Injector Options for CLIC Drive Beam Linac

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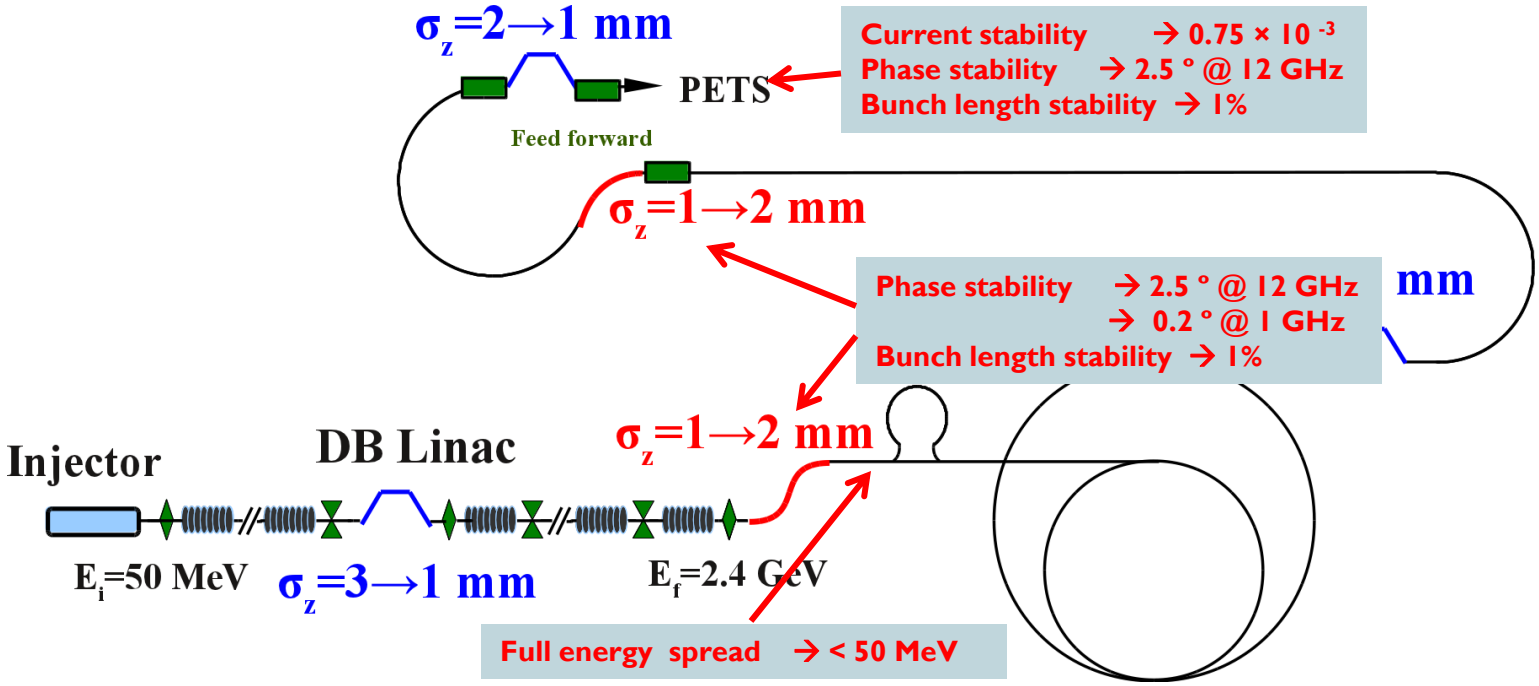
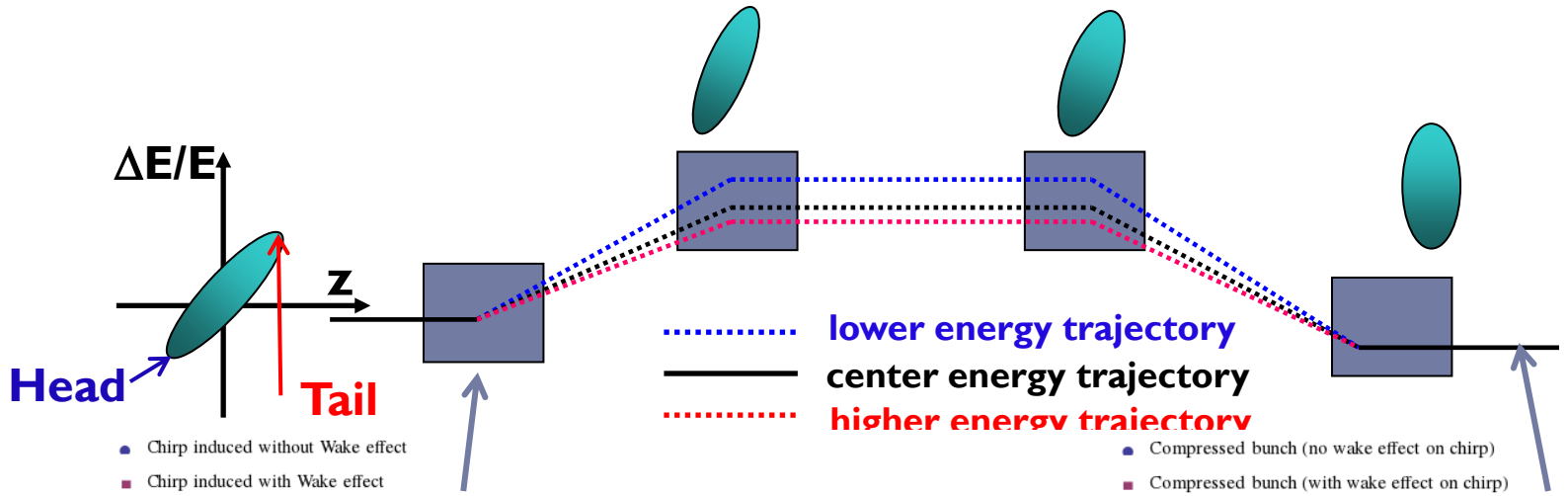
Introduction

