C+X option for energy upgrade

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I am a very beginner with accelerators.

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Beginner's lack

I am a very beginner with accelerators.

Beginner's luck

If we have had JLC,

Z W t (H?) H SUSY?

We missed. LHC will see.

JLC as soon as possible!

Start with …

C-band has nice feature for LC beginners.

$\lambda_C > \lambda_X$

- Less severe fabrication
- Less severe alignment

Yokoya-san's talk

Possible scenario

- Phase I C-band
  - $\sqrt{s}$ = 500 GeV
- Phase II C-band + X-band
  - $\sqrt{s}$ = 800 GeV
- Phase III X-band
  - $\sqrt{s}$ > 1TeV

We can start from any phase

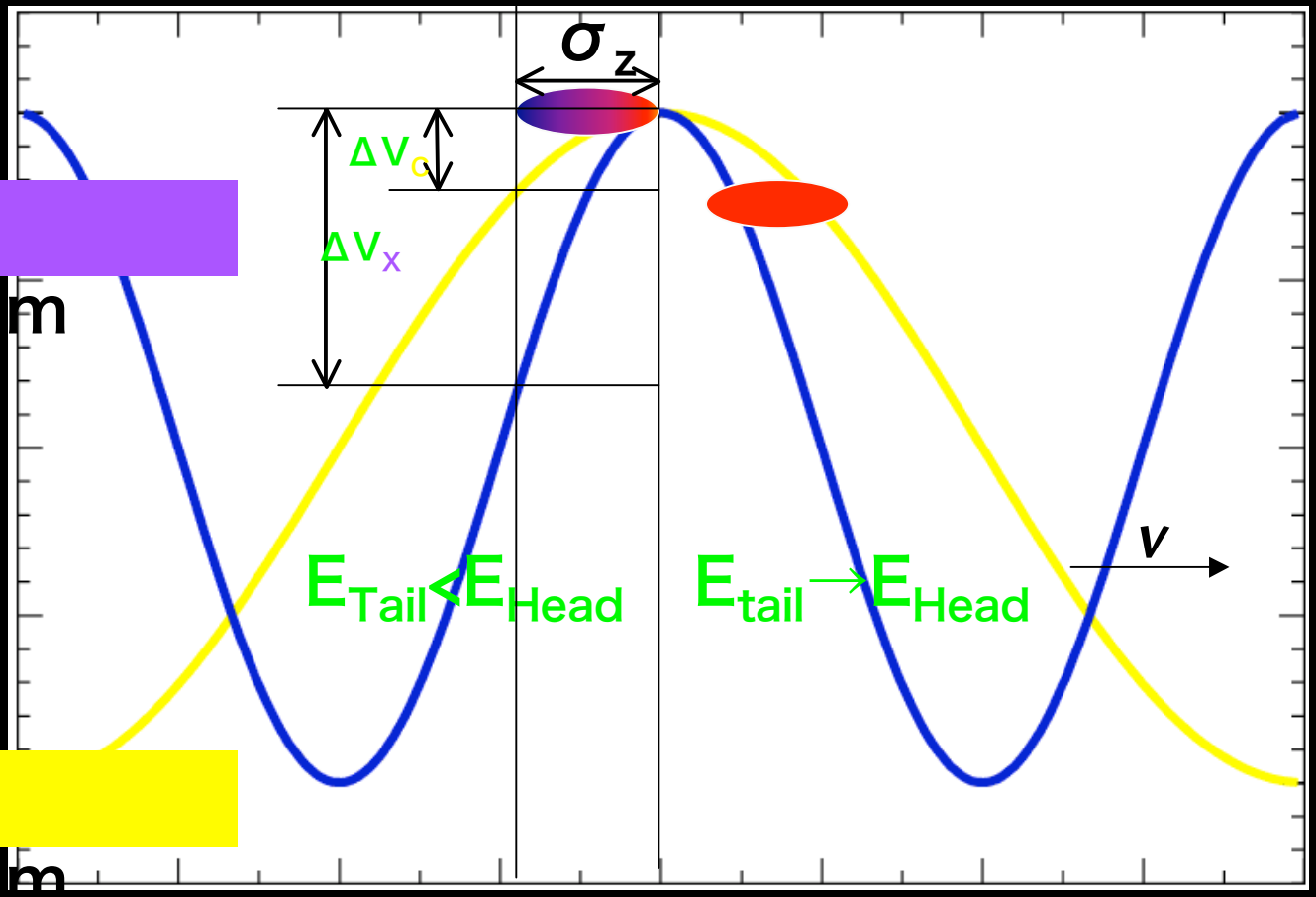
RF λ & Bunch Length σ_z

X

σ_z~ m

C

σ_z~ m



$\lambda_C = 2\lambda_X$ Bunch Length? Phase?

Design and study

Design Tools

- Optics SAD
- Dynamics SLEPT

Design Tools -optics-

SAD

Strategic Accelerator Design

http://acc-physics.kek.jp/SAD/sad.html

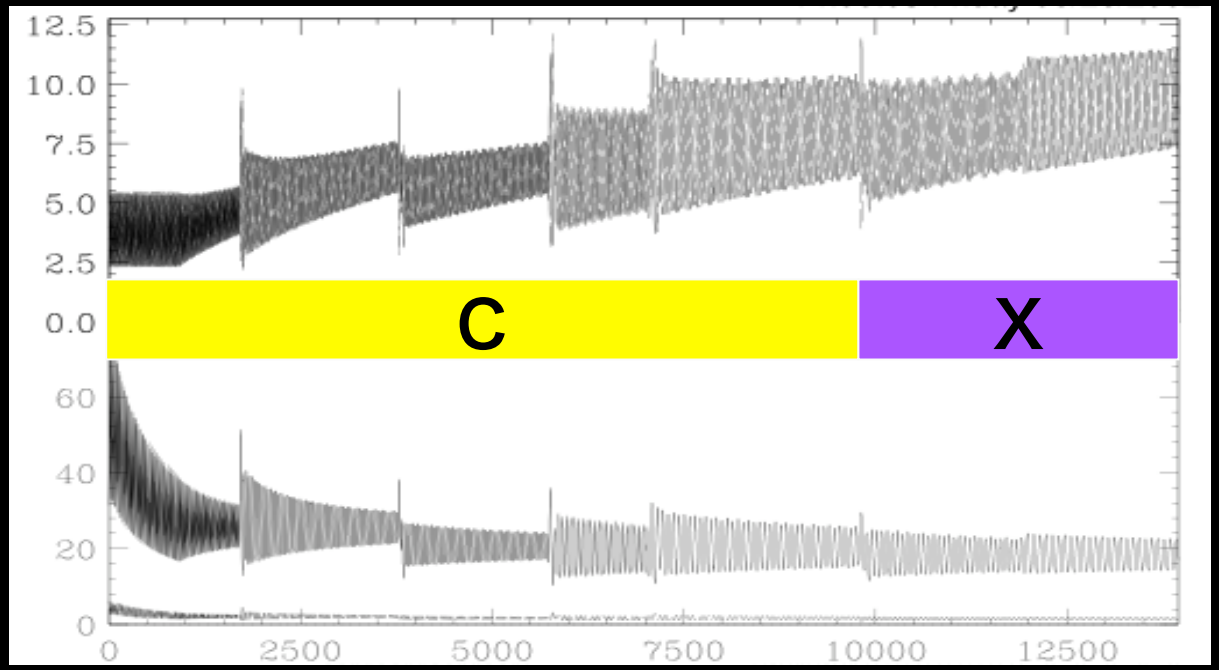
SAD is a computer program complex for accelerator design.
It has been developed in KEK since 1986.
The major functions are shown below but
more and more functions are being added.
SAD has proven to be powerful and useful in designs, simulations,
commissioning, and improvement of TRISTAN, KEKB, FFTB, ATF,
JLC, NLC, JHF and others.

