Progress activities in short bunch compressors

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Introduction

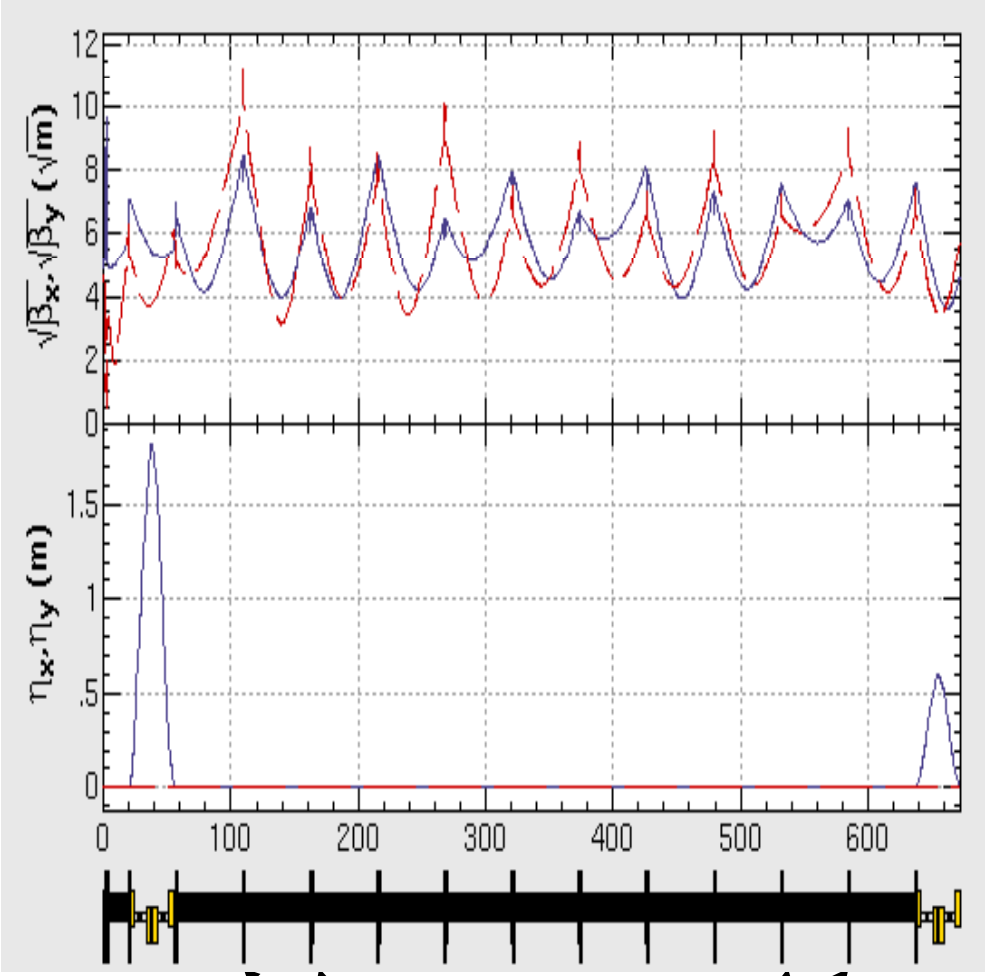
❑ Short 2-stage bunch compressor

- ✓ A little modifications, such as reduction in length of bends, were performed to improve the performance.
- ✓ Lattice tunings with dispersion and orbit corrections show that the system is error tolerant.

❑ Short 1-stage bunch compressor

- ✓ Several parameters, such as rf voltage, were modified.

