LER blowup and HER transverse coupled bunch instability

10/Feb./03 KEKB review

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1. LER blowup
   1) Installation of new solenoid
   2) Field calculation
   3) Effect of new solenoid
   4) Effect of wiggler

2. HER transverse coupled bunch instability
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   3) Measures

1. LER blowup

Installation of new solenoid

1) Short solenoids

In 2002 summer, 266 short solenoids were installed.

2) Permanent magnets

175 permanent magnets which cover BPM

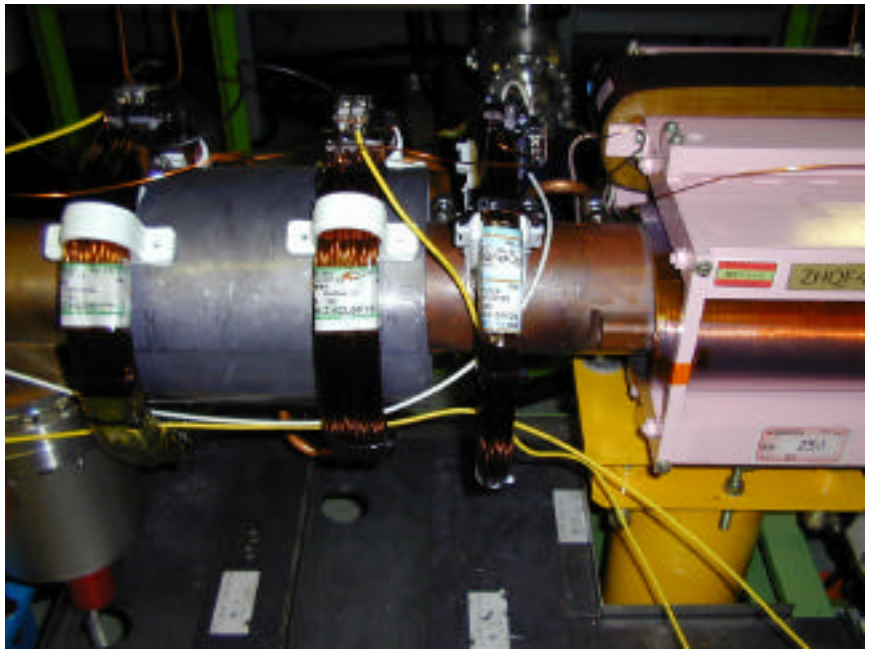
have been assembled.

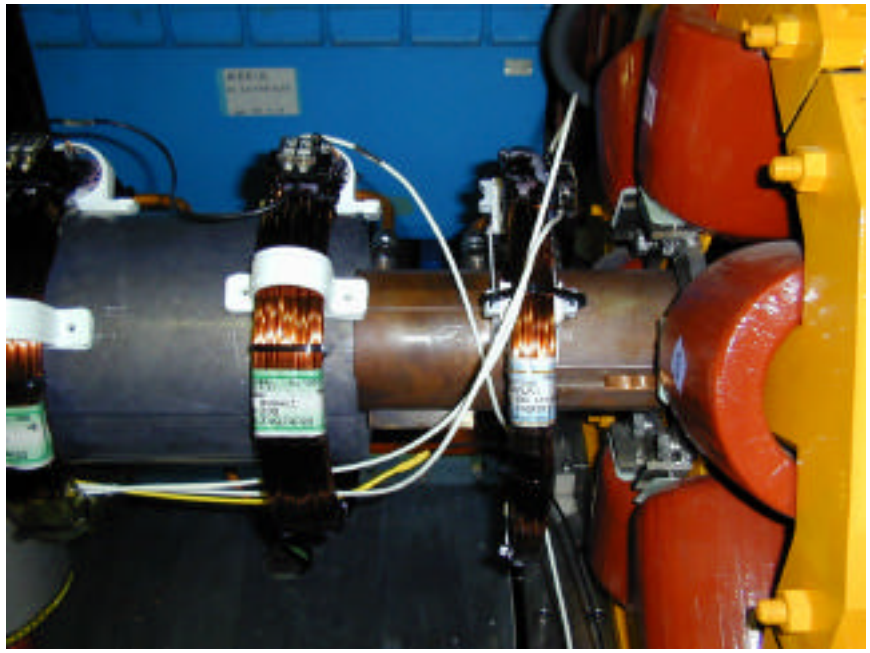
106 pieces were installed at 31th Oct.

Parts of another 175 permanent magnets were made.

Total 350 magnets will cover all BPM in arcs.