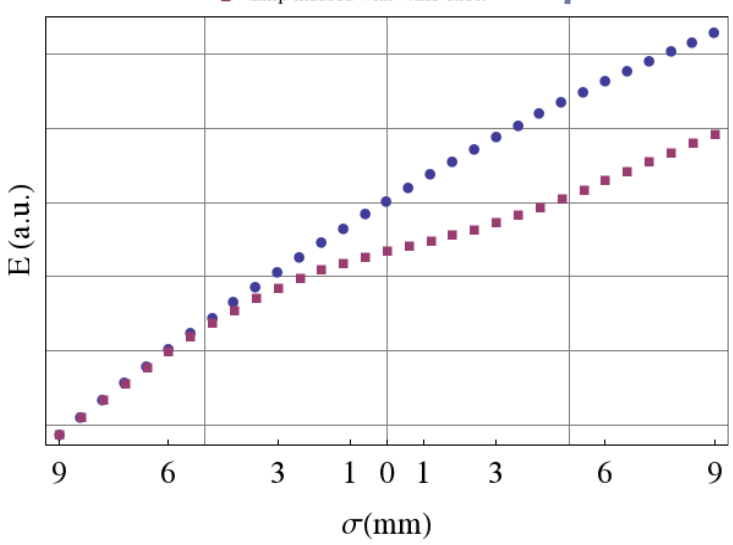


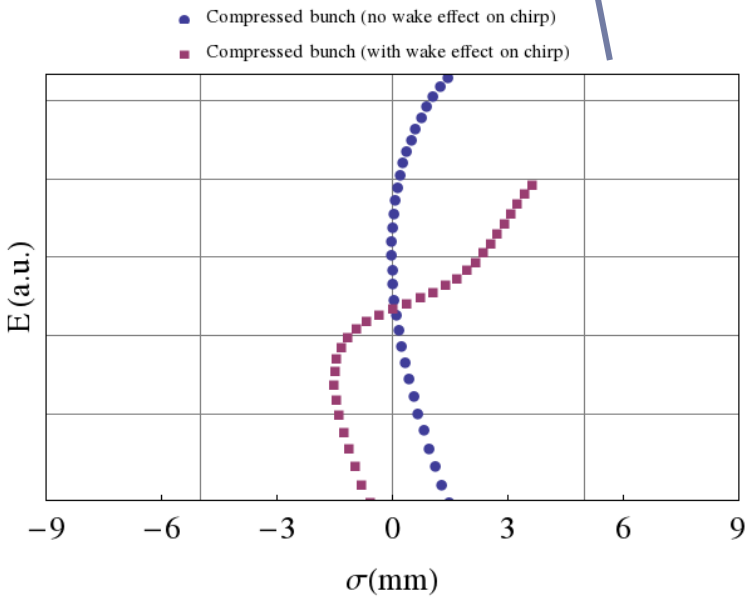
- The beam pulse with 140 μs pulse length and 4.2 A current which consists of 24 × 24 sub-trains of about 120 bunches each is accelerated up to 2.4 GeV in Drive Beam Linac (DBL).
- After DBL, 24 sub-trains will be merged into a single sub-train using delay loop (DL), combiner ring one (CR1) and combiner ring two (CR2). (Each sub train will have 100 A pulse current and 240 ns pulse length)
- In order to avoid effect of CSR the beam will be decompressed and compressed several times before and after dispersive sections.