Short 2-stage bunch compressor



locations of 4 skew quadrupoles

System length : 672 m

Number of bends : 8

Length of a bend : 3.4 m

Bending angle : 8.1 / 2.6 deg

RF voltage : 29 / 27 MV/m

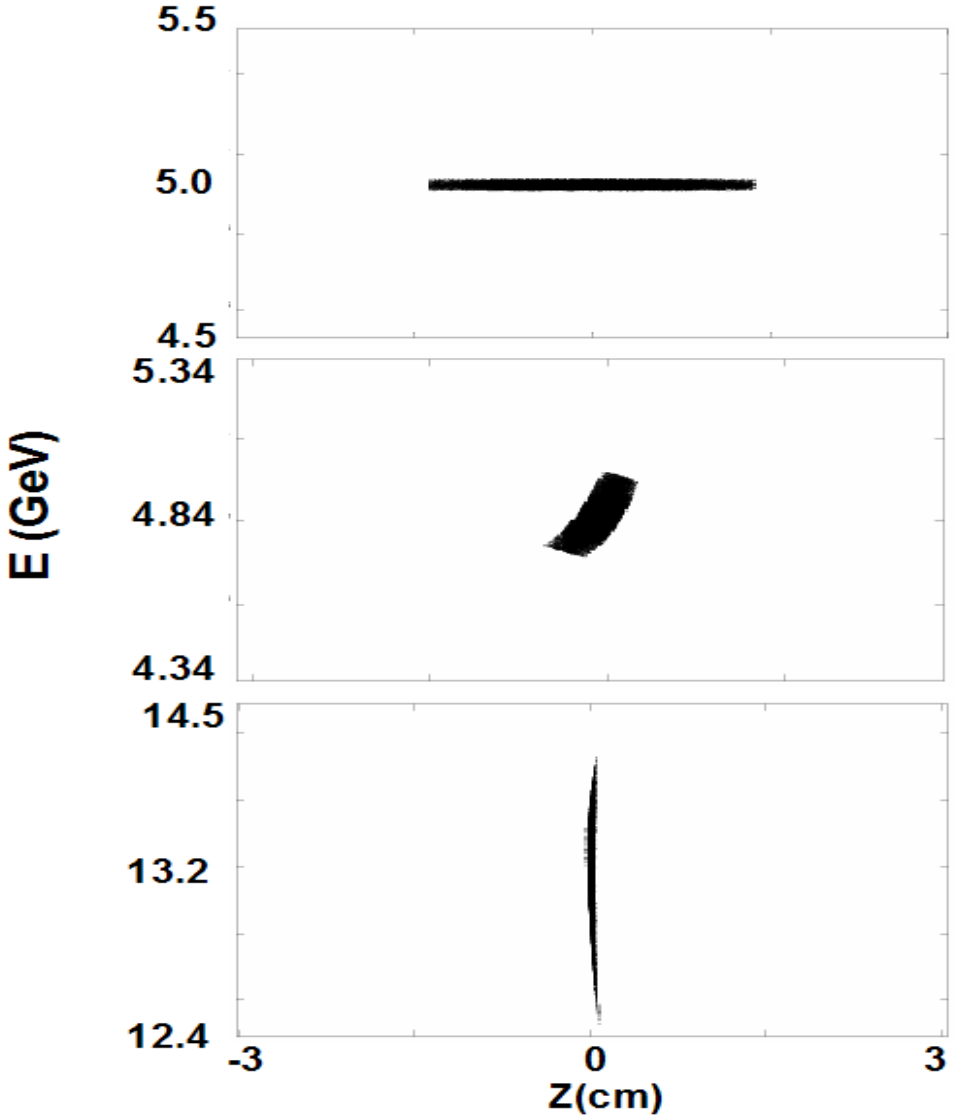
RF phase: -114/-45 deg (from crest)

R_{56} : -474.2 mm / -50.8 mm

Short 2-stage bunch compressor (Performances)

	Initial	Final
Bunch length	6 mm	0.15 mm
X-Emittance	8.0 μm	8.6 μm
Y-Emittance	0.20 μm	0.02 μm
Beam energy	5 GeV	13.2 GeV
Energy spread	0.15 %	2.4 %
Bunch charge	3.2 nC	3.2 nC

Short 2-stage bunch compressor (longitudinal phase space)



Initial

After chicane 1

After chicane 2

Short 2-stage bunch compressor

- We performed both dispersion correction and orbit correction at the same time such that they have a minimum value.

- Correction of vertical dispersion that is generated by skew components was performed by using of 4 skew-quadrupoles.