C+X optics

E_{beam}/GeV= 8 50 150 250 400

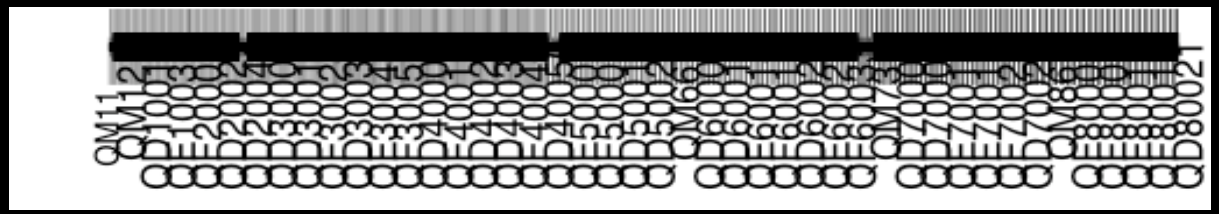
$\sqrt{\square}\left(\sqrt{m}\right)$

$\square(\square m)$



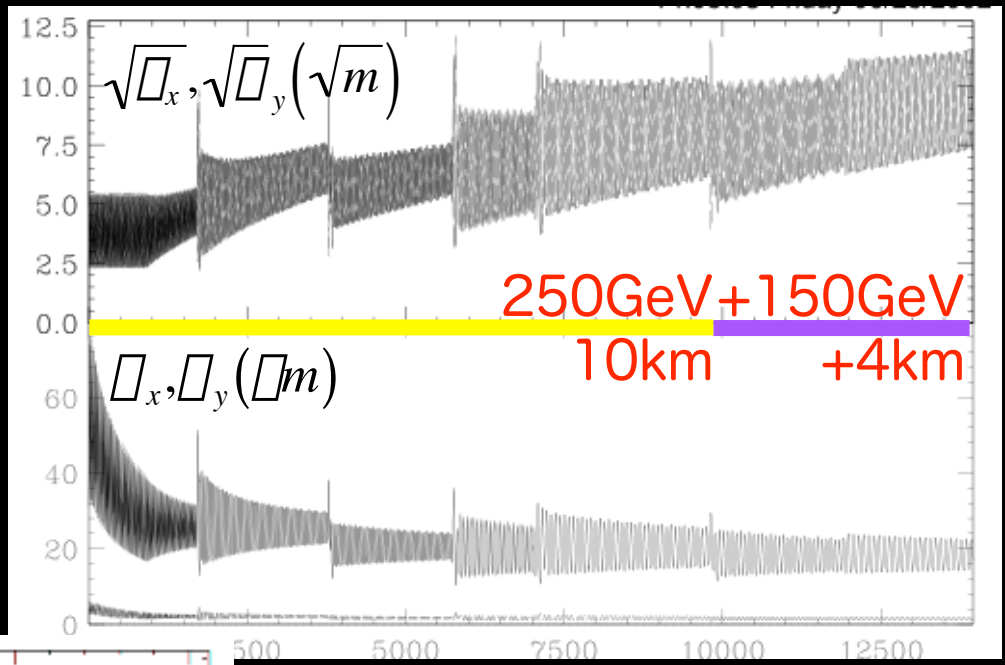
L/km= 0 5 10 14

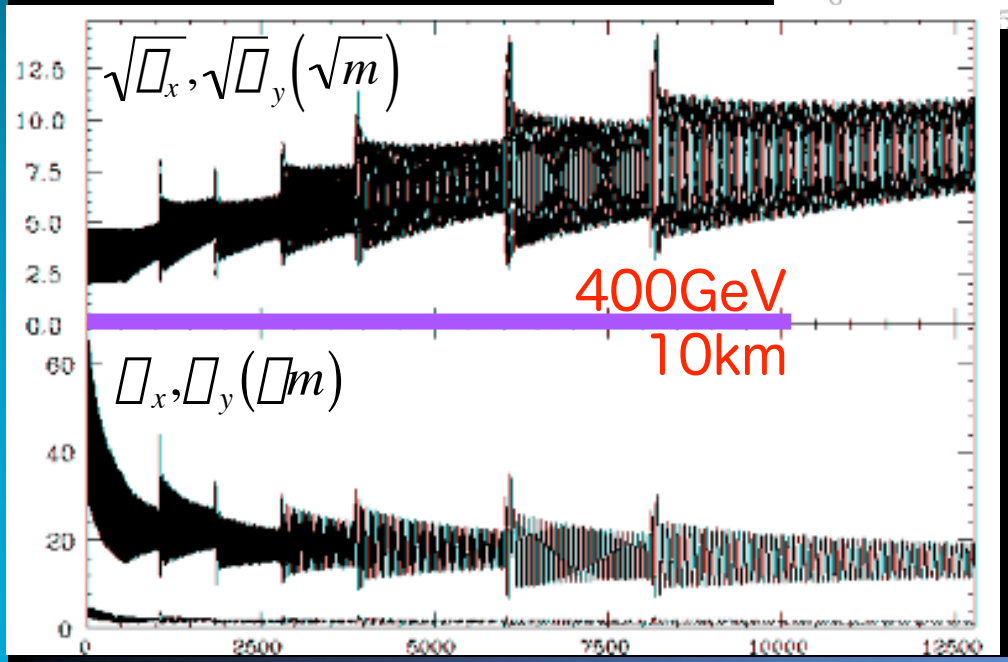
Lattice



Optics

X (by Dr.Kubo)





C+X

My first linac.
Need more study!