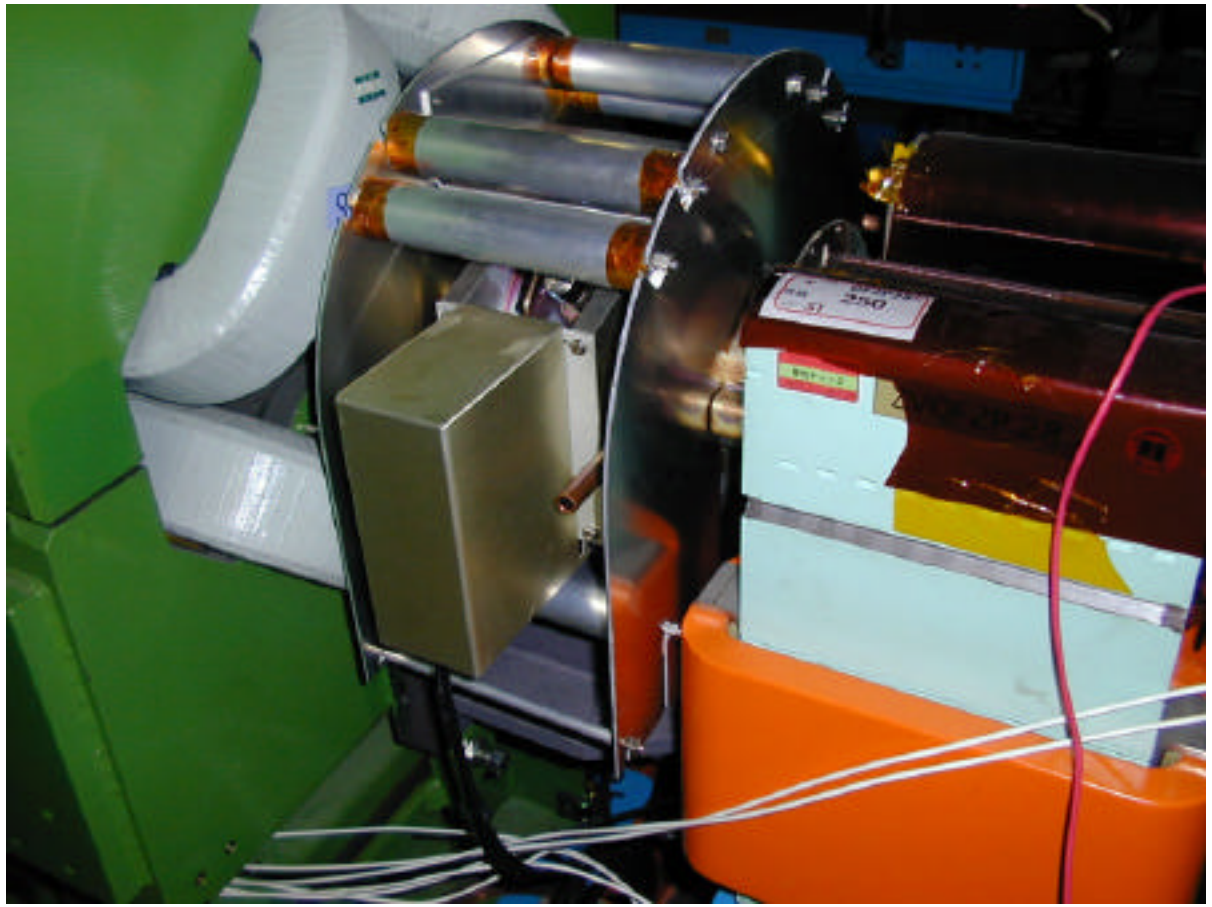
Short solenoid



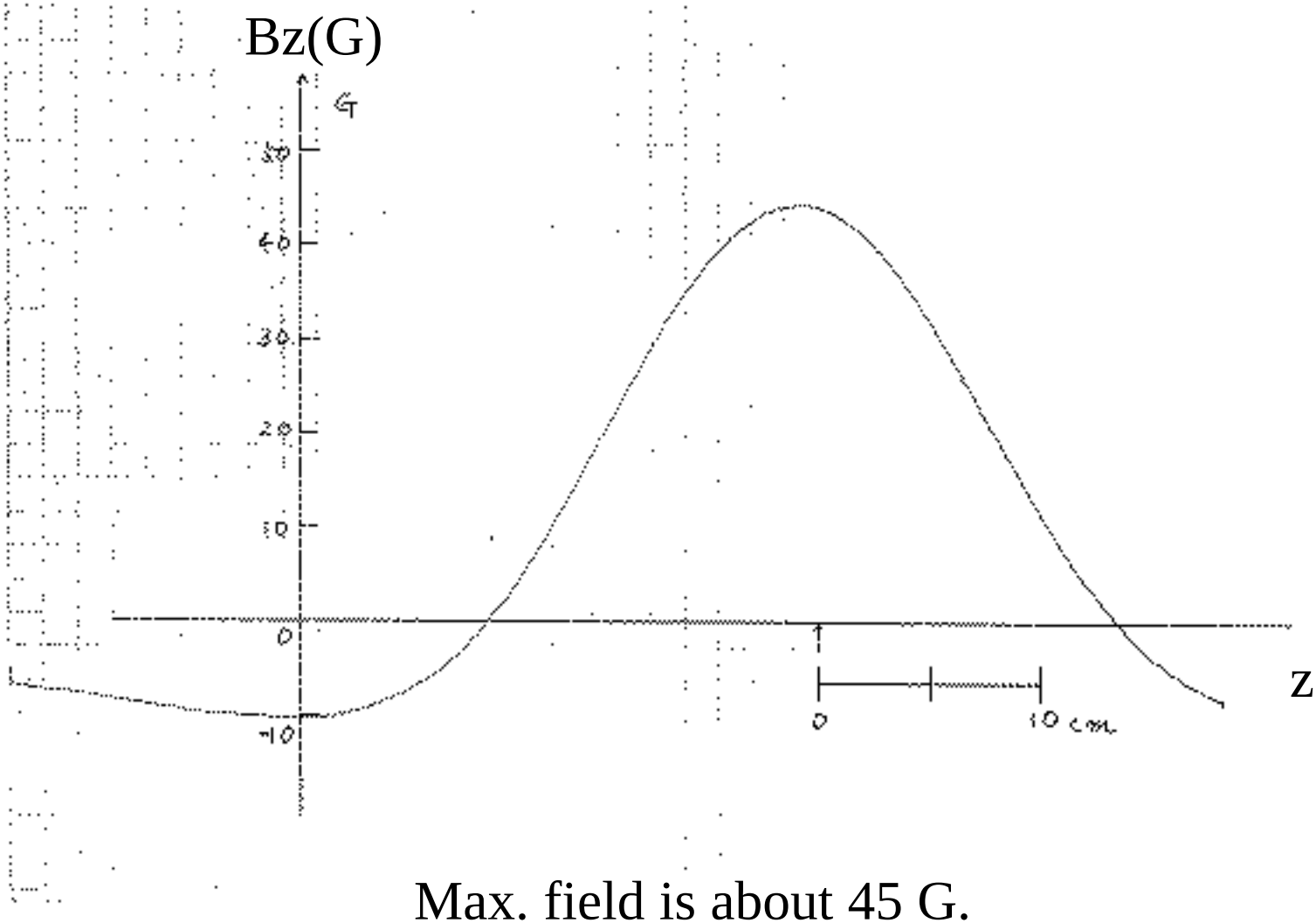


Permanent magnet on BPM (designed by H. Nakayama et al.)

(A solution for application of voltage to BPM electrode)



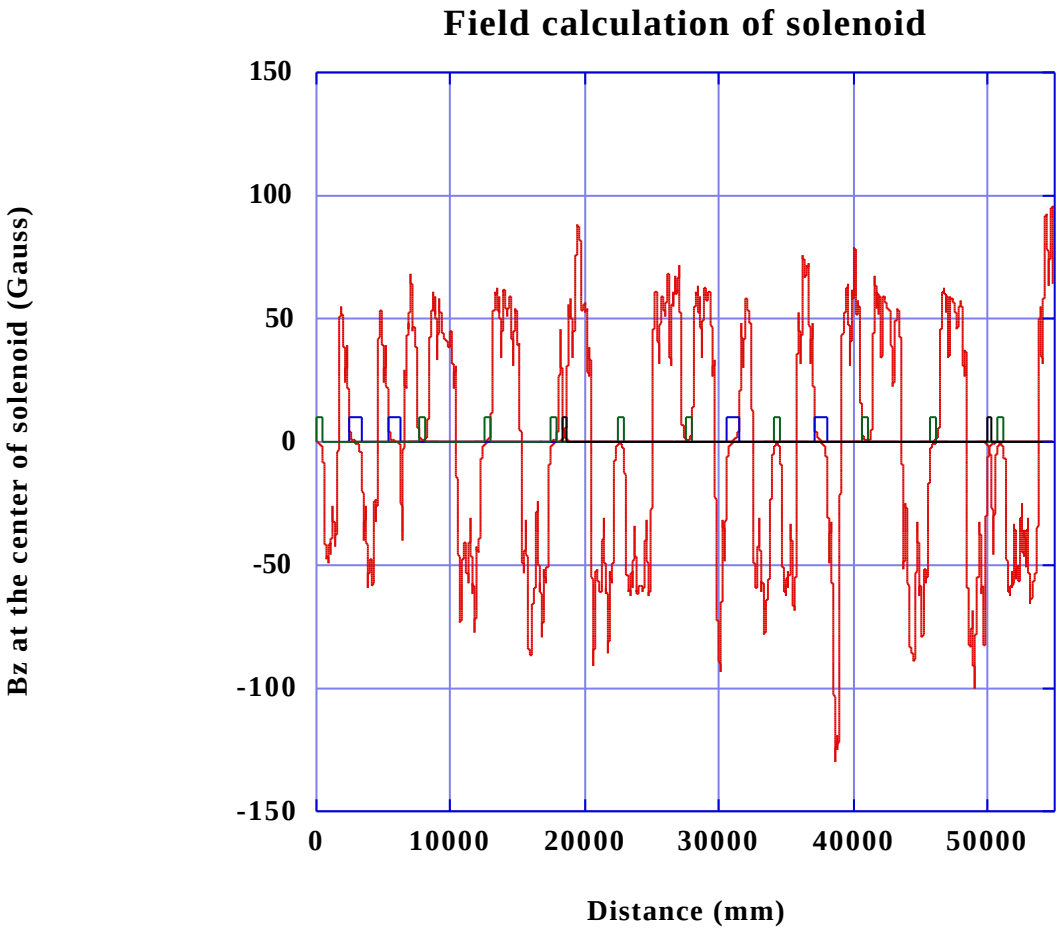
Field measurement of permanent magnet



Max. field is about 45 G.

Field calculation

Field strength of solenoids was calculated by 1/8 arc to estimate coverage of solenoid field more accurately.