Motivation

- Bunch compression





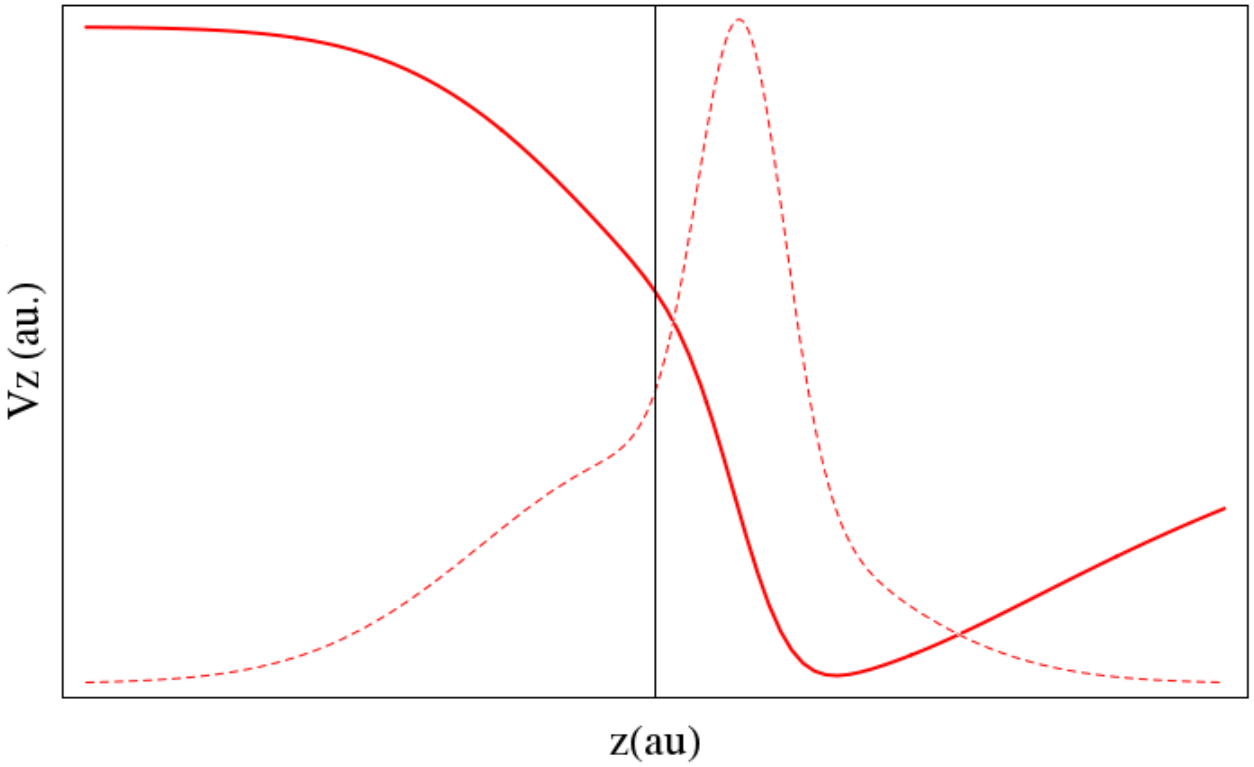


Motivation

- Effect of charge distribution to wake potential, therefore to relative energy spread..

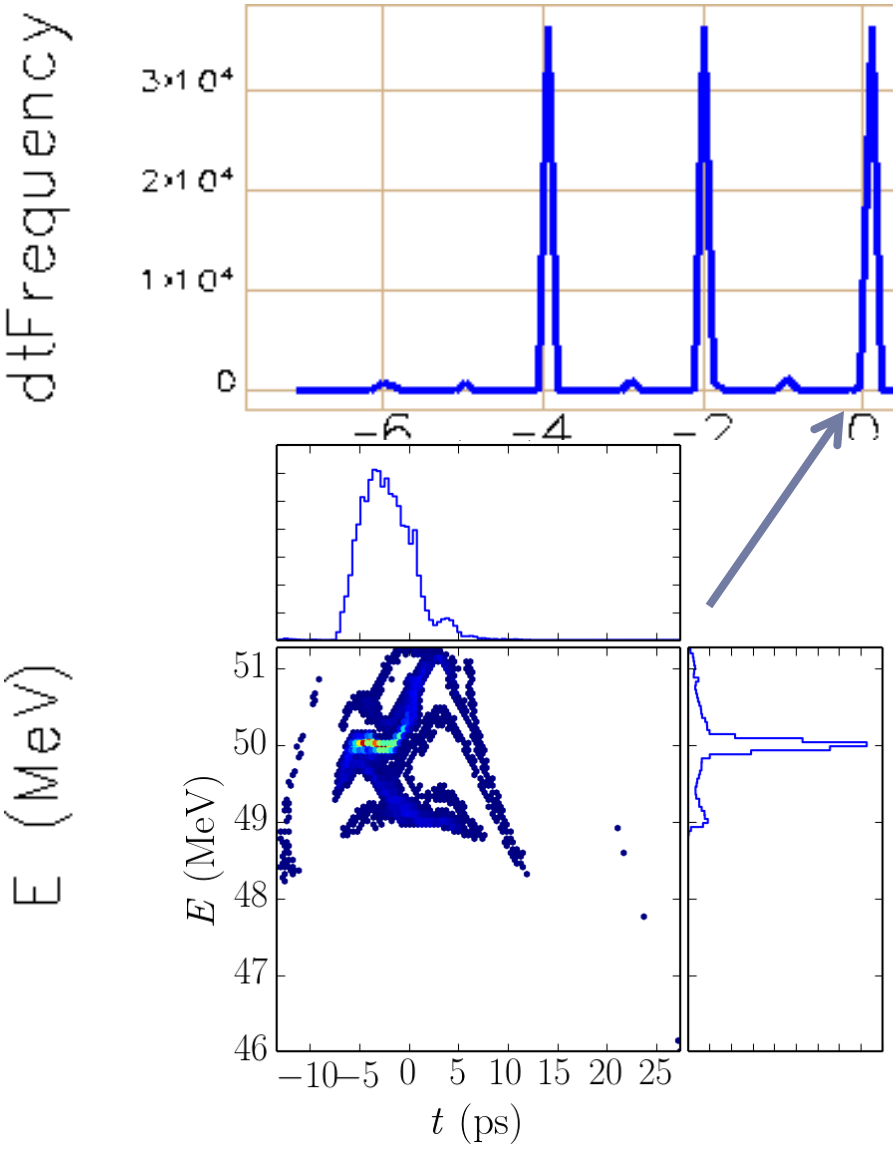
$$V_z(s) = \int_{-\infty}^{s} ds'\, \lambda(s')\, W_z(s - s')$$

λ → longitudinal charge distribution
Wz → wake function of structure



Any tail or spike on charge distribution will introduce nonelinear chirp..