Similar Characteristic

Design Tools -dynamics-

SLEPT

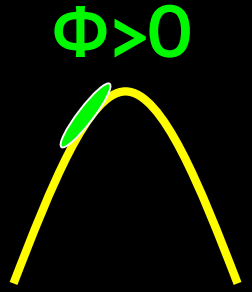
Simulation for Low Emittance by
Phase-space Tracking

http://atfweb.kek.jp/atf-j/member/kubo/slept.html

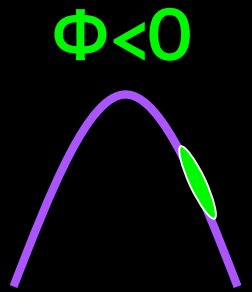
Simulation program for high energy, long linacs.
Developed for studies of beam dynamics in Linear Collider main linacs.

Bunch Length

- C-band section $E_{Tail}<E_{Head}$
  - BNS dumping
  - Check by *final emittance ($\gamma\varepsilon$)*

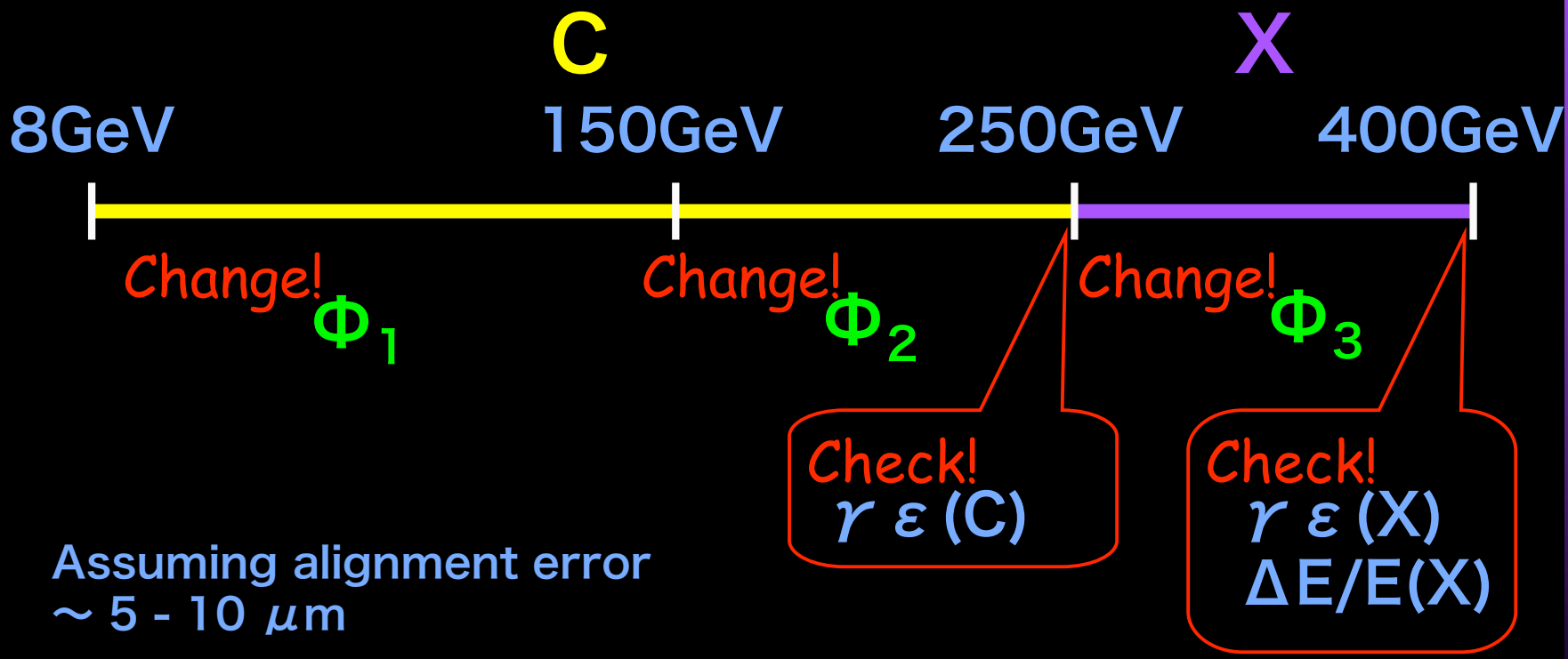


- X-band section $E_{Tail}\rightarrow E_{Head}$
  - Energy spread compensation
  - Check by *final energy spread ($\Delta E/E$)*