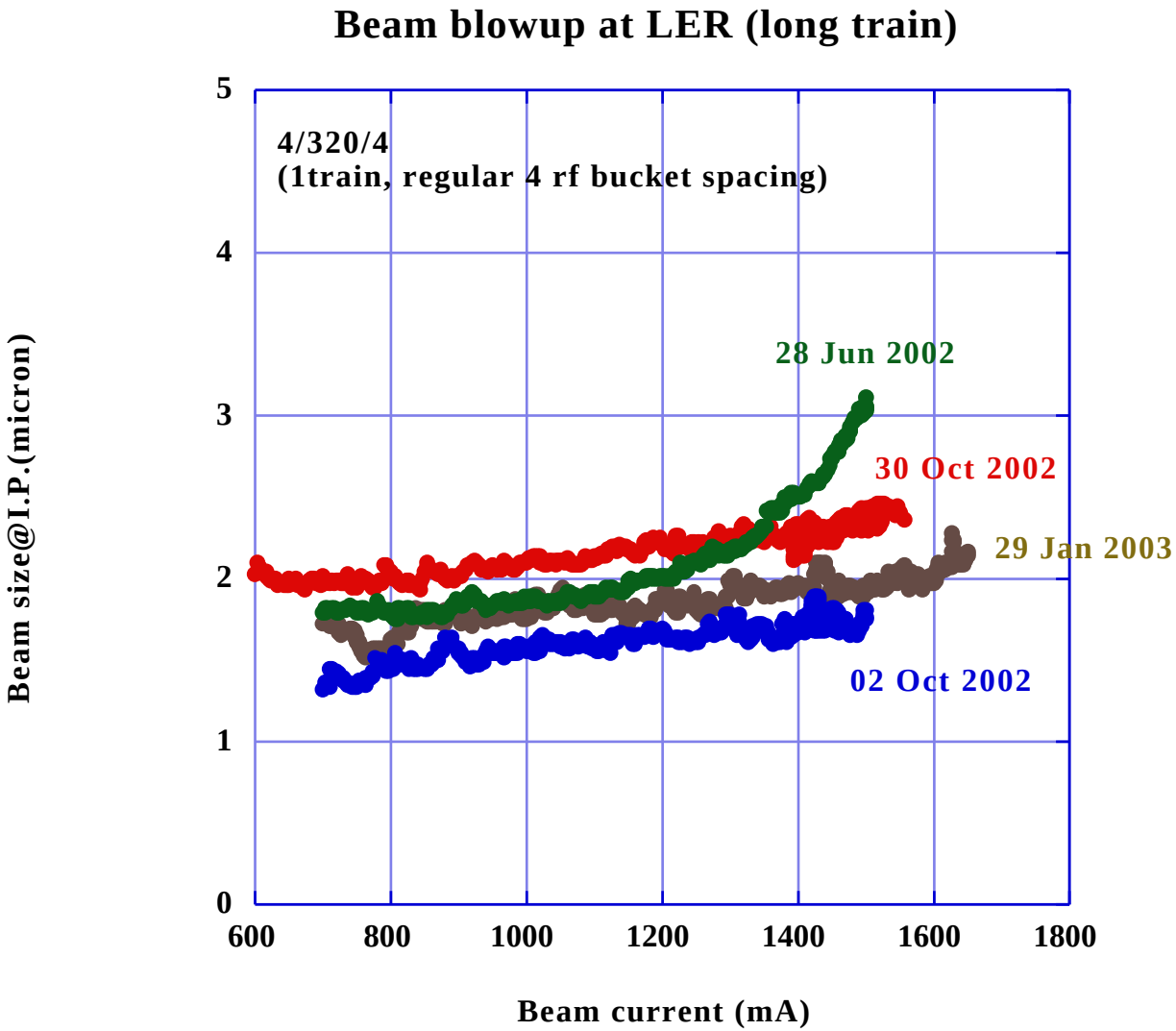


Length lager than 20 G

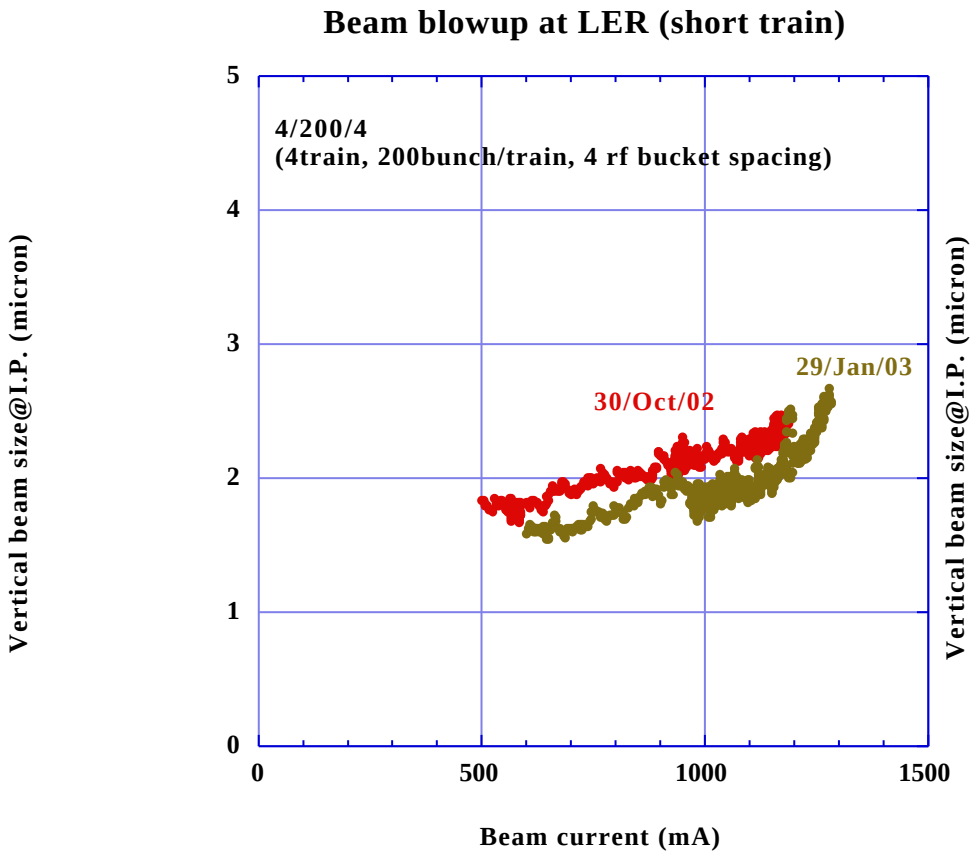
91% of drift region

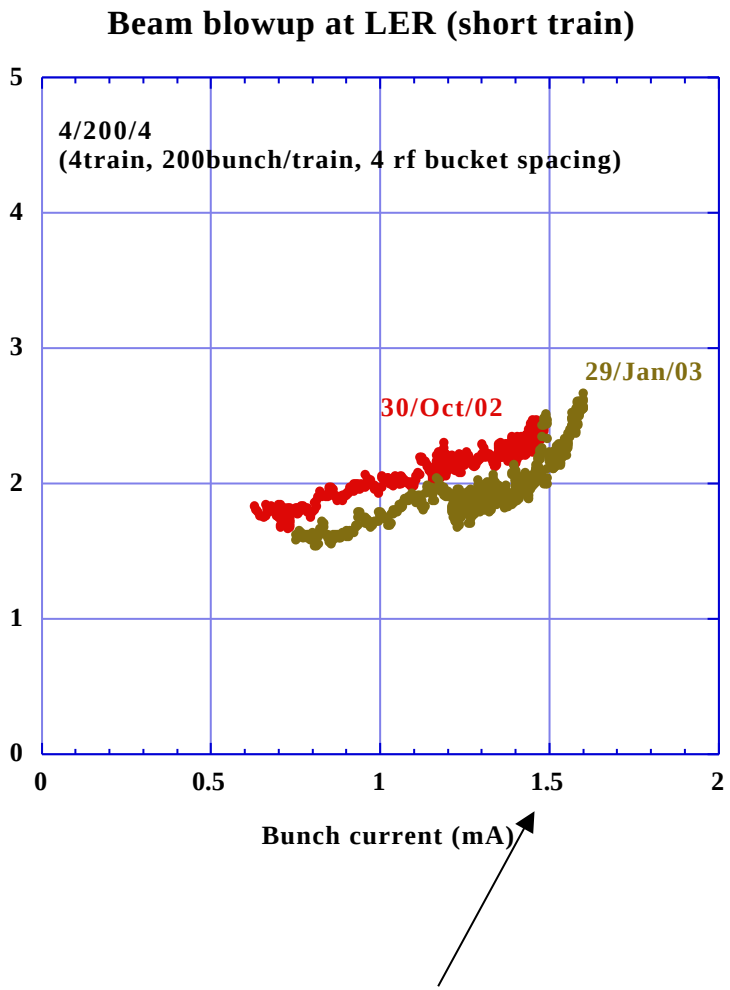
78% of total length

Effect of new solenoid on blowup



Short train



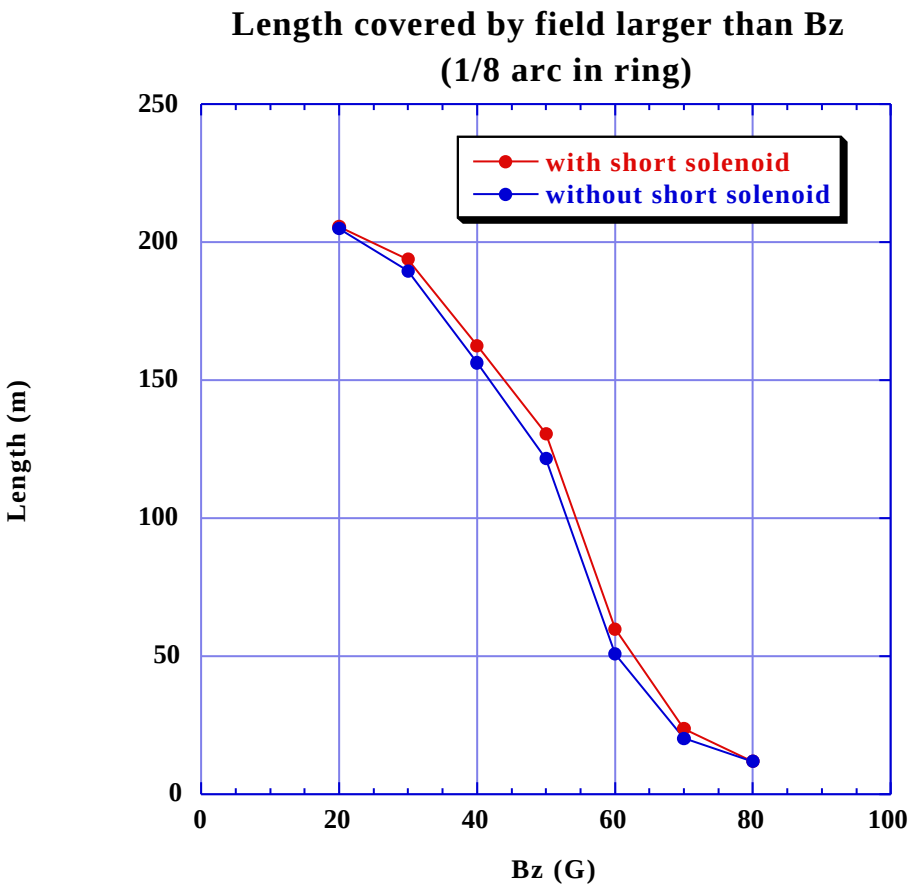


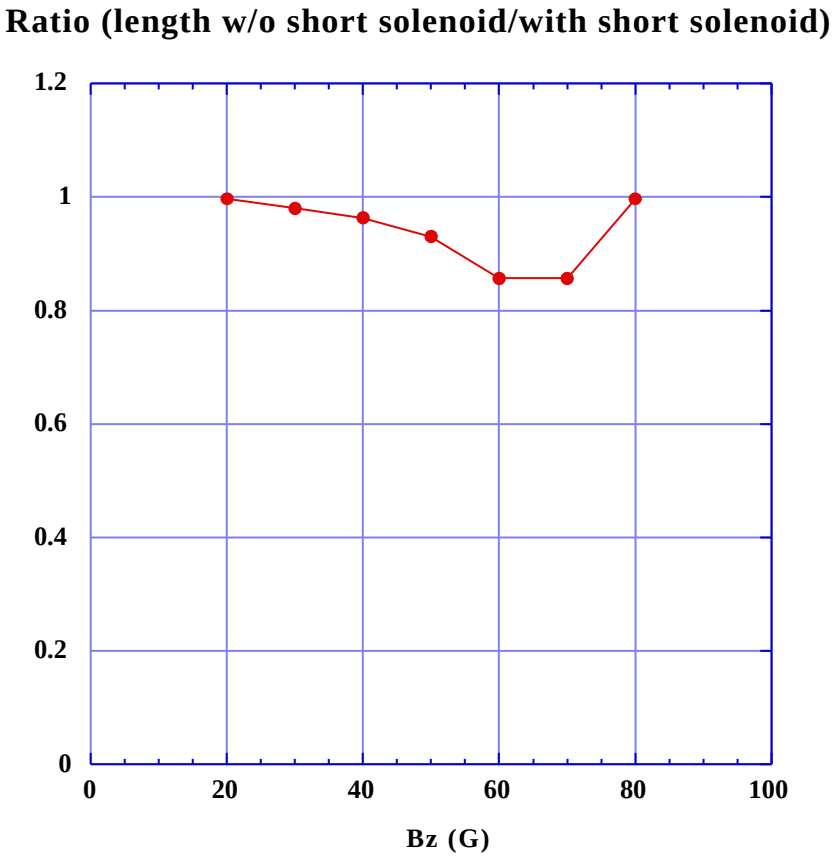
Equivalent to 1800mA for 1200 bunches