Bunch coming from injector



Not only the satellites are problem

Bunch charge distribution will lead the wakefield effect

Parameter	Unit	Value
E	MeV	49.981
$\varepsilon_{n,x}$	μm	78.977
$\varepsilon_{n,y}$	μm	78.765
ε_z	keV.ps	1204.96
σ_x	mm	1.524
σ_y	mm	1.523
σ_z	ps	2.655
σ_E	keV	454.95
$\Delta E/E$	%	0.910

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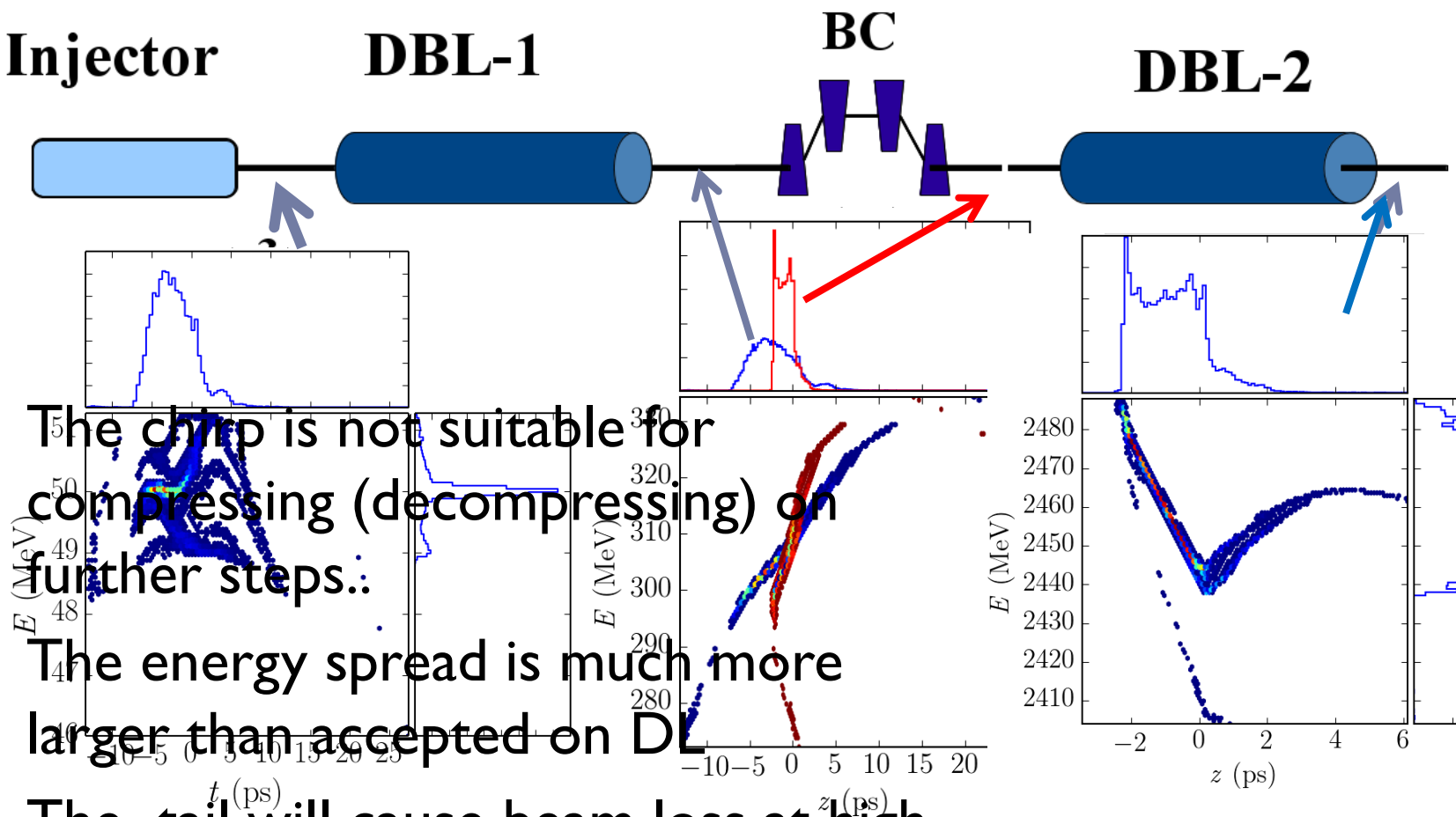
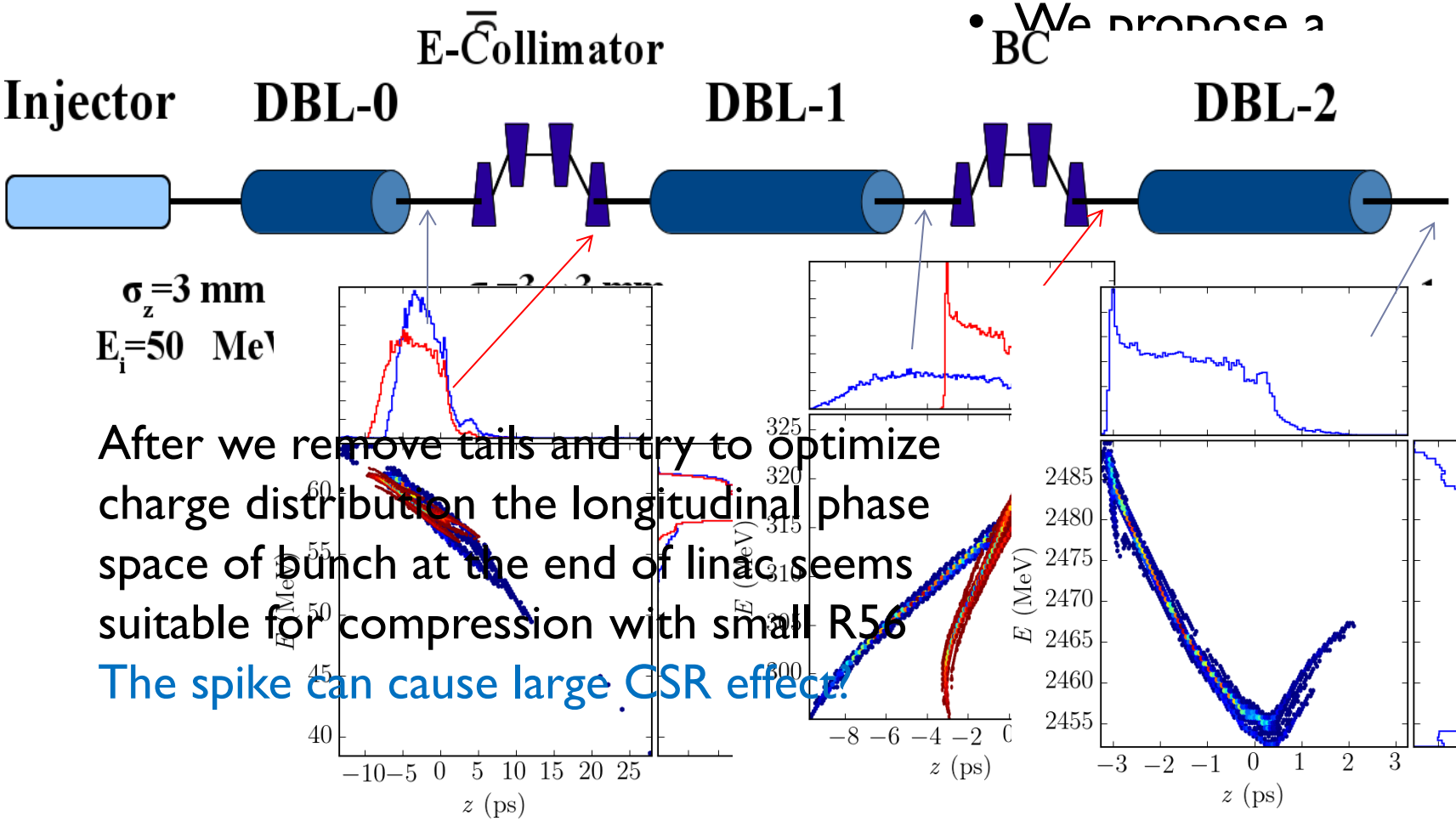
Tracking the bunch through linac