Optimization

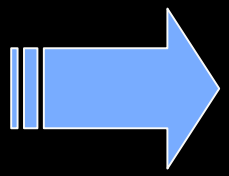
σ_z = 100μm, 150μm, 200μm



Assuming alignment error
~ 5 - 10 μm

C-band section

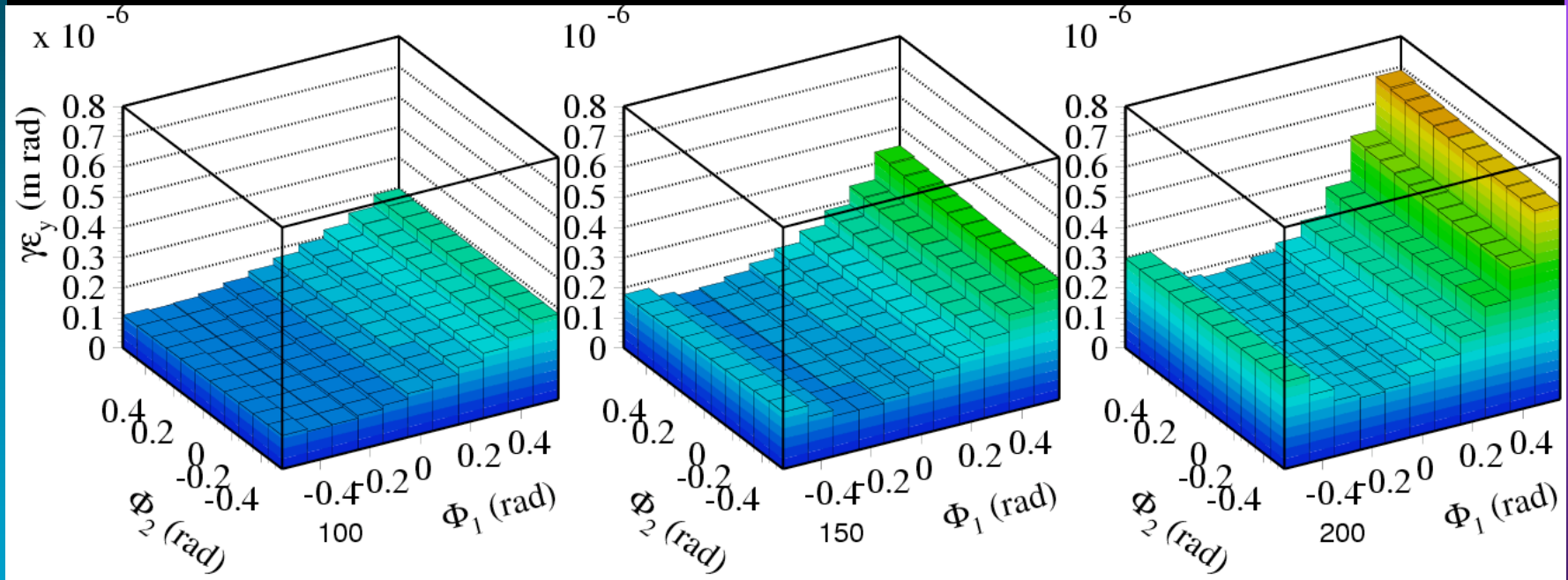
- Bunch length
  - σ_z = 100μm, 150μm, 200μm
- Phase
  - Φ_1 = -0.5, -0.4, ・ ・ , +0.5 (　8-150GeV)
  - Φ_2 = -0.5, -0.4, ・ ・ , +0.5 (150-250GeV)

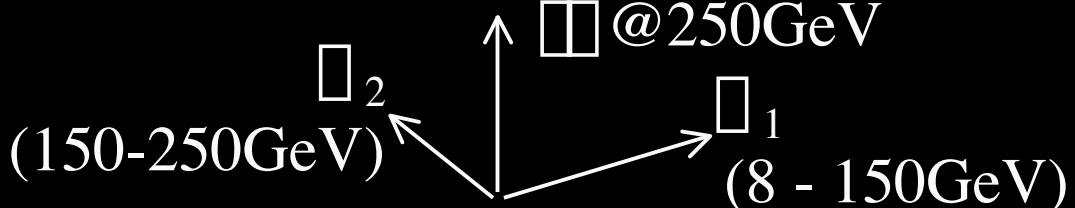


$\gamma\varepsilon$?

C-band section ($\gamma\varepsilon$)