Can we confirm the improvement of the blowup is due to short solenoids ?

We can not directly prove that this improvement is due to additional solenoids installed in this summer, because their power supplies can not be switched off selectively.

How much the length covered by solenoids increased by short solenoids?





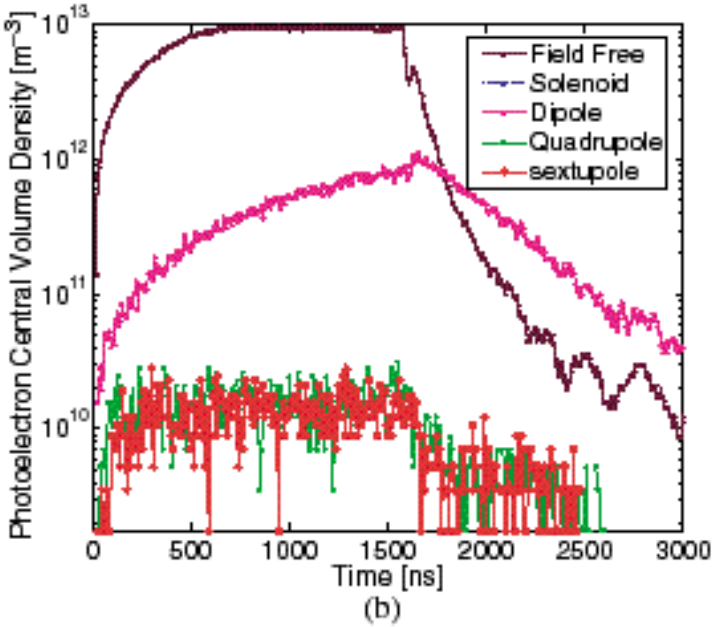
Stronger field is better ?

