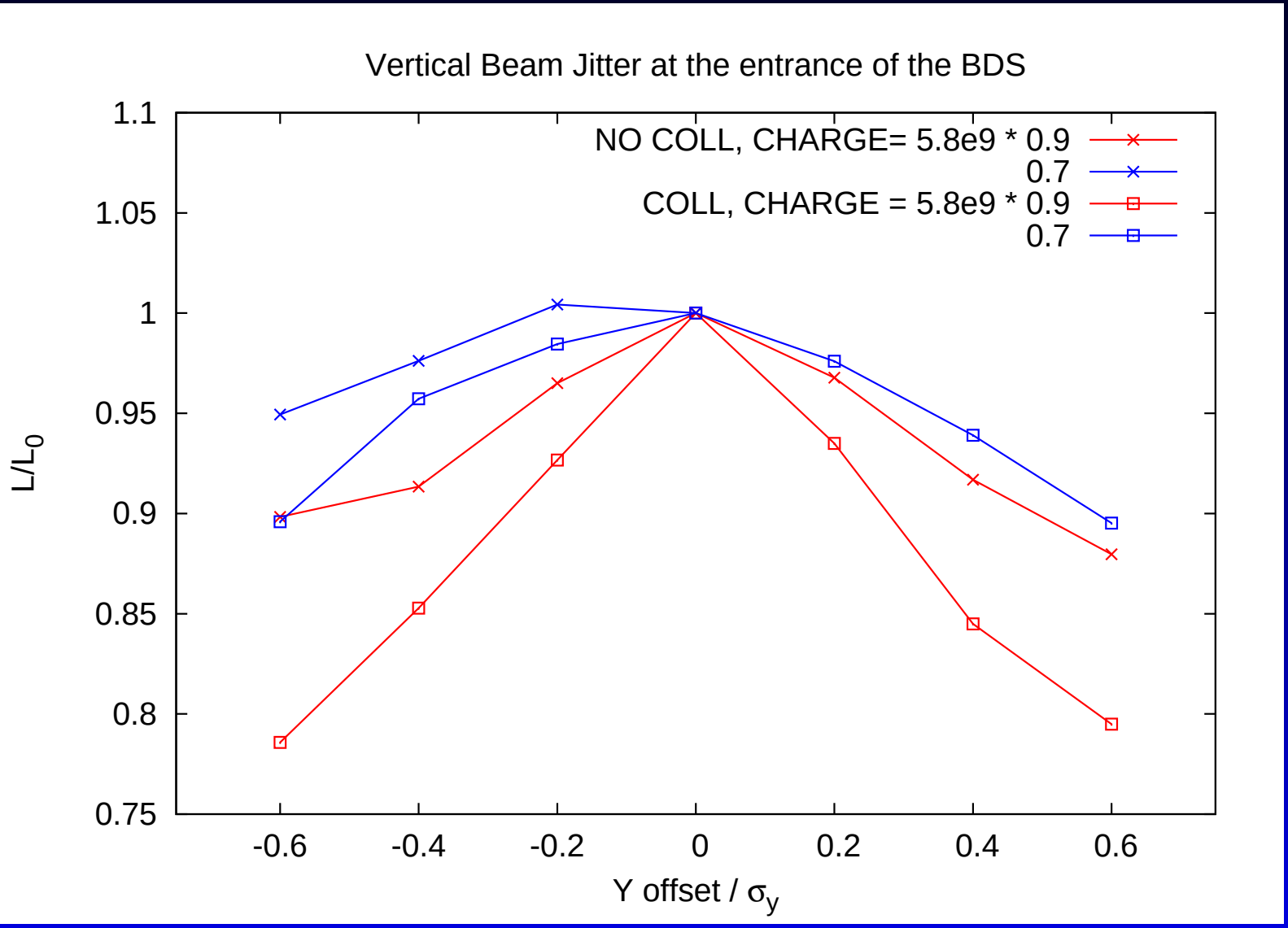
Collimation: New parameters

Name	D_x [m]	a_x [mm]	a_y [mm]	Material	σ_x [mm]	σ_y [mm]
3ESP	0.270	3.51	25.4	Be	0.795	0.0243
4EAB	0.416	5.41	25.4	Ti(Cu)	1.231	0.0181
5BDSP	0	10.0	0.08	Be	0.010	0.0021
6BFSP	0	0.08	10.0	Be	0.010	0.0021
7BFAB	0	1.00	1.00	Ti(Cu)	0.005	0.0005
8BDAB	0	1.00	1.00	Ti(Cu)	0.021	0.0014

Collimator survival, efficiency...