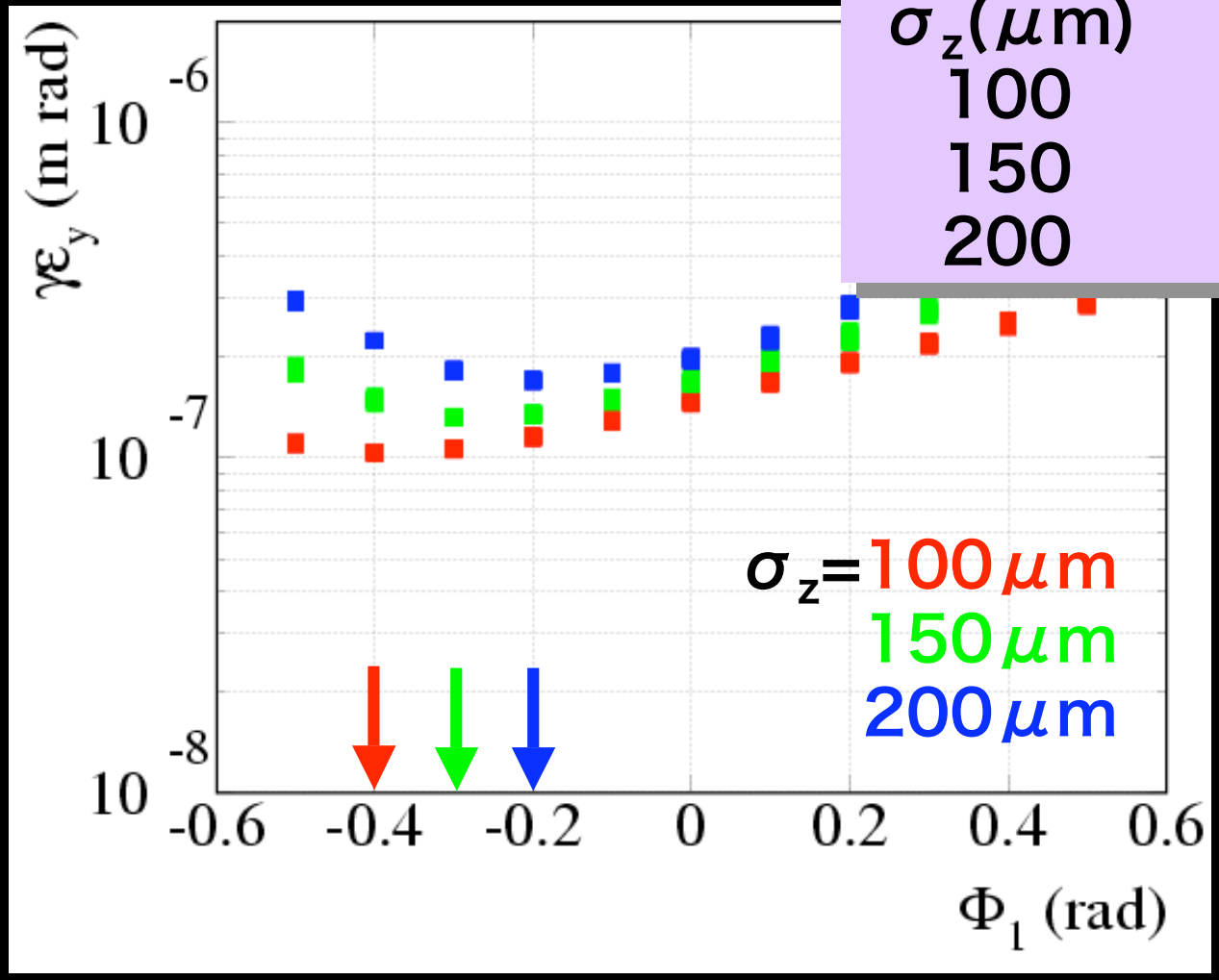
σ_z=100μm σ_z=150μm σ_z=200μm



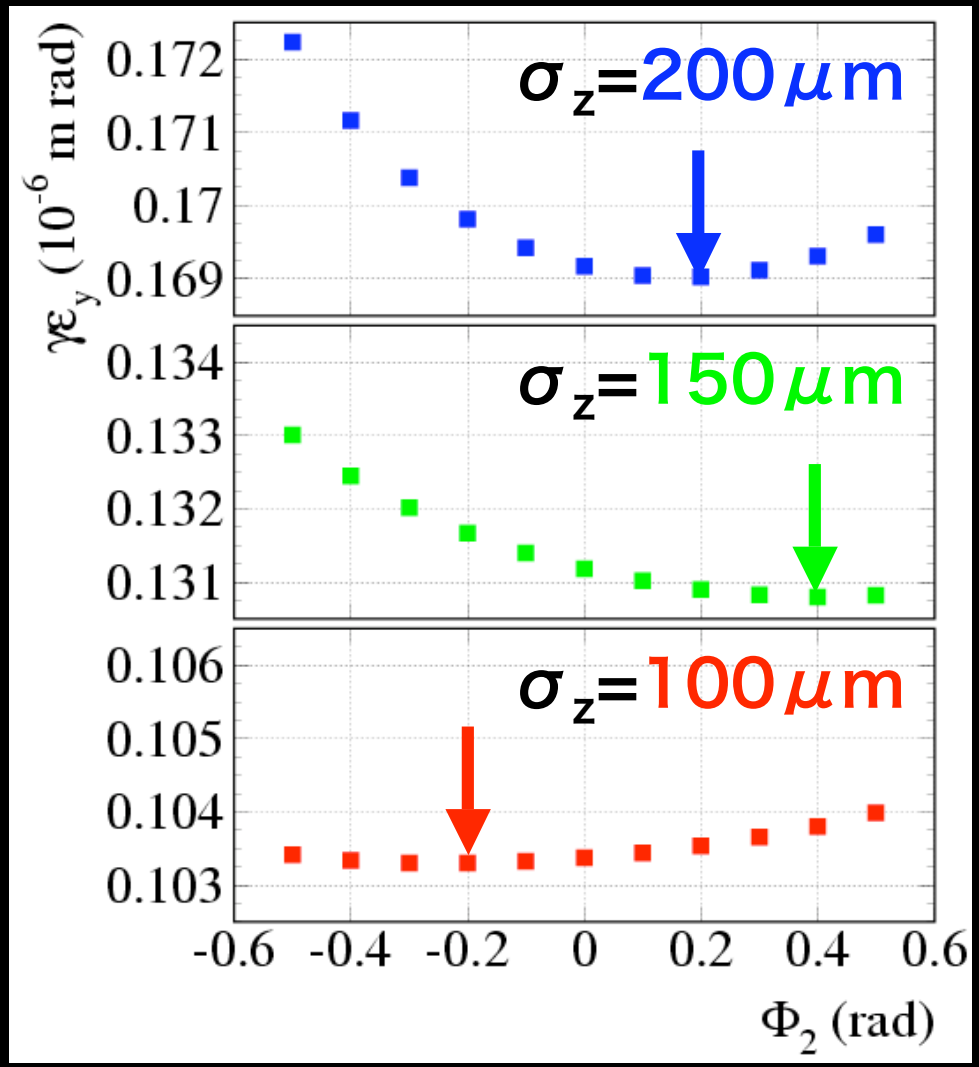


C-band section ($\gamma\varepsilon$ vs Φ_1)

$\sigma_z(\mu m)$	Optimum Φ_1
100	-0.4
150	-0.3
200	-0.2



C-band section ($\gamma\varepsilon$ vs Φ_2)



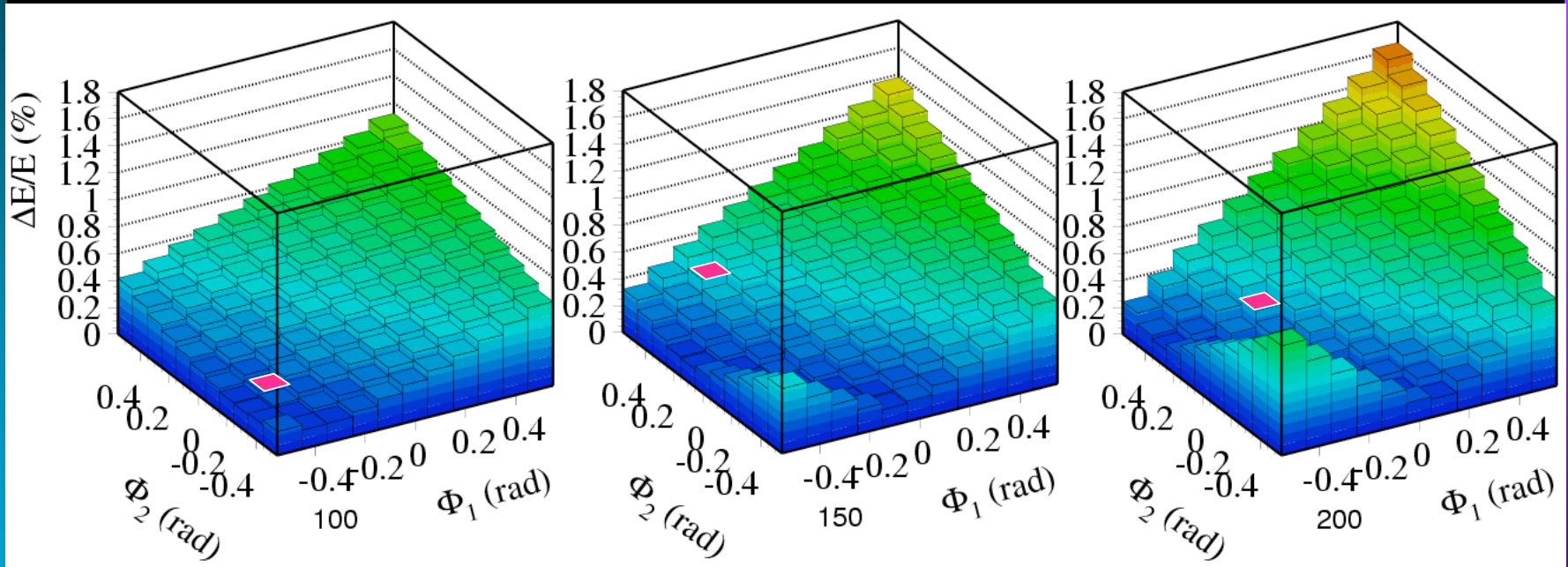
Weakly dependent on Φ_2

C-band section

σ_z	Φ_1 <150GeV	Φ_2 >150GeV
100	-0.4	-0.2
150	-0.3	+0.4
200	-0.2	+0.2

C-band section (ΔE/E)