Effect of wiggler on blowup

by L. F. Wang

Do electrons inside bends affect to the blowup ?

A simulation shows the density of the electrons near the center of vacuum chamber in bend is larger than 1/10 of drift space.



Total length of wigglers:100m
≈ total length of lattice bends

Turn off wigglers and observe beam size and tune shift.

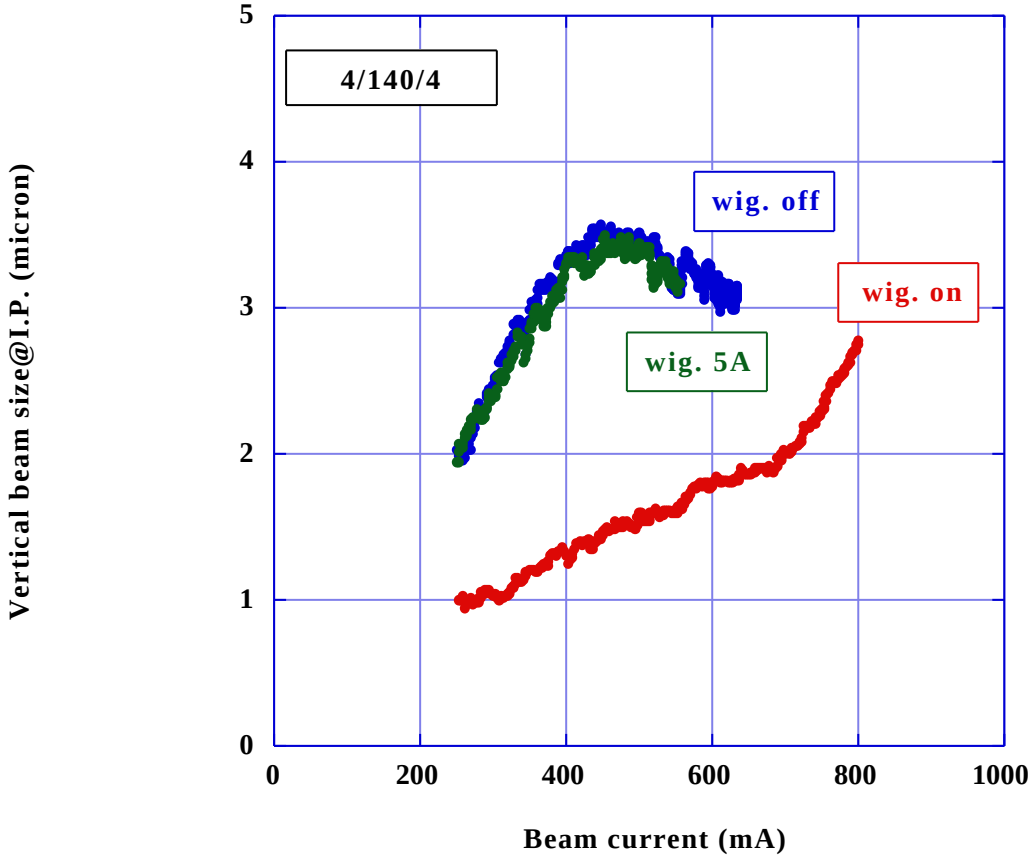
	wig. on	wig. off
Emittance (nm)	19	30
Radiation damping time(transverse) (ms)	43	87
Bunch length (mm)	5.5	5.4