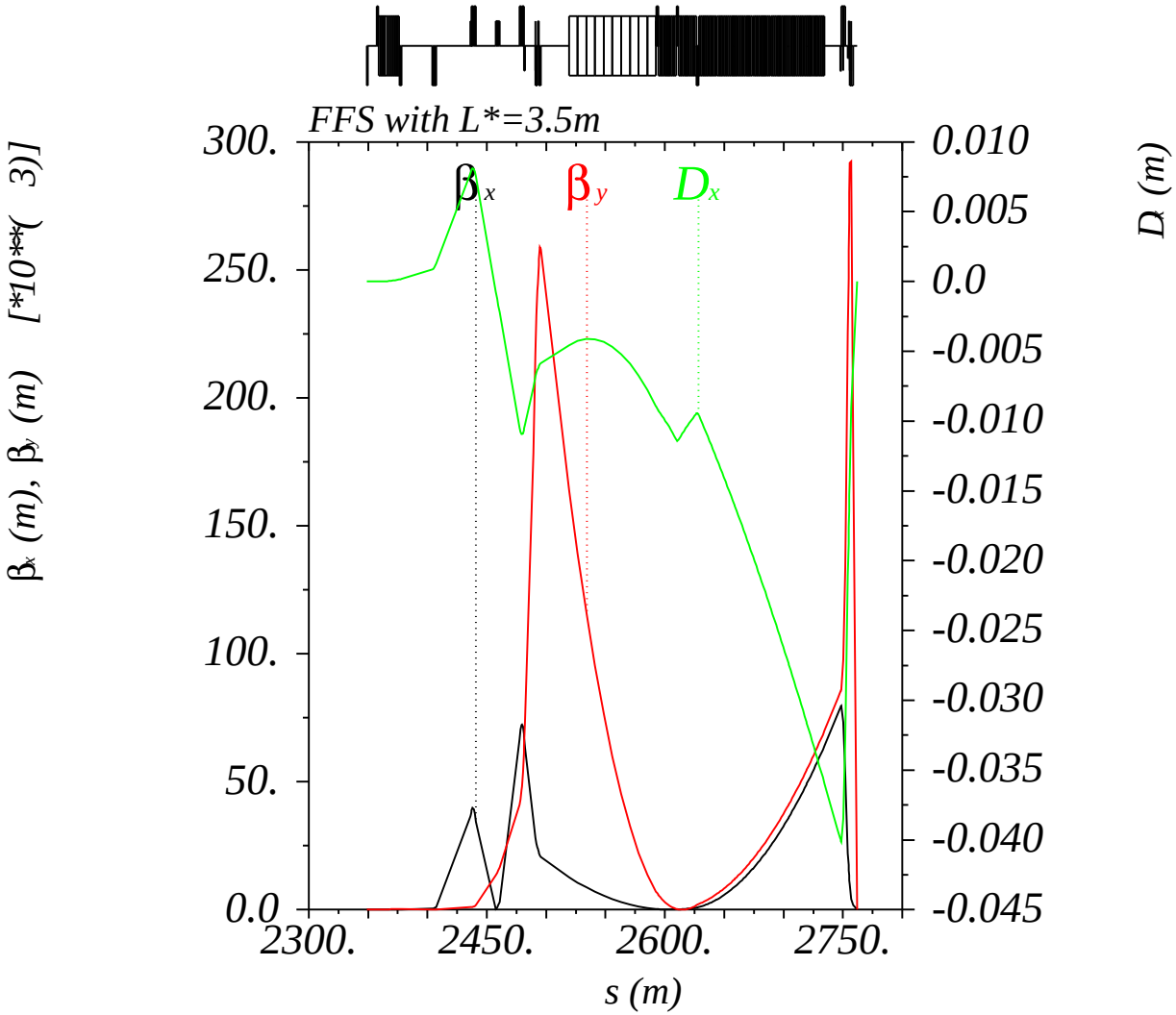
Come in the afternoon!

Collimation wakefields

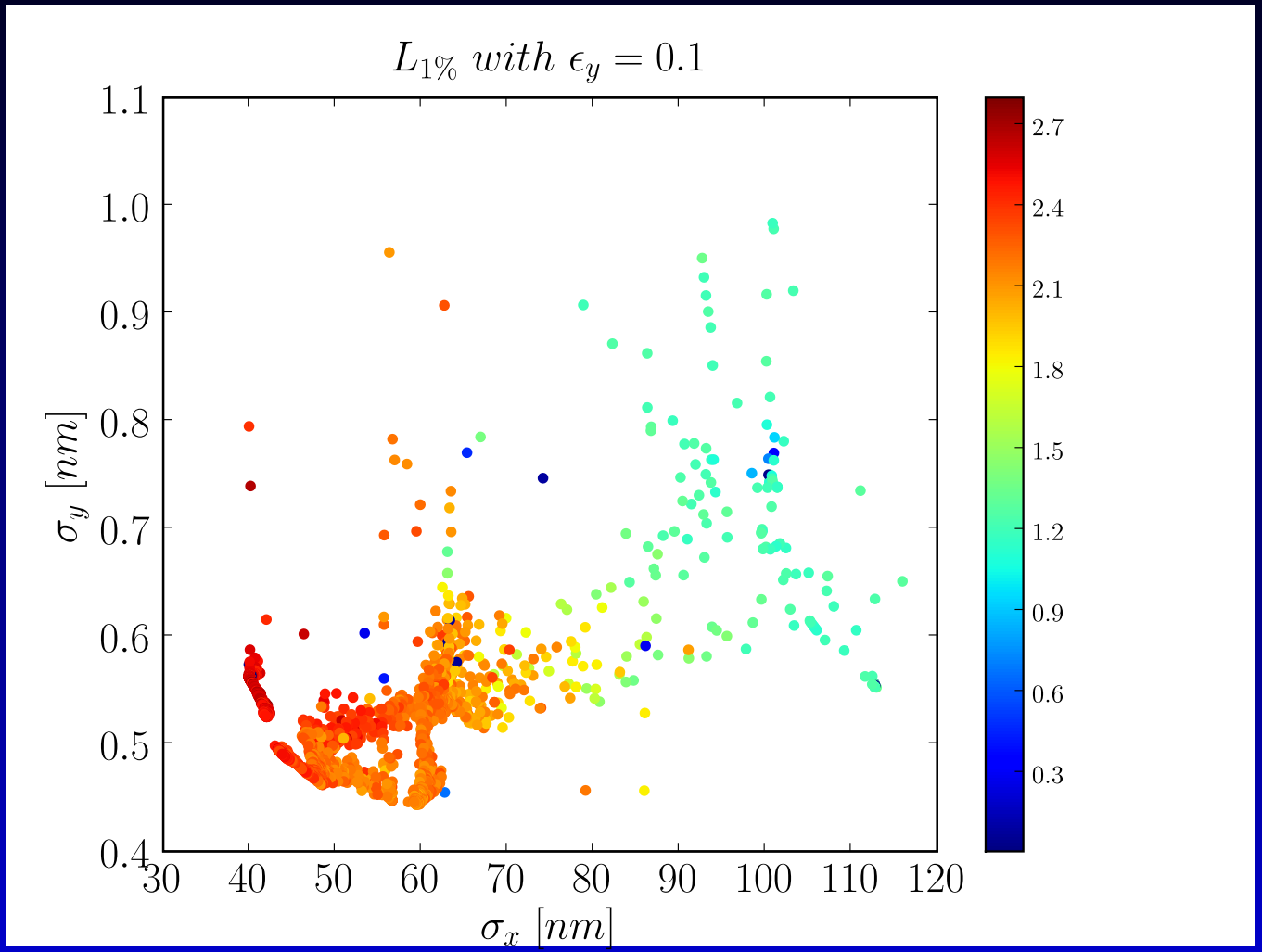


Tolerance in the level of the $0.1\sigma_y$ (more later today)