Short 2-stage bunch compressor (Considered machine errors)

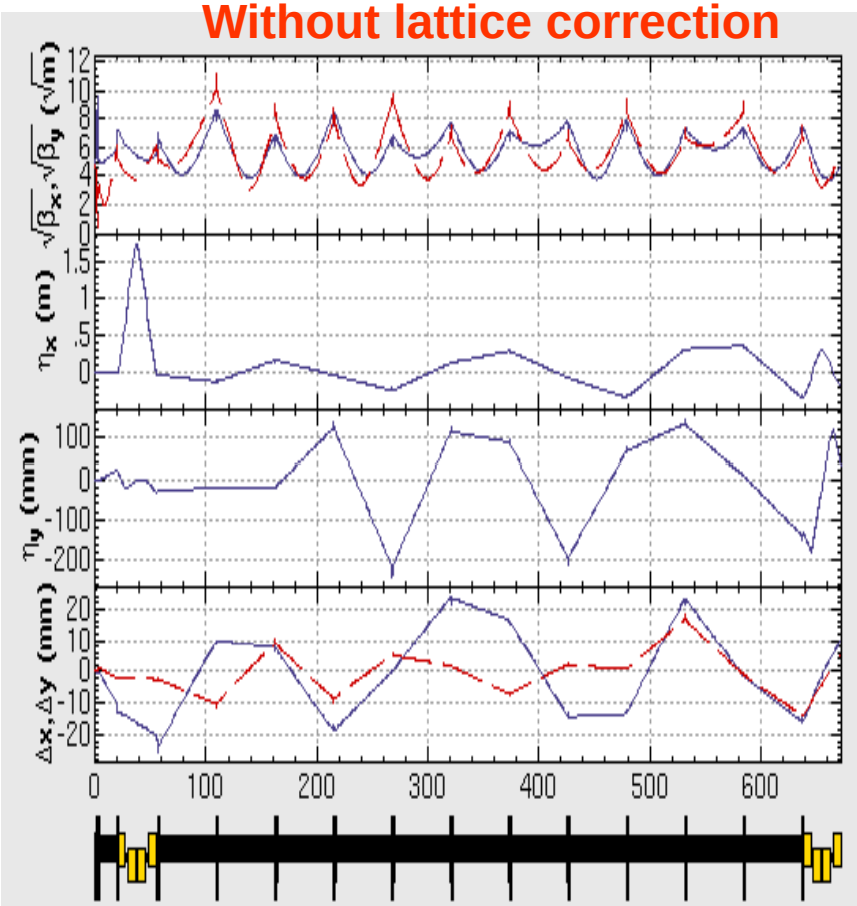
Error	Magnitude
H-misalignment in Q	300 μm rms
V-misalignment in Q	300 μm rms
Rotation in Q	300 μrad rms
V-misalignment in B	300 μm rms
H-misalignment in B	300 μm rms
Rotation in B	300 μrad rms

Short 2-stage bunch compressor

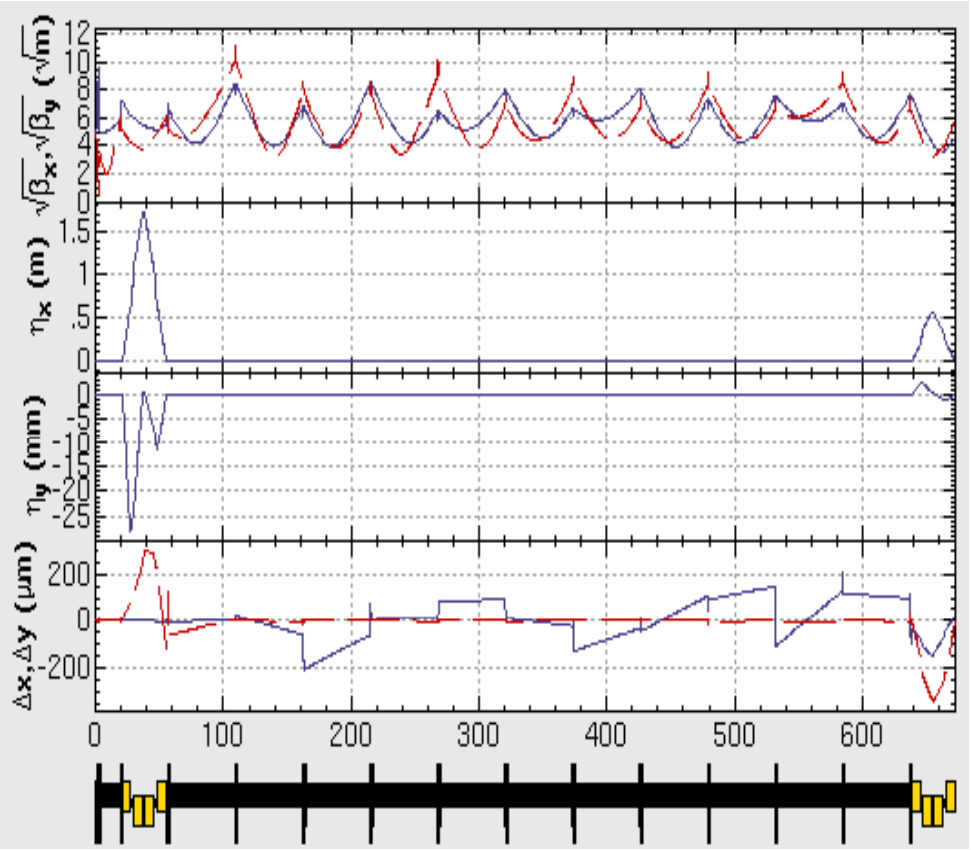
(lattice distortion and corrections)