σ_z=100μm　　σ_z=150μm　　σ_z=200μm

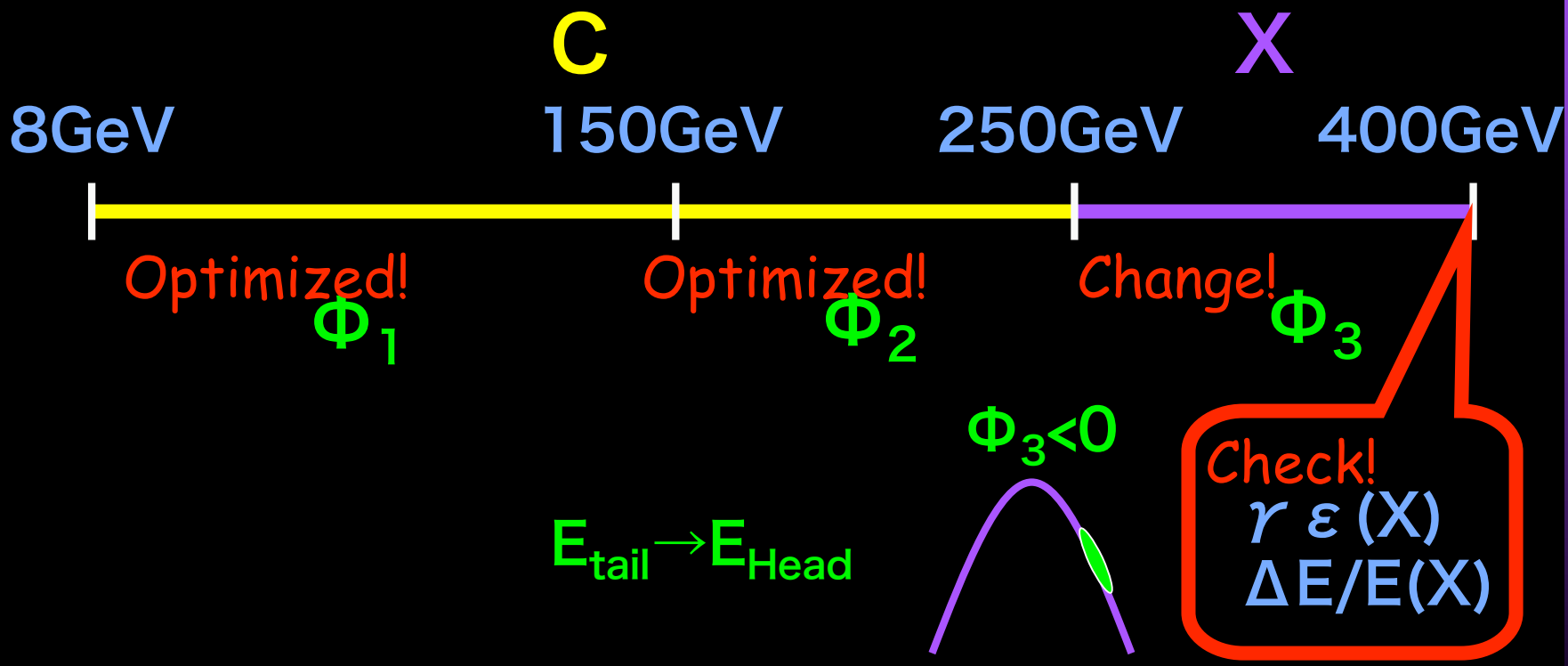


ΔE/E@250GeV

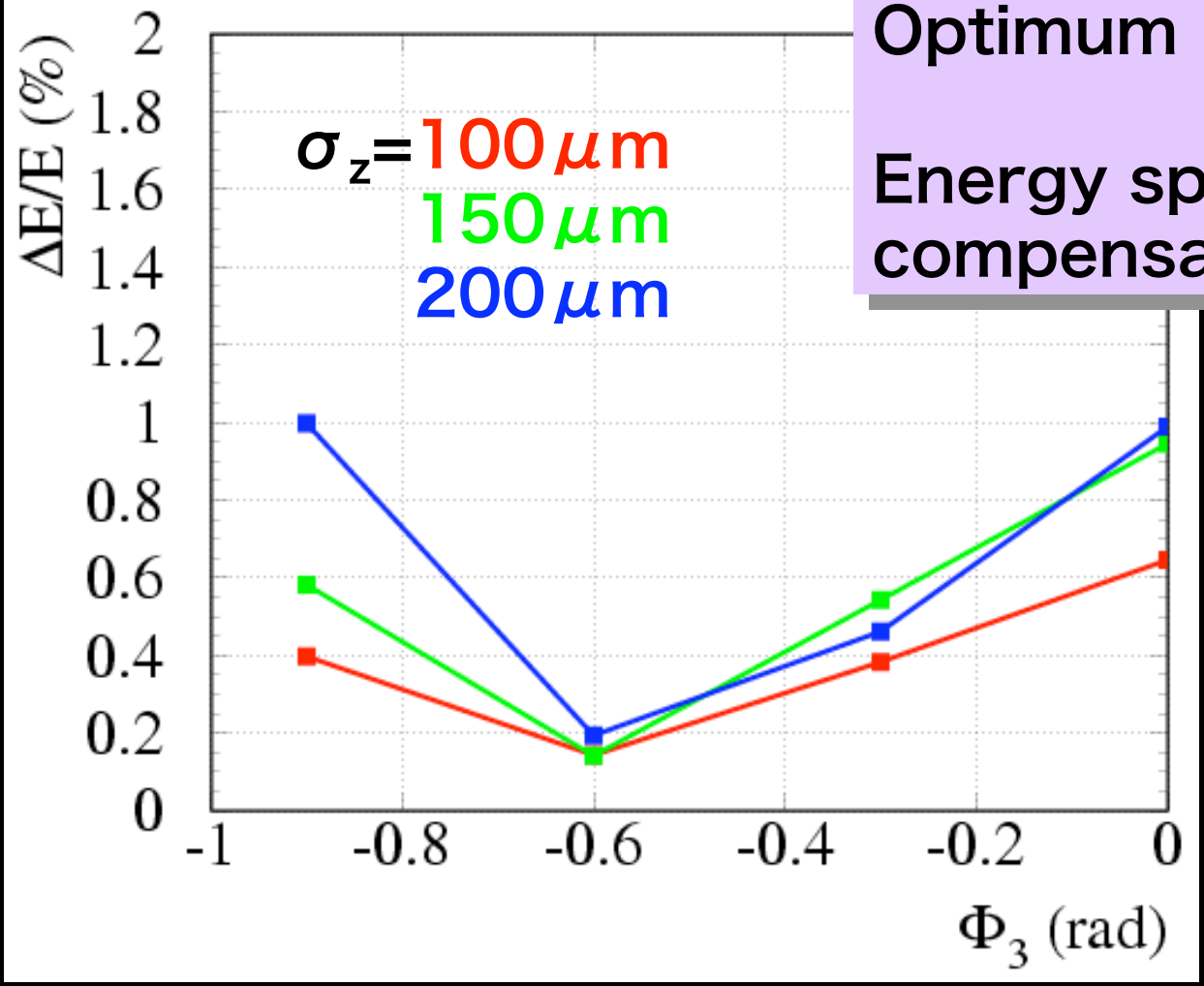
0.2%　　0.4%　　0.4%

Optimization

σ_z = 100μm, 150μm, 200μm



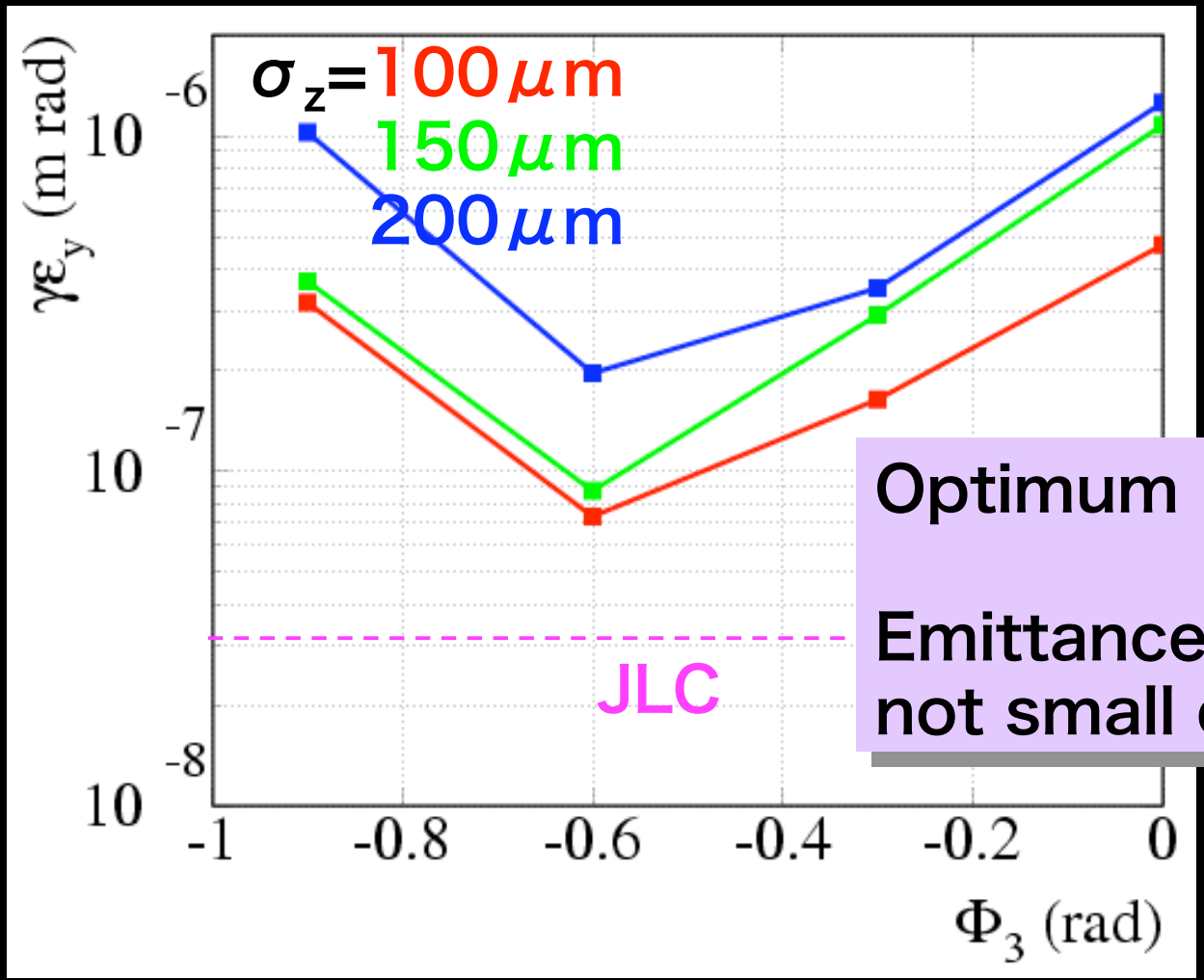
Final Energy Spread



Optimum Φ_3=-0.6 rad.

Energy spread was compensated

Final Emittance



Optimum Φ_3=-0.6 rad.

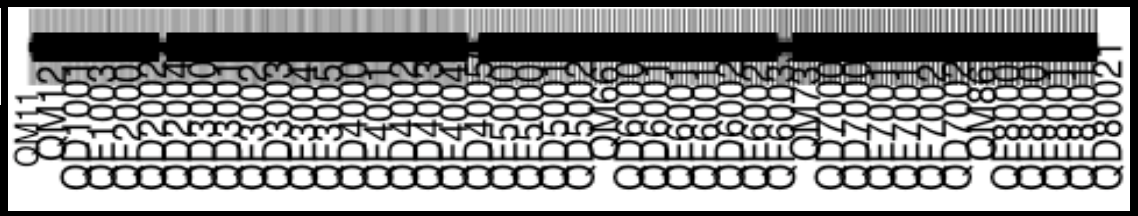
Emittance was not small enough

Low efficiency.
Need more study!