Final Focus System with L*=3.5m

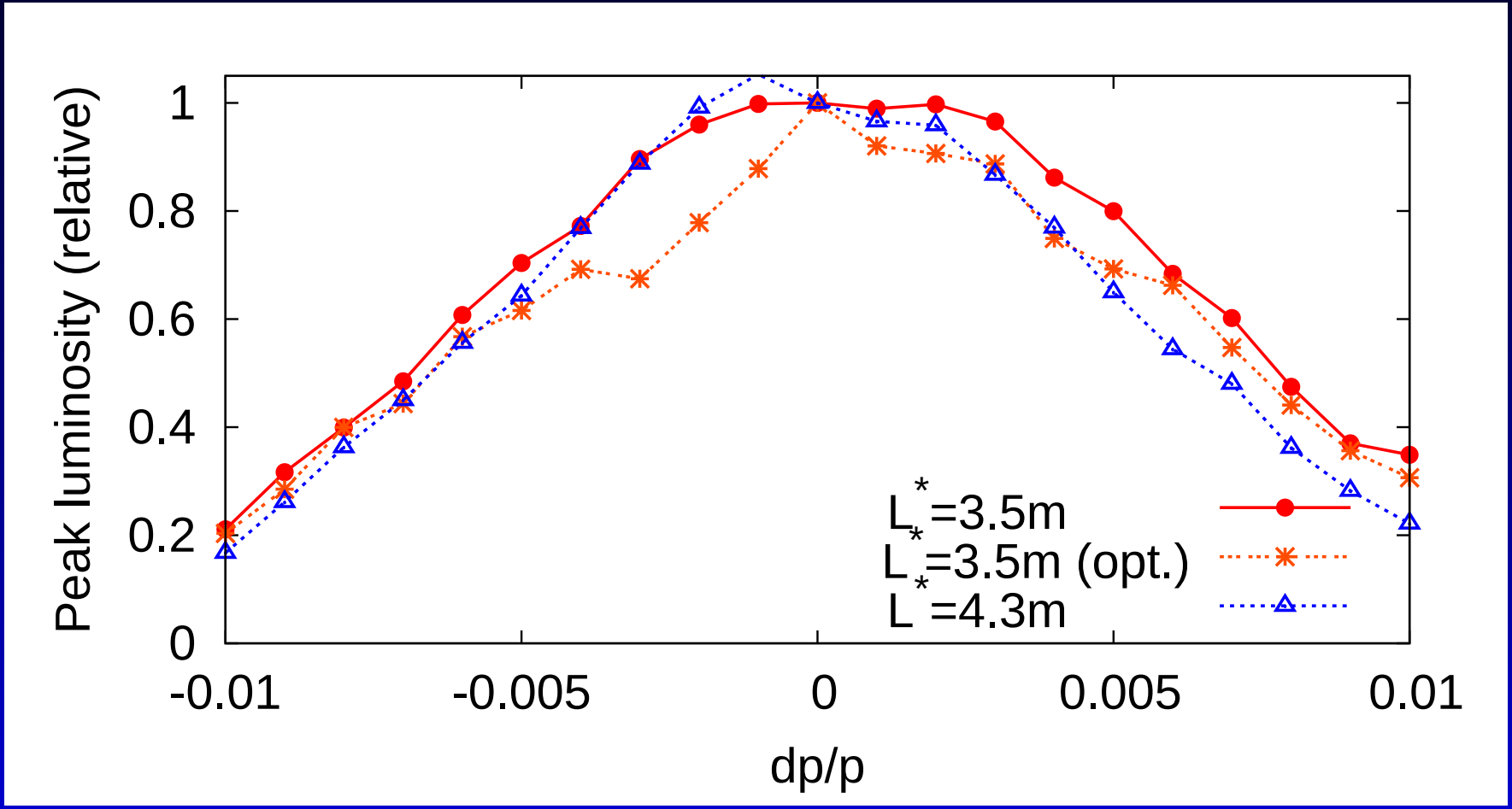


Optimizain the FFS with MAPCLASS



Peak Luminosity has been optimized by varying dispersion, betas, adding decapoles (CLIC-Note-735).