- The chirp is not suitable for compressing (decompressing) on further steps..
- The energy spread is much more larger than accepted on DL
- The tail will cause beam loss at high energies

We propose energy collimator just after injector (a)

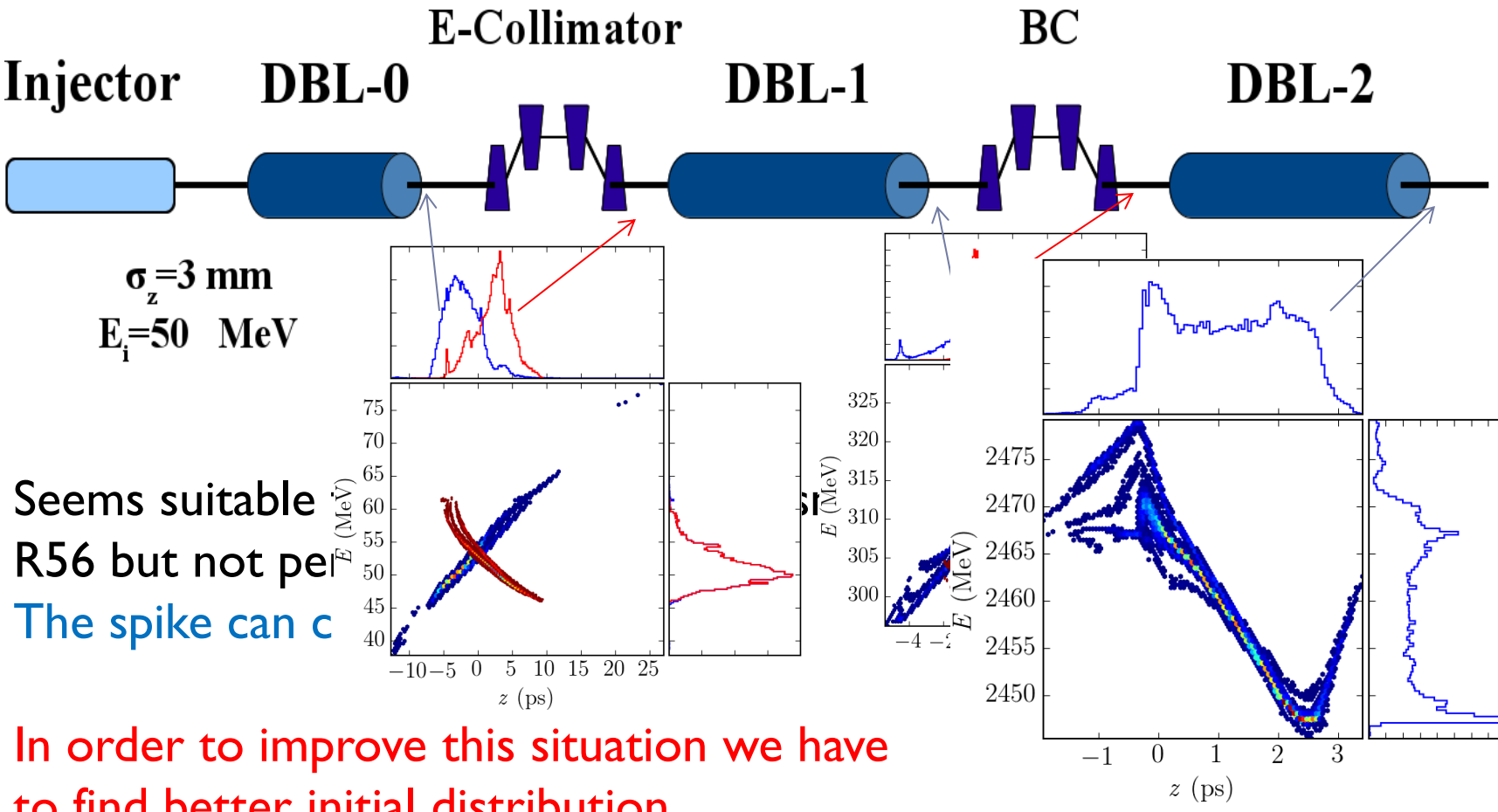


- We propose a BC

After we remove tails and try to optimize charge distribution the longitudinal phase space of bunch at the end of linac seems suitable for compression with small R56

The spike can cause large CSR effect.

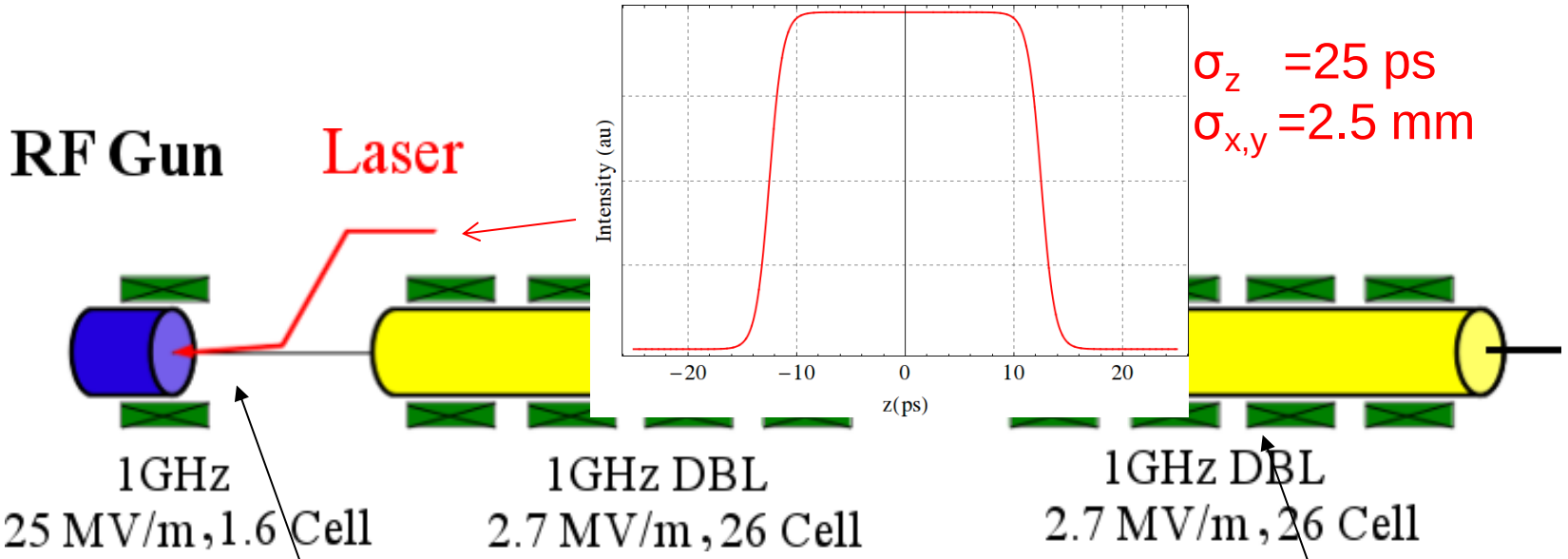
We propose energy collimator just after injector (b)