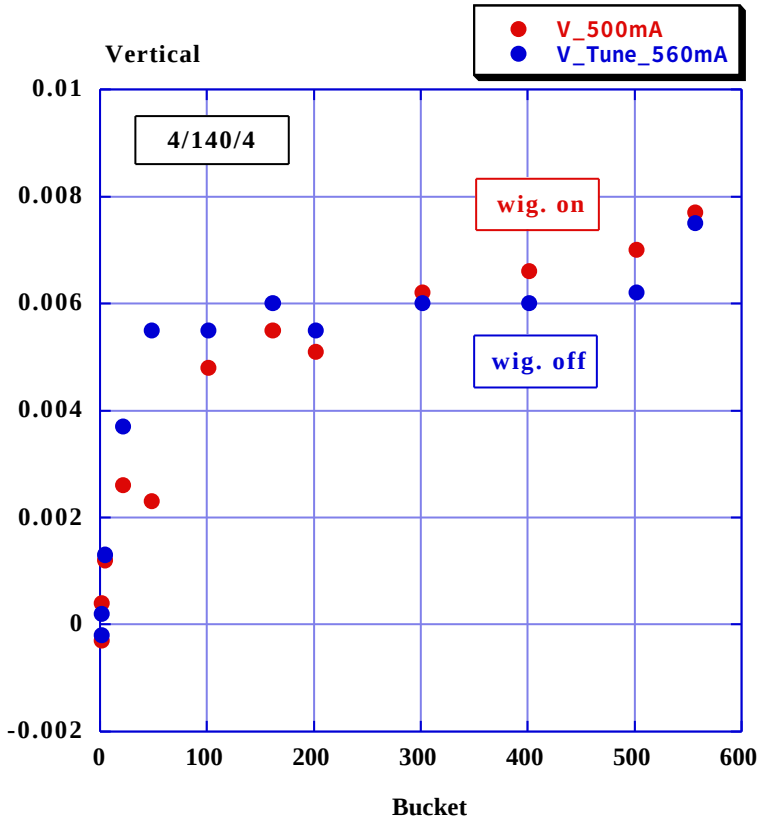
Beam size

Vertical tune shift

4 spacing

Wig. 5A< -> 40G



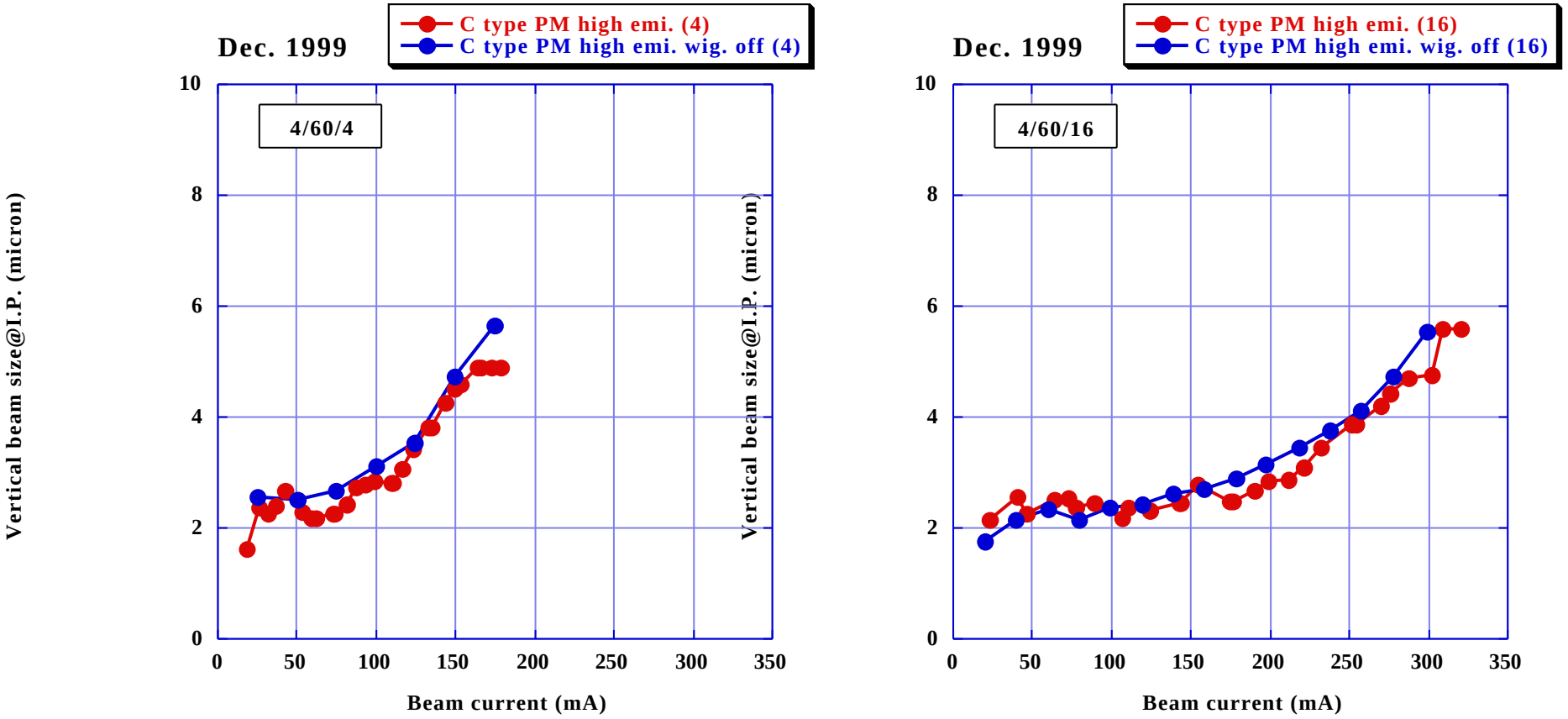


large difference of beam size

no large difference of tune shift

Effect of damping time on the blowup may be larger than that of cloud.

Measurement in Dec. 1999



no large difference of blowup with and w/o wiggler.

Summary

1) Short solenoids and permanent magnets were installed.

2) After the installation the blowup is not seen up to 1650mA in fill pattern for physics.

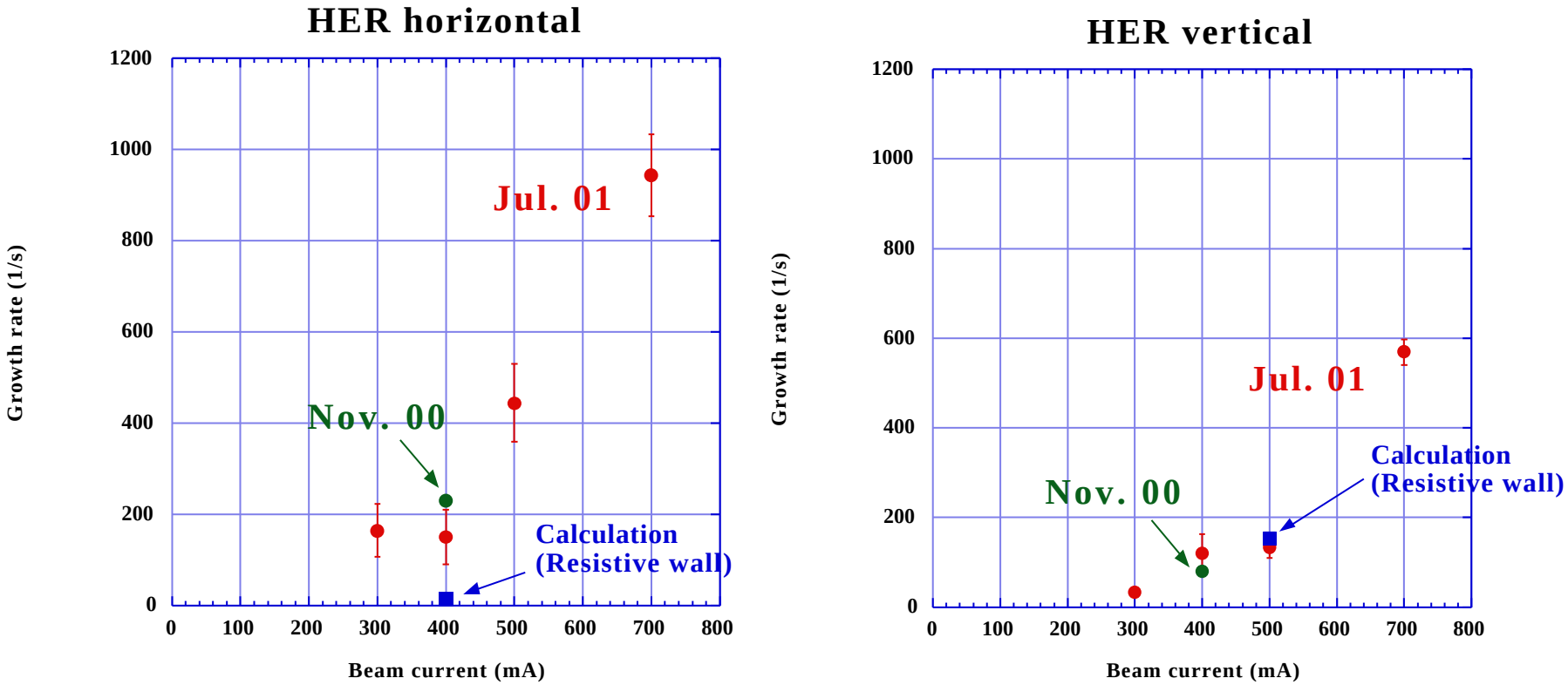
3) We can not prove experimentally that the short solenoids are effective or not. If effective, stronger field may be better to suppress the blowup.

4) Large blowup was observed when the wigglers were turned off. The result is not understood yet.

2. HER transverse coupled bunch instability

Observations

1) Growth rate



Horizontal > Vertical

Non-linear to beam current.

Almost same value in 2000.11 and 2001.7.

2) Mode Sharp peak appeared at low frequency observing at a fixed position.

EXPERIMENTAL OBSERVATION OF COUPLED BUNCH INSTABILITY

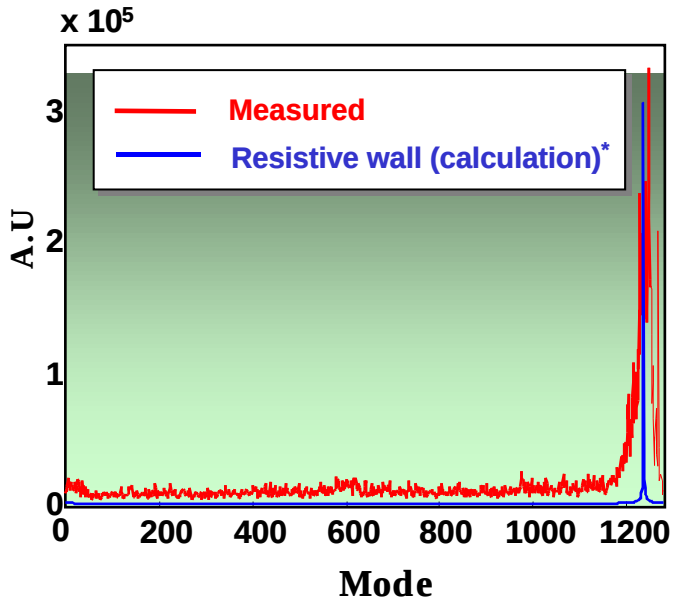


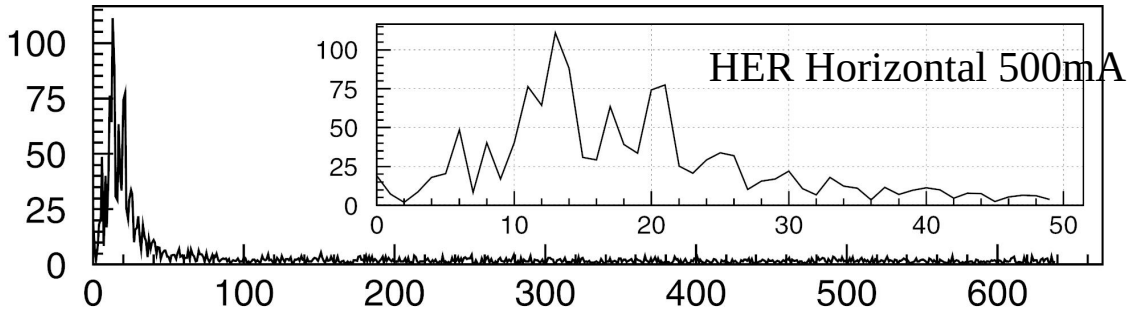
Figure 2: Vertical mode spectra of HER at 700 mA

Fill pattern: 1 train/1153 bunches/8 ns bunch spacing

*Ref. paper for resistive wall calculation: K. Thompson and R. Ruth, "Transverse Coupled-Bunch Instabilities in Damping Rings of High-Energy Linear Colliders," Phys. Rev. D 43, 3049 (1991).