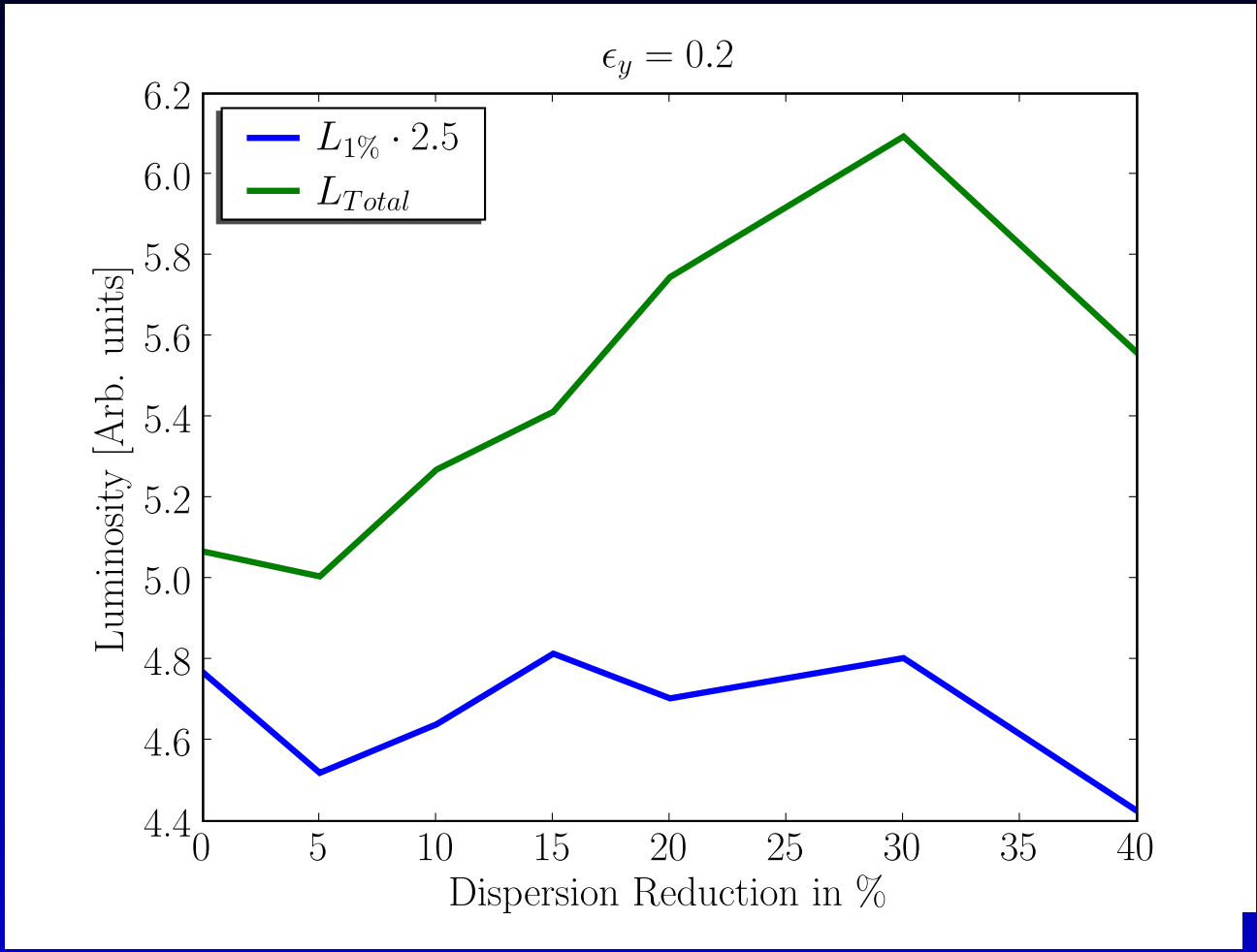
Final Focus Systems, 3.5m versus 4.3m L*



→ Larger peak-lumi-bandwidth for the 3.5m L* FFS

(also preferred for ϕ-error tolerance and wakefields)