Growths of emittance : factors of 1.48 / 254 in H / V

Without lattice correction



With lattice correction



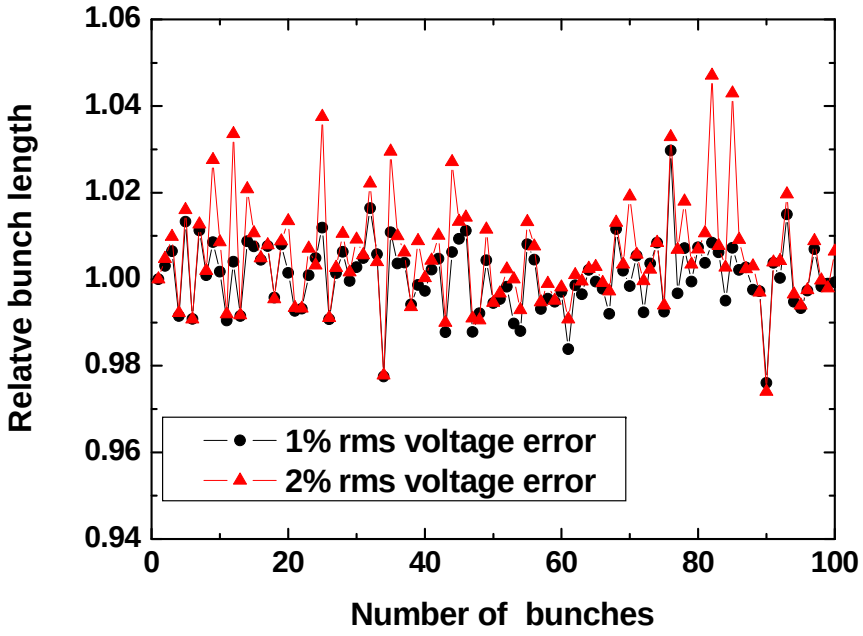
Growths of emittance : factors of 1 / 1.04 in H / V

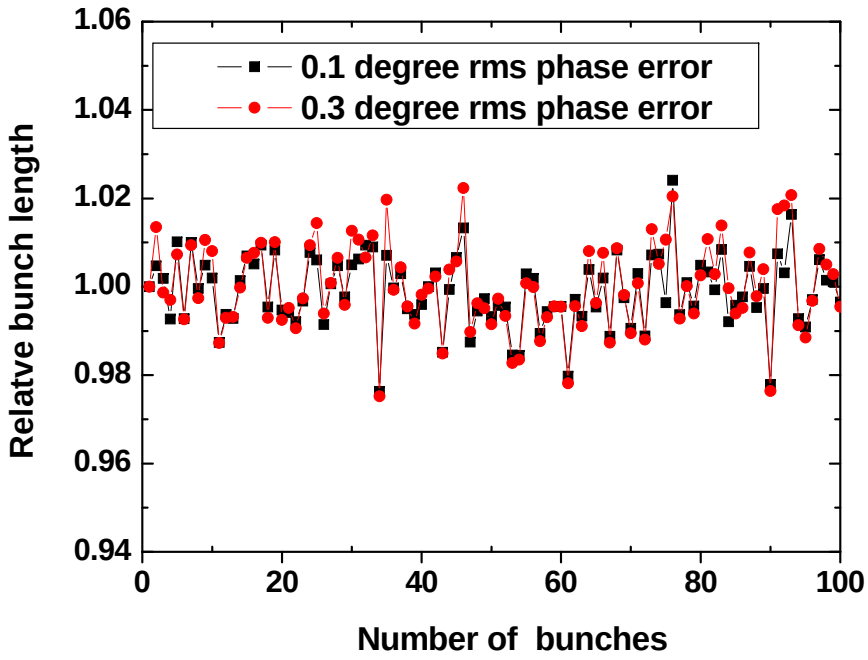
Short 2-stage bunch compressor
(effects of ISR and CSR on emittances)

Effect	Growth of X-emittance
CSR	0.20 μm
ISR	0.43 μm
CSR+ISR	0.63 μm

ISR is a main source to emittance growth.