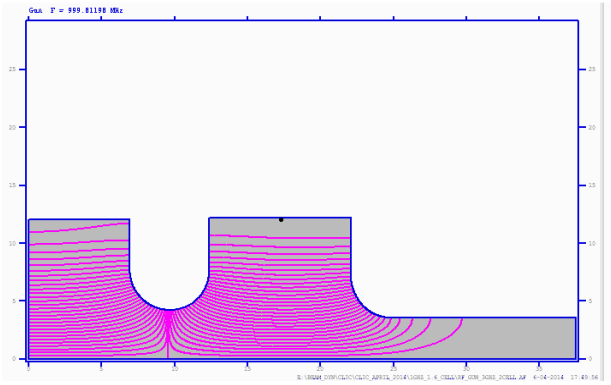


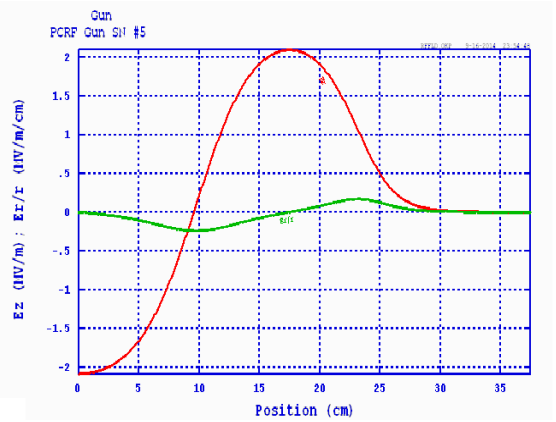
Seems suitable
R56 but not per
The spike can c