Saturation of the peak luminosity

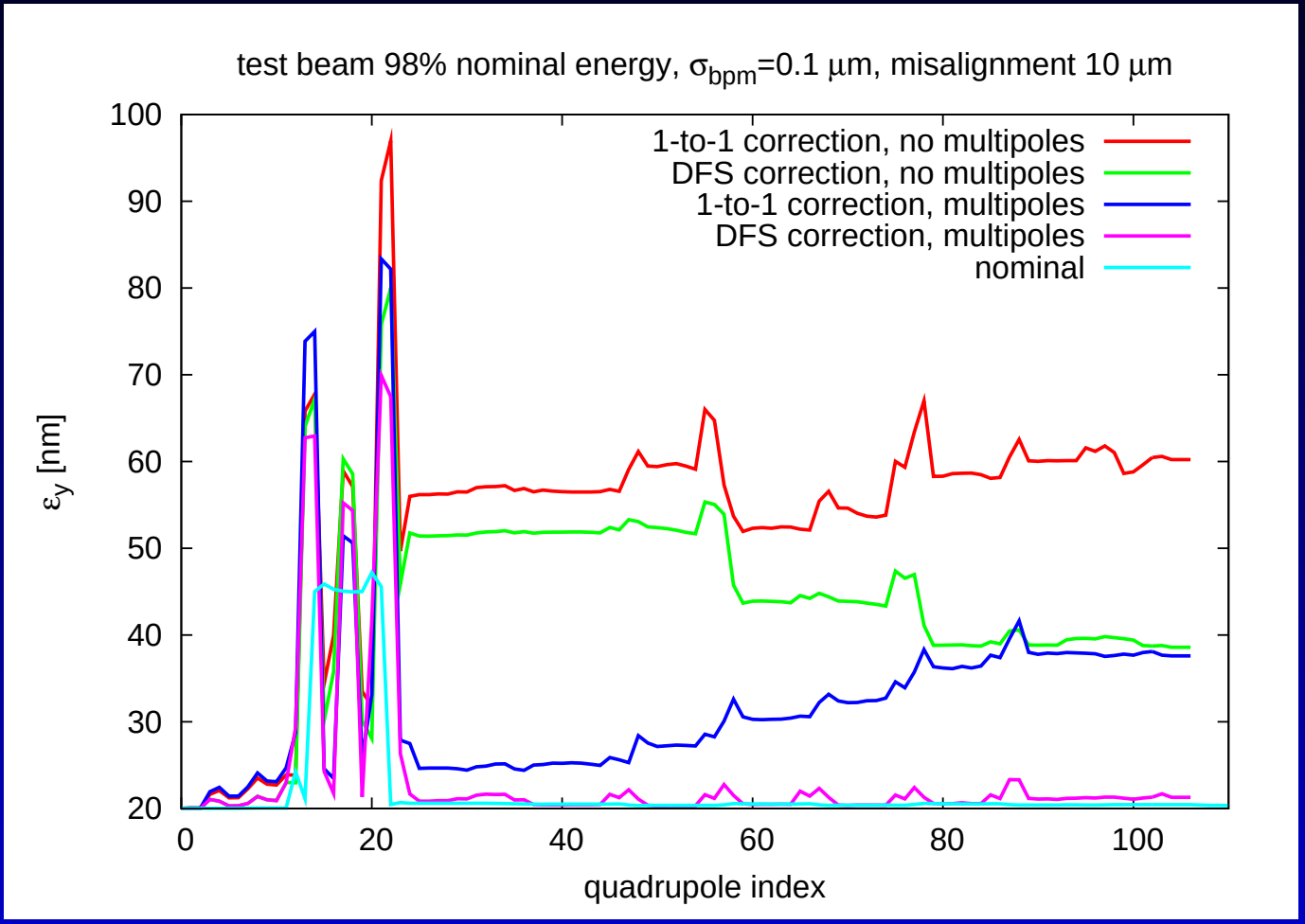


$\rightarrow$ With the current beam parameters further reductions of IP beam size do not increase peak luminosity

Final doublet quadrupoles - New specs.

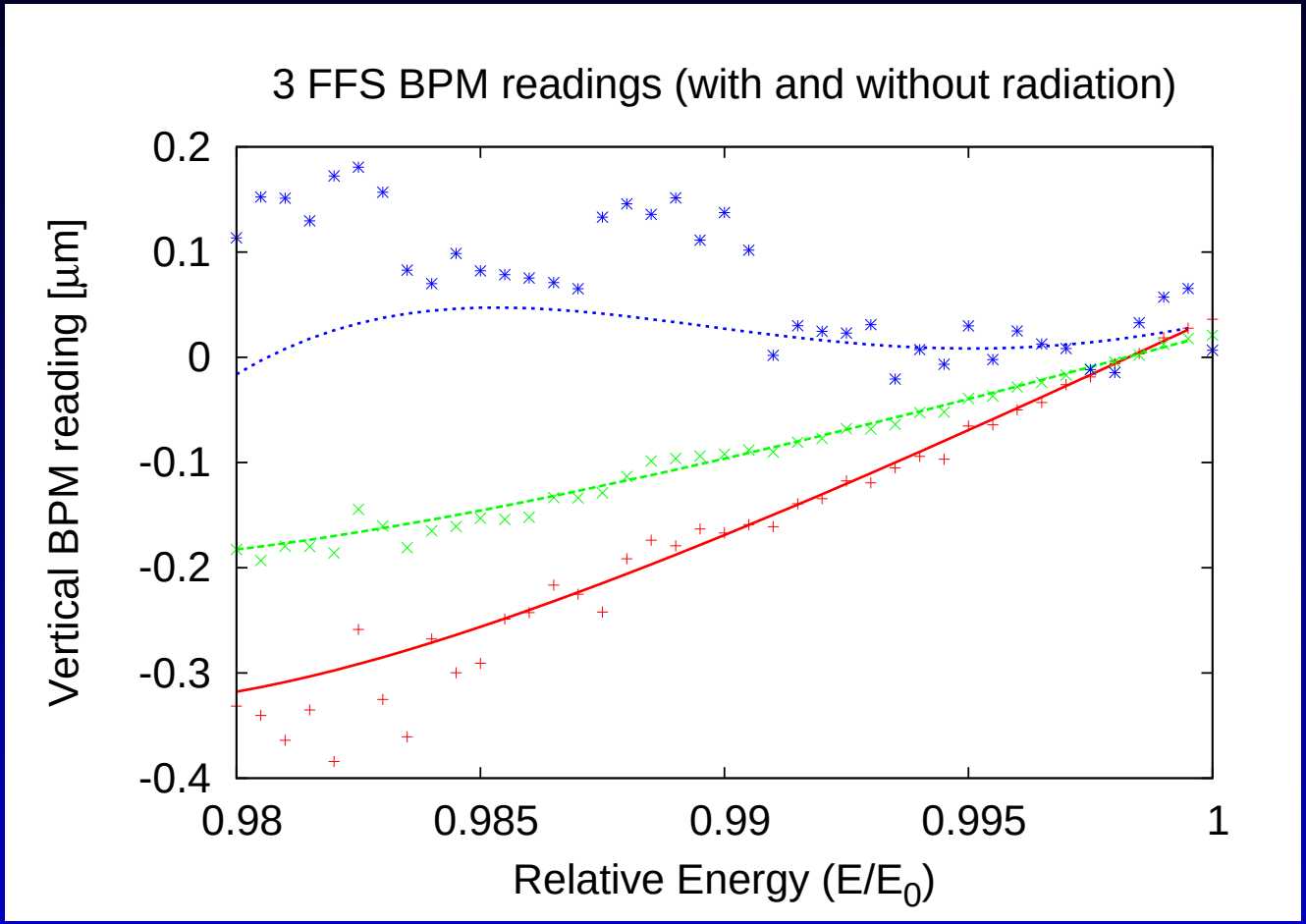
	Unit	L^*=3.5m		L^*=4.3m	
		QF1	QD0	QF1	QD0
Gradient	T/m	200	-575	133	-382
Length	m	3.26	2.73	4.0	3.3
Aperture (radius)	mm	4.69	3.83	6.67	6.76
Outer radius	mm	-	< 35	-	< 43
Peak field	T	0.94	2.20	0.89	2.58
Field stability	$\frac{\Delta k}{k} 10^{-4}$	0.3	0.08	0.3	0.08
Octupolar error	10^6T/m^3	-	< 1	-	< 0.5
Dodec. error	10^{16}T/m^5	-	< 2	-	< 1.0

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, general tuning algorithms must be used.