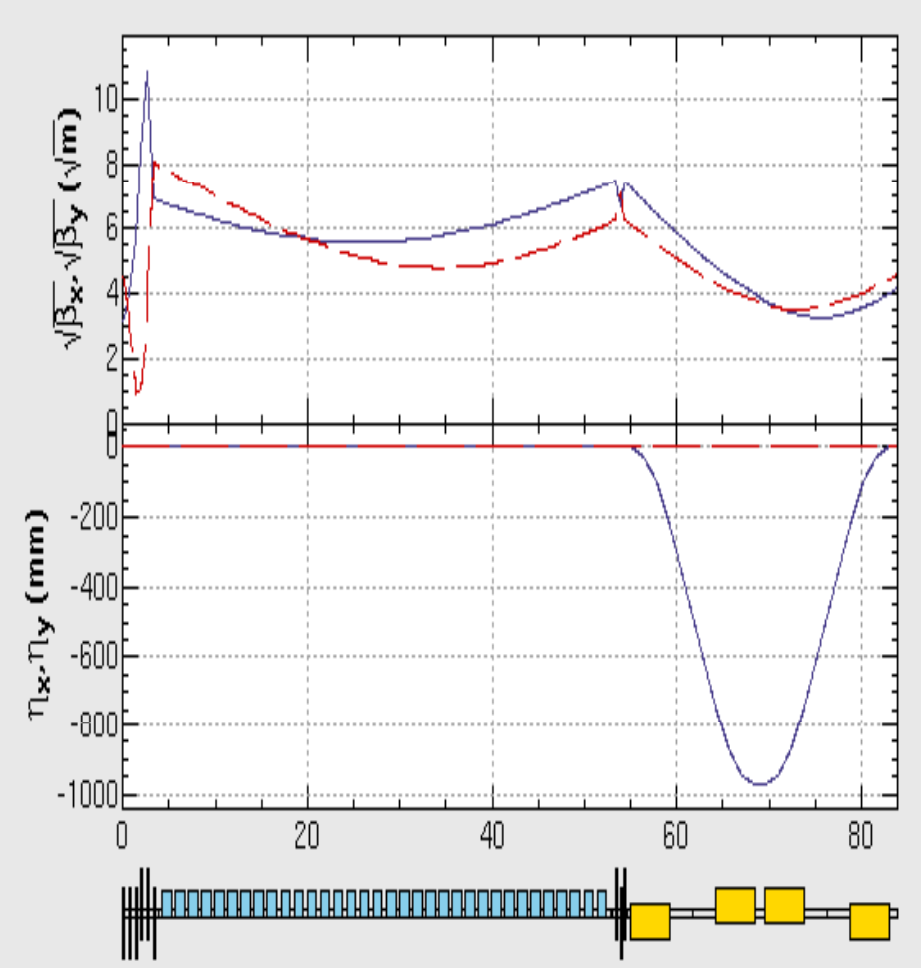
Short 2-stage bunch compressor (fluctuation in bunch length)





100 successive bunches due to rf voltage jitter (left) and rf phase angle jitter (right).