In order to improve this situation we have to find better initial distribution

Photocathode RF gun based injector



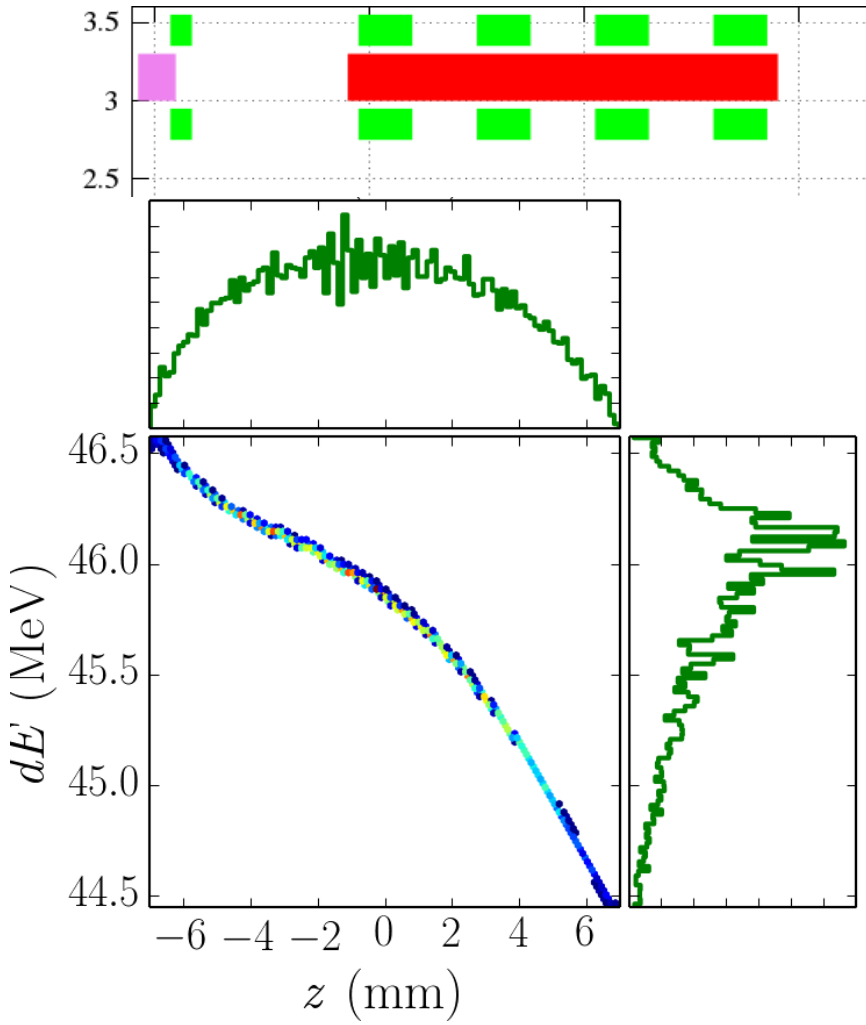




Structures are identical to DBL structure

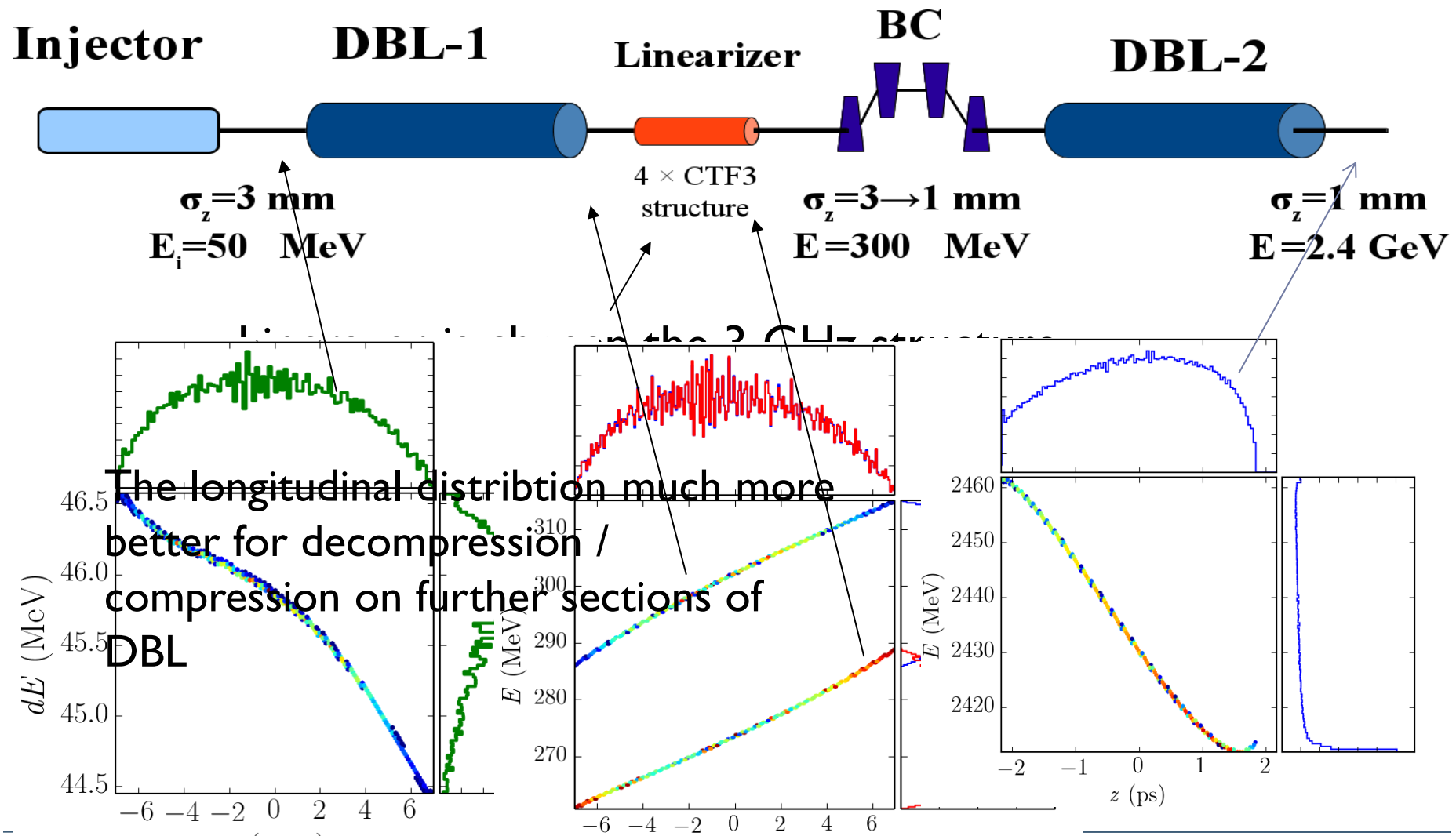
- Phin gun is scaled to 1 Ghz

Bunch after Photo injector



Parameter	Unit	Value
E	MeV	45.790
$\varepsilon_{n,x}$	mm.mrad	8.904
$\varepsilon_{n,y}$	mm.mrad	8.888
ε_z	keV.mm	345.254
σ_x	mm	0.842
σ_y	mm	0.842
σ_z	mm	3.361
σ_E	keV	450.601
$\Delta E/E$	%	0.984

DBL layout with photo injector



The longitudinal distribtion much more better for decompression / compression on further sections of DBL

Conclusion

We have preliminary compared thermionic gun based injector and photocathode gun based injector

- The advantages of photocathode gun
  - Satellite problem can be solved
  - Lower emittance
  - Better charge distribution against the effect of wakefiled
- The disadvantages of photocathode gun
  - Laser technology
  - Laser stabilization → charge

- The advantages of thermionic gun
  - Demonstrated at CTF3 and operation for long time
  - Easy to operate
  - Long cathode life time
- The disadvantages of thermionic gun
  - Almost impossible to remove satellites

- In terms of longitudinal tolerances the photocathode injector is more relax than thermionic case since we use single dispersive section.
- It is possible to reduce R56 on chicane also
- One should also compare the efficiency of power gene
  distributions

Thank you !