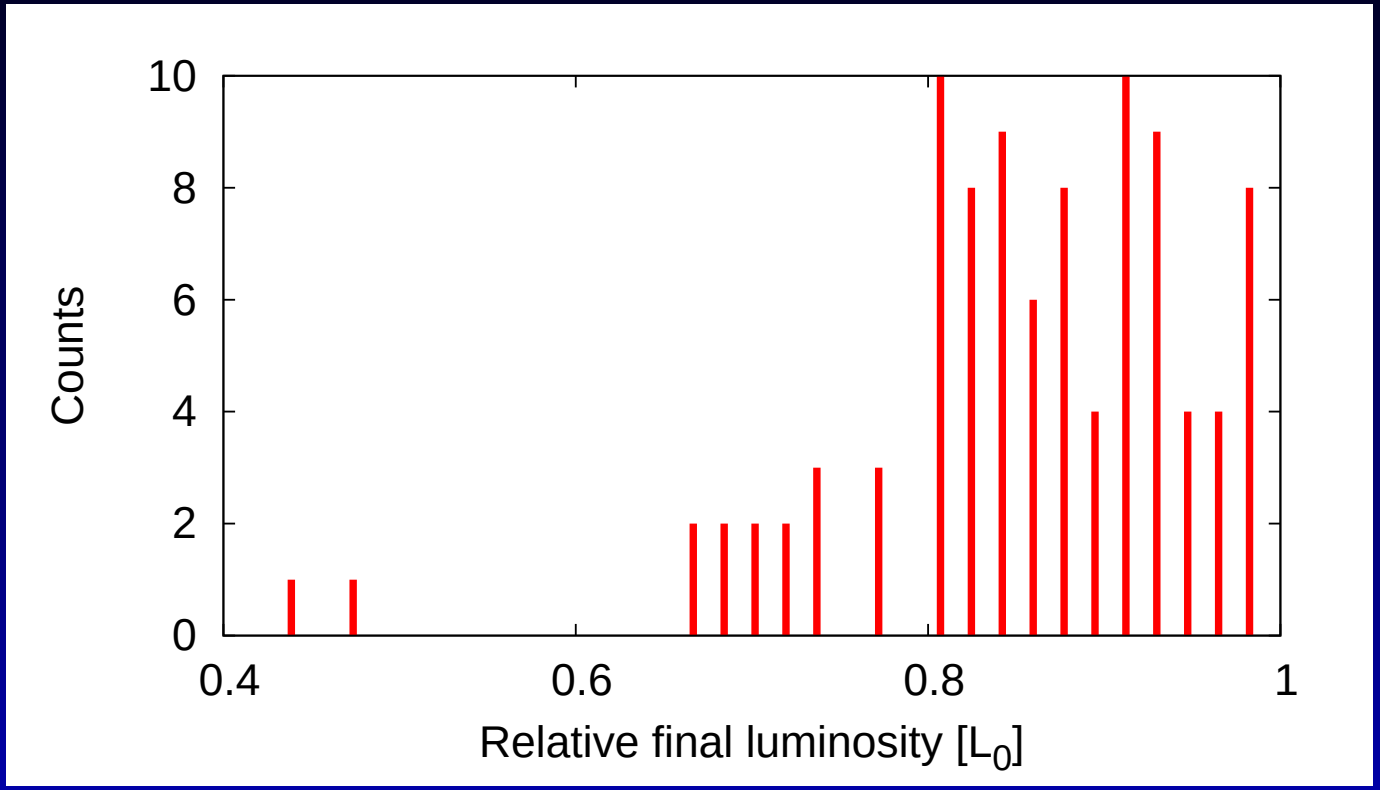
Tuning algorithm

- Using knobs for tuning was abandoned because of small linear range:

  http://accelconf.web.cern.ch/AccelConf/e06/PAPERS/MOPLS094.PDF

- Tuning algorithm is a Simplex having:
  variables:x, y, roll and magnet strength
  observables:Luminosity and BPM reading optional
- However, knob generation might need to be revisited

Luminosity after tuning



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

P. Raimondi proposal: increase FFS length to increase dispersion and reduce sextupoles strengths.

ATF2 ultra-low β proposal

EU contract number RII3-CT-2003-506395 CARE/ELAN Document-2008-002

Exploring ultra-low β* values in ATF2 - R&D Programme proposal

D. Angal-Kalinin[6], S. Bai[1,2], P. Bambade[1], H. Braun[3], J.P. Delahaye[3], J. Gao[2], Y. Honda[4], J. Jones[6], S. Kuroda[4], T. Okugi[4], Y. Renier[1], A. Scarfe[6], D. Schulte[3], A. Seryi[5], T. Tauchi[4], R. Tomás[3,#], J. Urakawa[4], D. Wang[2], M. White[1,5], M. Woodley[5], X.W. Zhu[2], F. Zimmermann[3]

1) CNRS-IN2P3-LAL, Orsay, France
2) IHEP, Beijing, China
3) CERN, Geneva, Switzerland
4) KEK, Tsukuba, Japan
5) SLAC, Stanford, USA
6) Cockcroft Institute, Daresbury, UK

More on Frank's talk

Abstract

We propose to explore the beam sizes and performance of the ATF2 Final Focus System for reduced IP beta functions up to a factor between 2 and 4 below its design. The results will demonstrate the feasibility of the system in a chromaticity regime of interest for CLIC and ILC.