Short 1-stage bunch compressor



System length : 83.9 m

Number of Quadrupoles : 9

Number of bends : 4

Bending angle : 2.5 deg

Length of a bend : 4.25 m

RF voltage : 31.5 MV/m

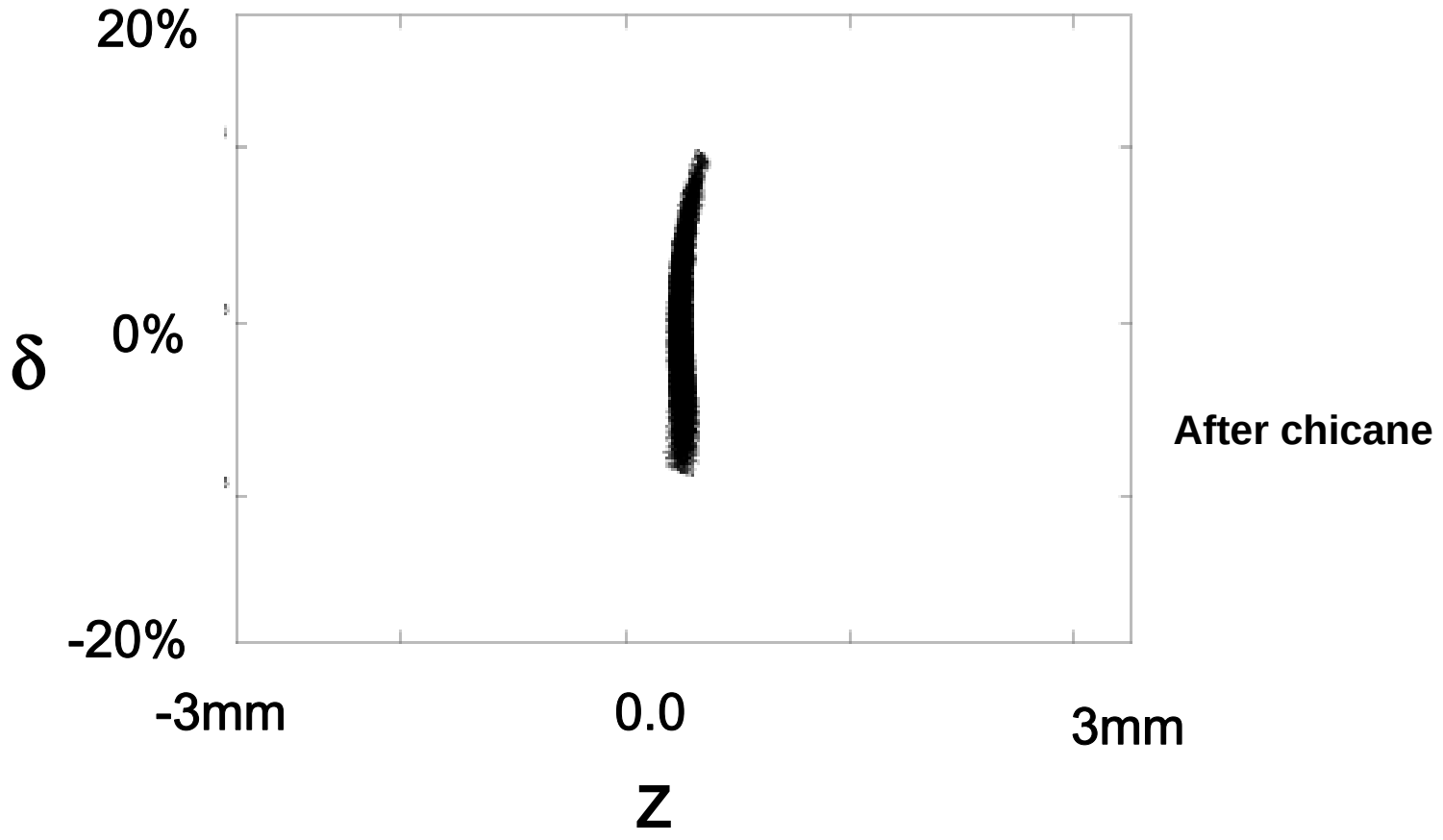
RF phase : -114 deg (from crest)

R_{56} : -0.172 m

Short 1-stage bunch compressor (Performances)

	Initial	Final
bunch length	6 mm	0.3 mm
energy spread	0.15 %	3.46 %
X-Emittance	8.0 μm	8.28 μm
Y-Emittance	0.02 μm	0.02 μm
Beam energy	5 GeV	4.57 GeV

Short 1-stage bunch compressor (longitudinal phase space after chicane)



Short 1-stage bunch compressor
(effects of ISR and CSR on emittances)

Effect	Growth of X-emittance
CSR	0.27 μm
ISR	0.01 μm
CSR+ISR	0.28 μm

CSR is a main source to emittance growth.

Summary

- Studies on machine errors and lattice tunings in short 2-stage BC were presented.
  - ✓ The results show that the system is error tolerant.

- As short 1-stage BC has smaller number of magnets, it is expected that effects of machine errors will be smaller and the system be also error tolerant.