Another data (Y. Ohnishi)

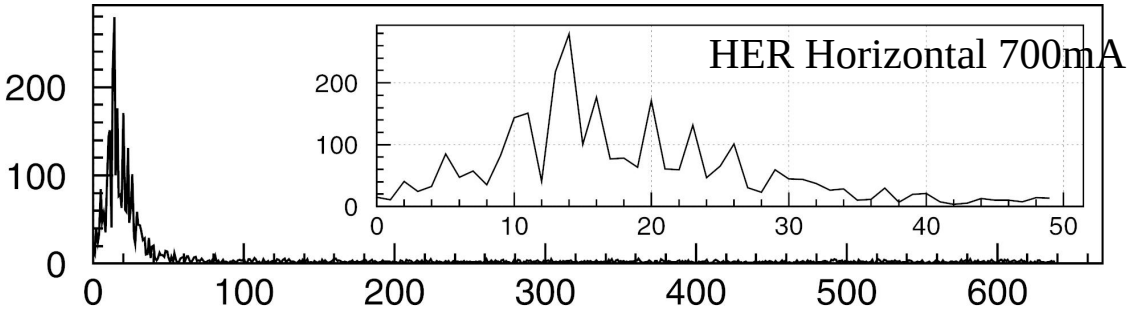
Wave number (horizontal)



Wave number = 13

⇕

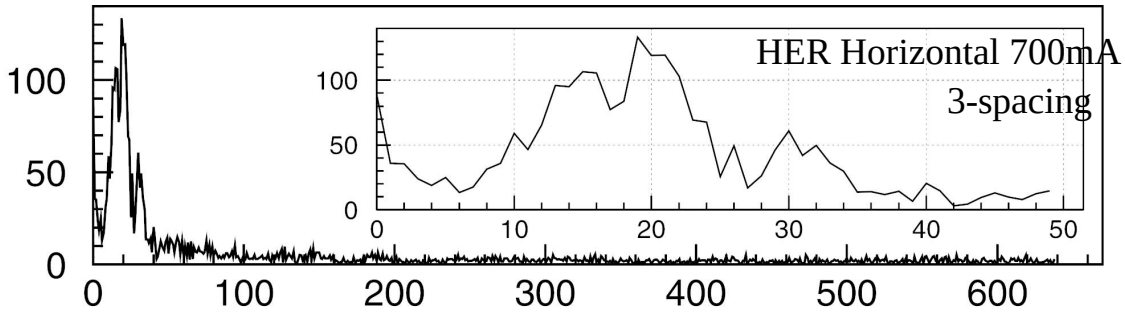
Analytic formula (of fast ion): 20



Wave number = 14

⇕

Analytic formula: 23



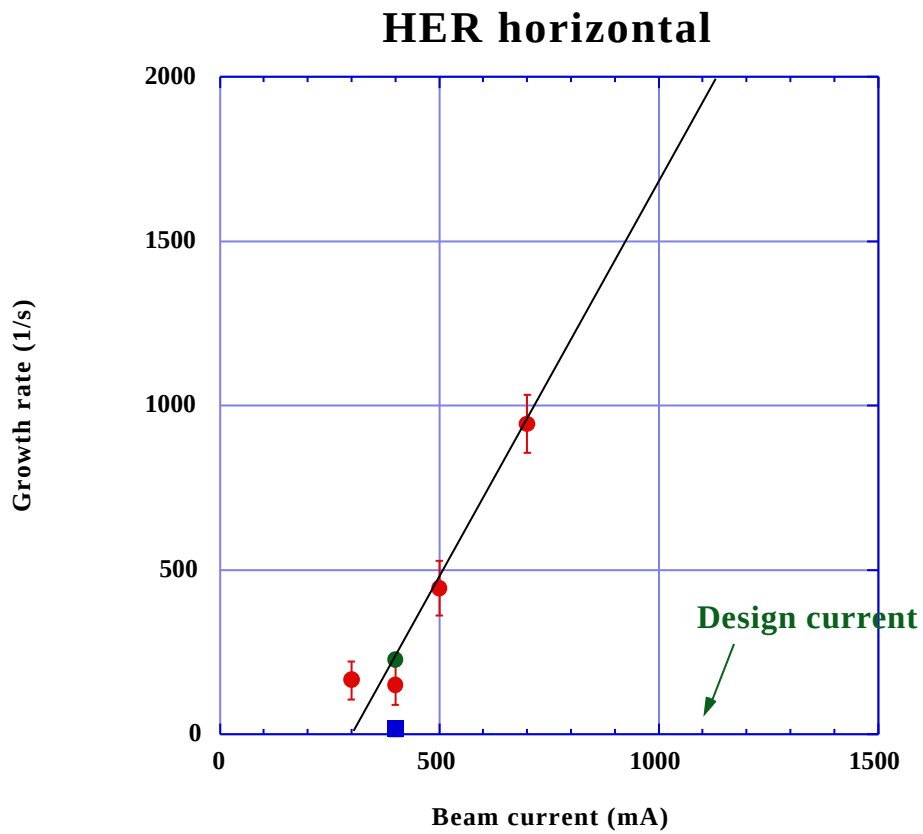
Wave number = ~20

⇕

Analytic formula: 27

Wave number

3) How serious ?



Damping time of 0.5ms is necessary for suppressing the CBI at the design current of 1.1A.

Candidates of source

1) Resistive wall

Pros - Some data show mode 0 of the CBI.

Cons - Some data do not show mode 0.
Growth rate : Horizontal > Vertical

2) Ion

Pros - Some data show mode near ion oscillation.
(But peak position of mode is not dependent on beam current.)

Cons - Some data show mode 0.
Growth rate : Horizontal > Vertical

3) HOM in vacuum chamber

a) RF cavity ?

b) IR chamber

Cons - Mode and growth rate in HER are different from those in LER.

c) Mask ?

Cons - Almost same growth rate in Nov00 and Jul01.
D9, D12 vertical masks were replaced from Ver. 3.1 to Ver. 4.

d) Other chamber ?

Measures

1) Remove instability source

2) Bunch feedback system
   Damping time of 0.5ms is needed to suppress the CBI at design current.
   As the typical damping time of the present feedback system is 0.5ms (PHYSICAL REVIEW ST - AB, 3, 012801 (2000)) , it is expected that the instability is cured by the present feedback system up to the design current.