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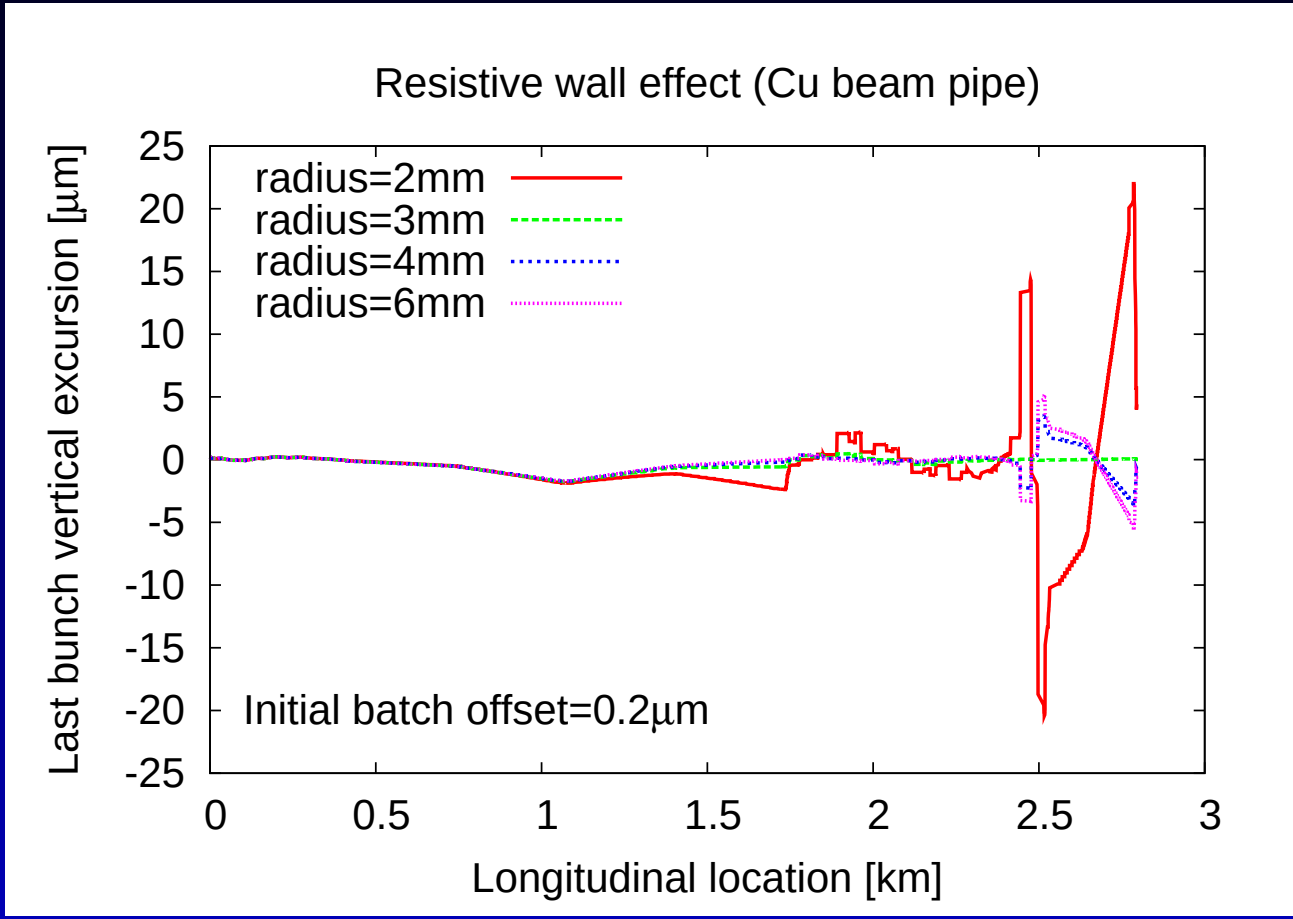
Fast ion instability in the CLIC BDS

- Fast ion instability does not develop for vacuum in the order of 10 nTorr
- Field ionization under study