Upgradability

C, C+X, X

Lattice



C

C X

C→X X

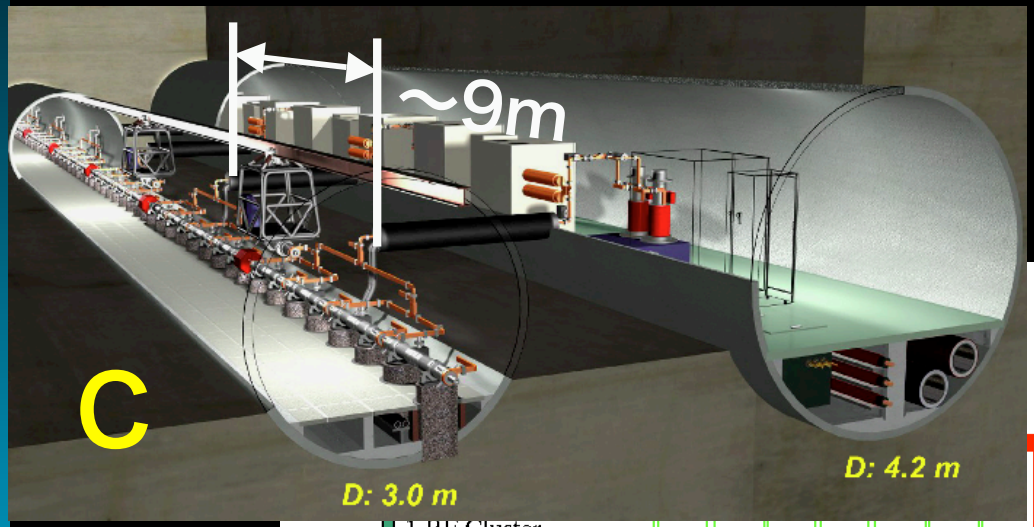
X

500GeV

800GeV

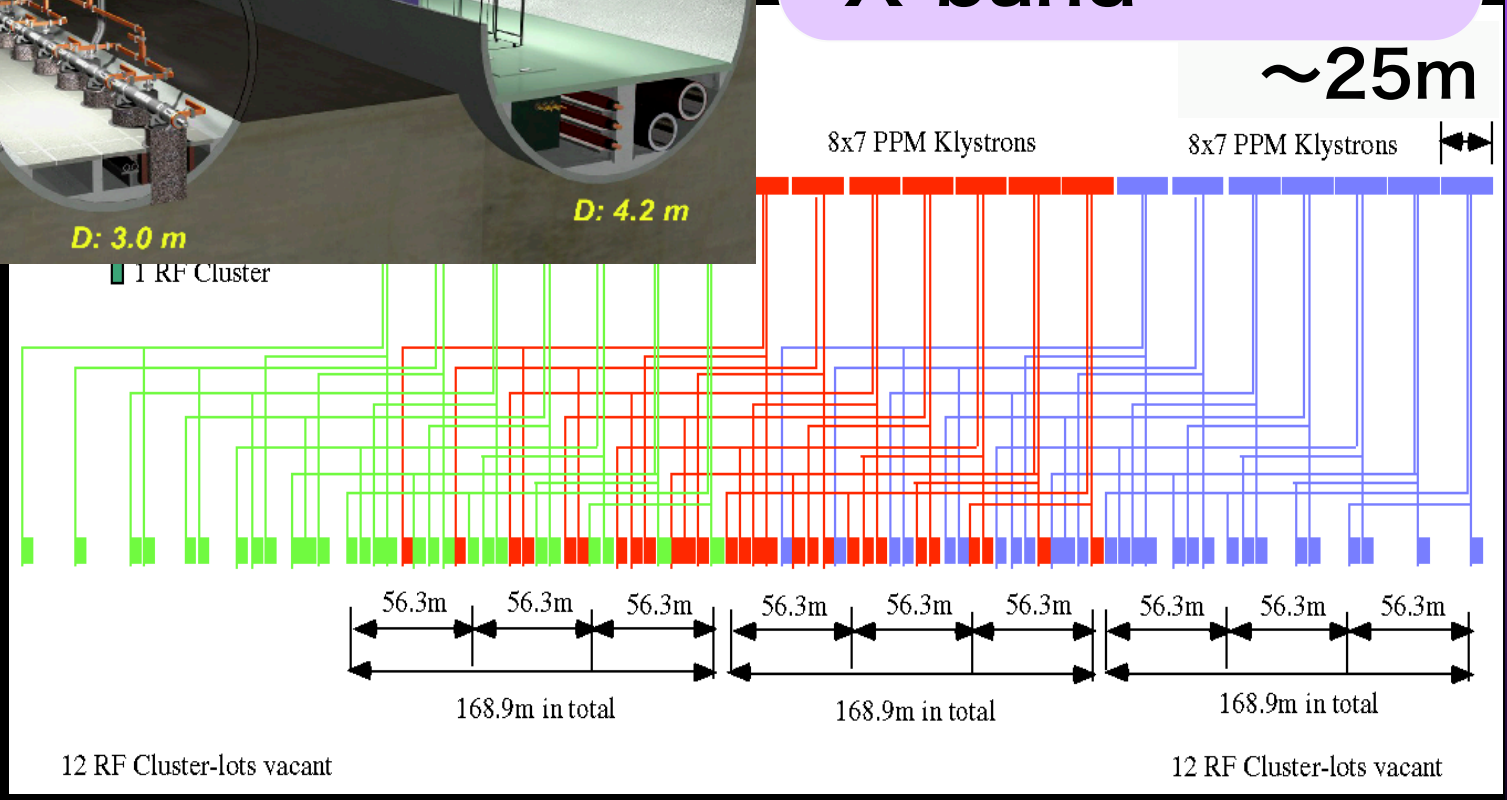
1TeV

Tunnel compatibility



C-band can be replaced by X-band

X



Summary

- C+X hybrid optics was studied
- Emittance and Energy spread
  - May be controlled small enough
- Bunch length
  - σ_z=150μm seems to be OK
- OK to upgrade to ultimate JLC-X

Of course

- Need more study
  - Optimize optics
  - Realistic beam parameters
  - Detailed study of alignment tolerance

⋮

Beginner's lack ?

or

Beginner's luck ?