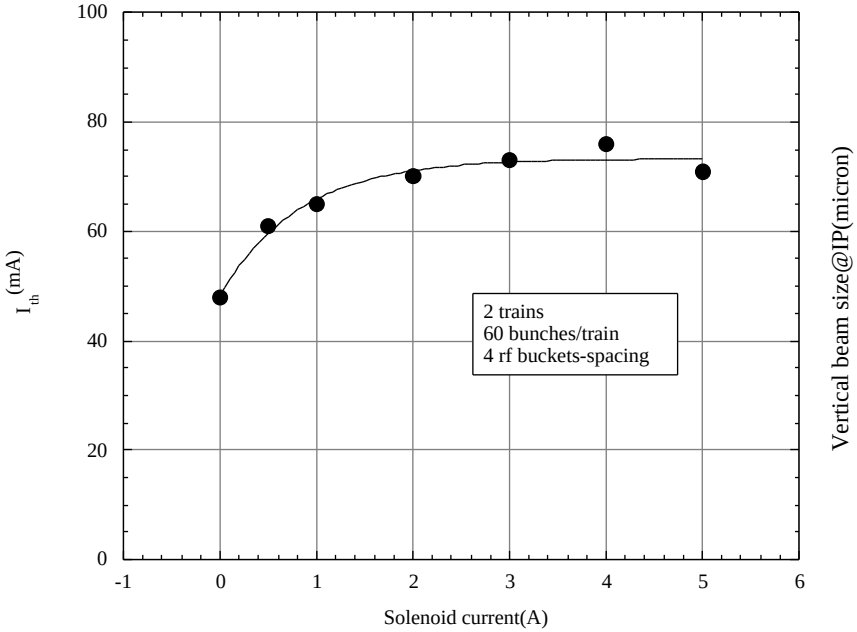
Summary

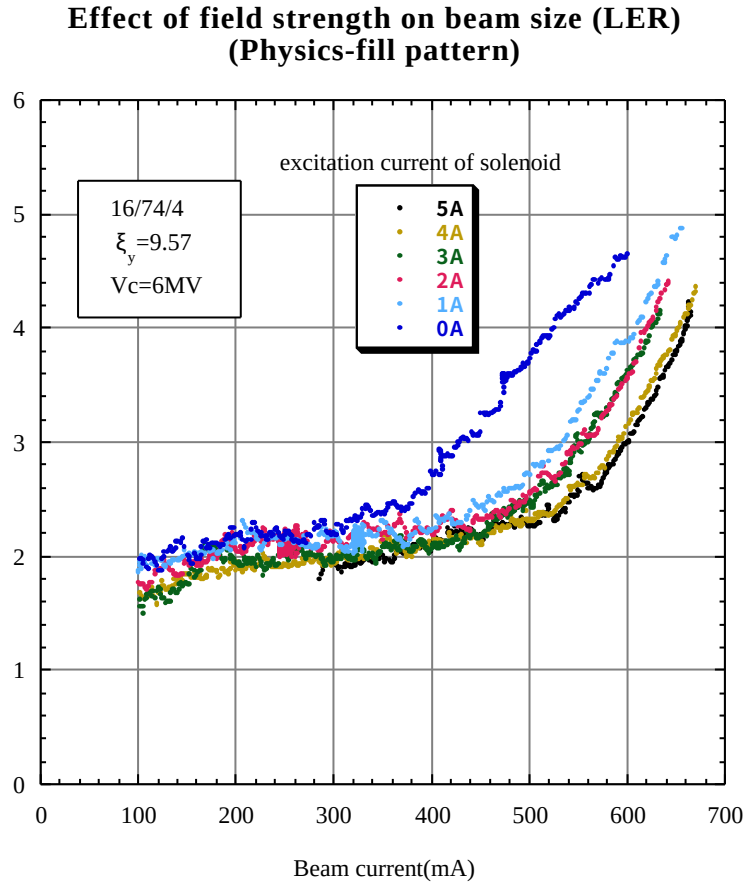
1) Horizontal coupled bunch instability is observed in HER.

2) There is no consistent model to explain the observation.

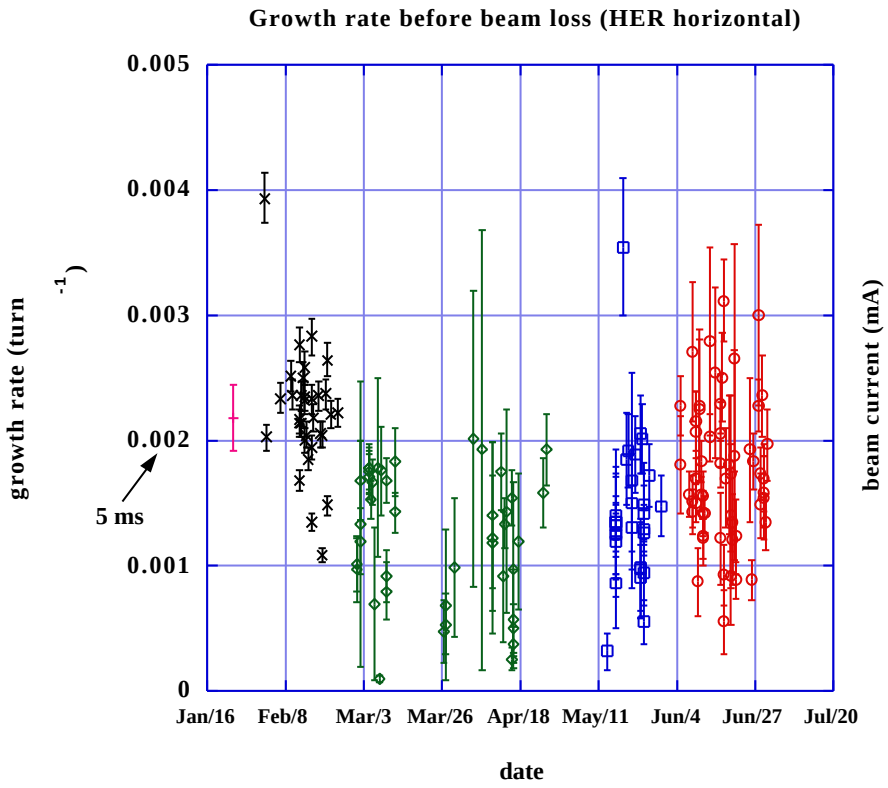
3) It will be suppressed by the feedback system up to the design current.

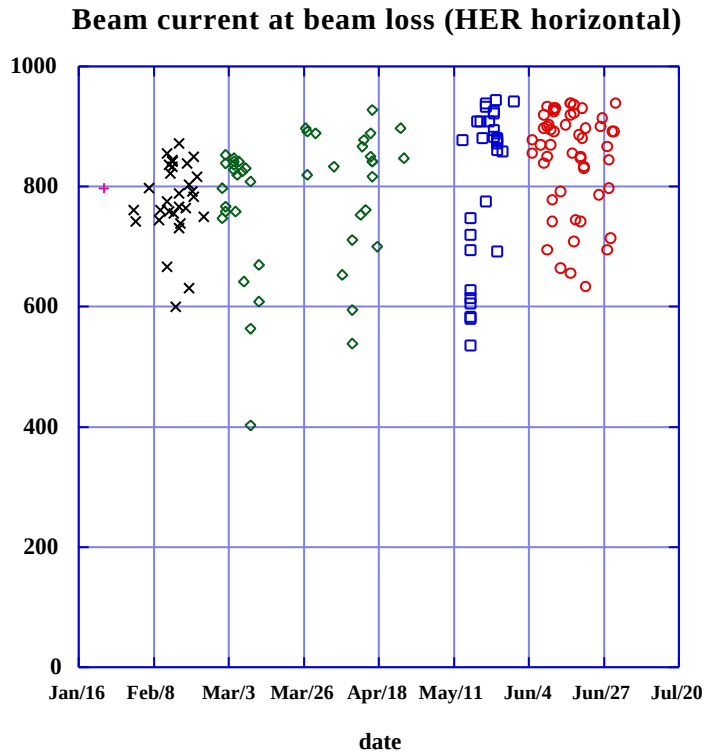
In 2000 autumn, 20 G was enough.





Statistics of growth rate at beam abort





Growth time at beam abort with bunch feedback = 3ms-10ms(@900mA)