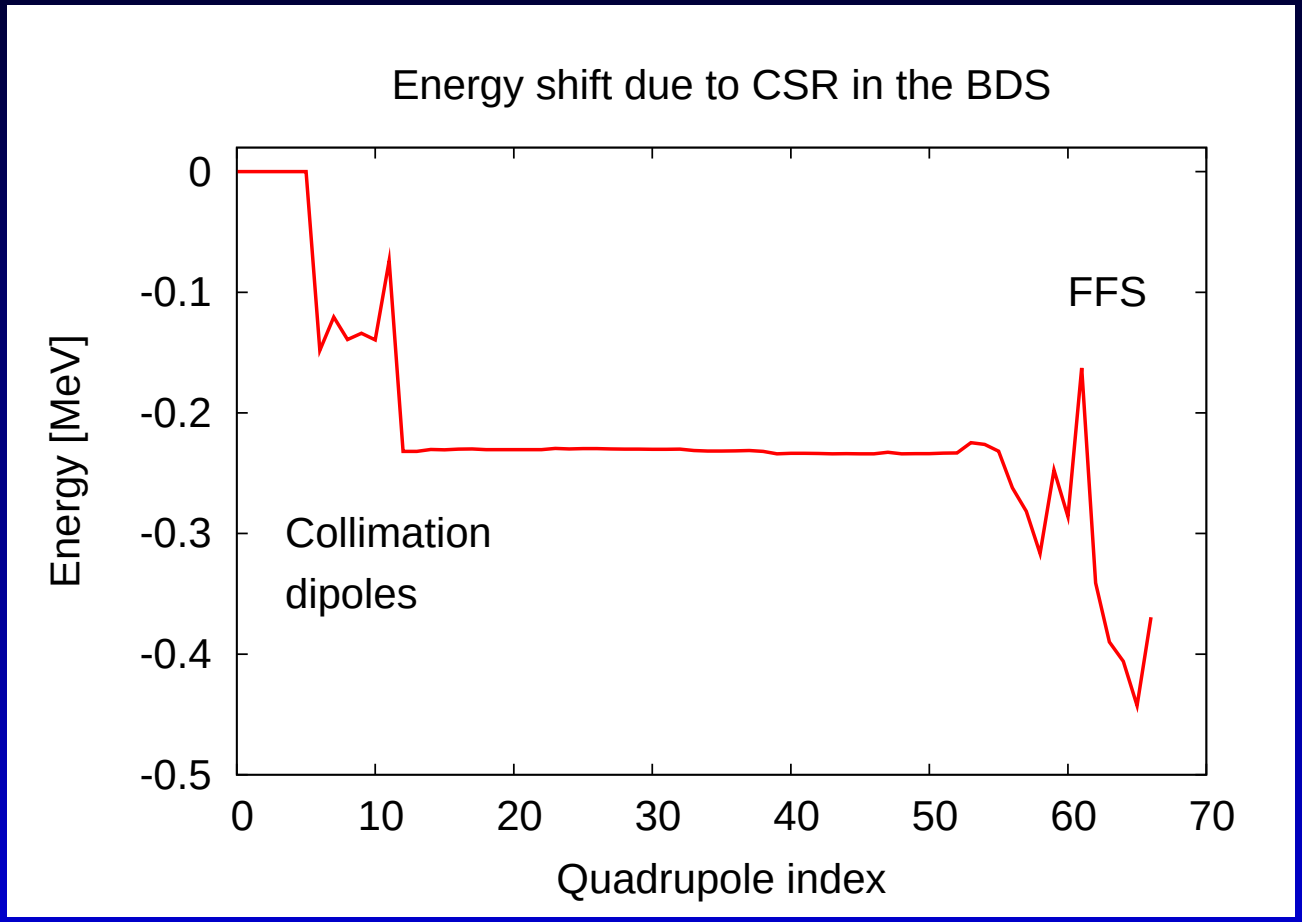
Resistive wall in the BDS



Simulations by G. Rumolo and D. Schulte suggest a beam-pipe radius of 8mm

CSR in the BDS?

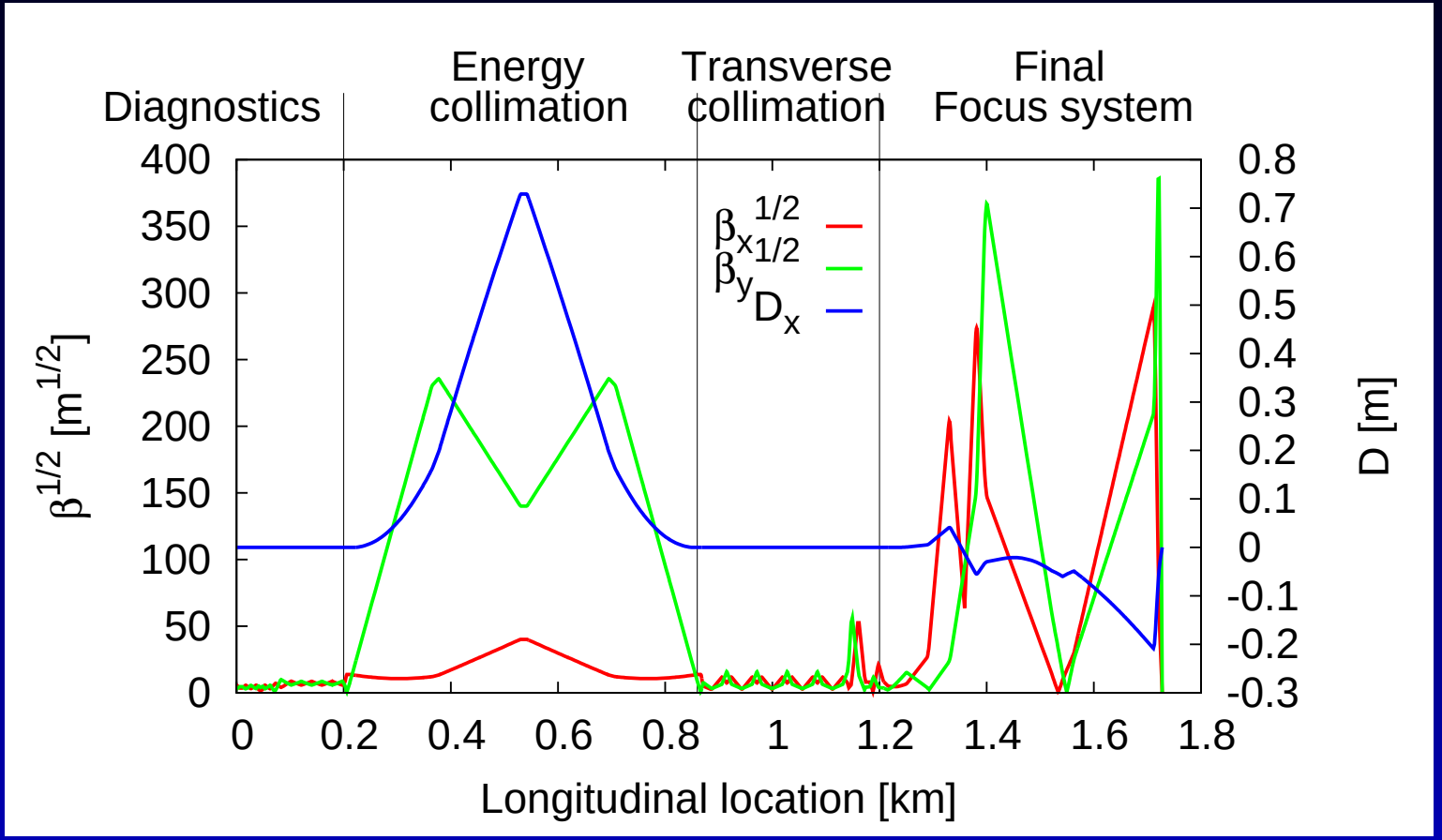
CSR module in PLACET by E. Adli.



Negligible effect, also from formula:

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

CLIC 500GeV BDS: a proposal



Collimation section can be scaled by a factor 2.

Dispersion and efficiency still to be optimized.

Summary

- Basic diagnostics in conceptual stage
- Convergence to an optimized BDS design
- Guaranteed excitement during collimation talks
- New Final Doublet design a bit more difficult
- ATF2 ultra-low betas proposal to demonstrate CLIC-like chromaticities
- The challenge remains to verify tuning the CLIC FFS in realistic simulations with dynamic effects
- Lots to learn from ATF2 and ATF2 ultra-low betas experience
- CLIC lattices repository: http://cern.ch/CLICr/

Thanks!

Enjoy the workshop

(and make it even more exciting!)