

LER Blowup & Solenoid

(Feb.25 10:55-11:15 H.Fukuma)

LER beam size blowup and effect of solenoid

KEKB MAC (25th Feb. 2002)

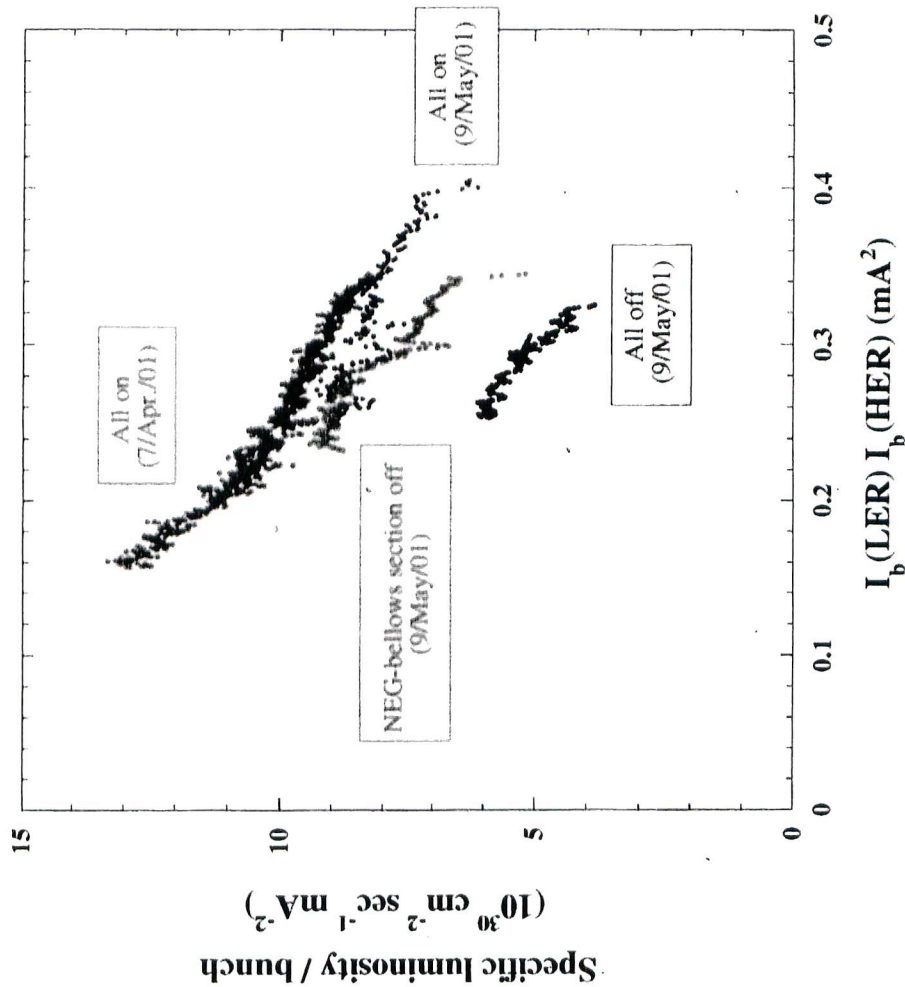
H. Fukuma, KEK

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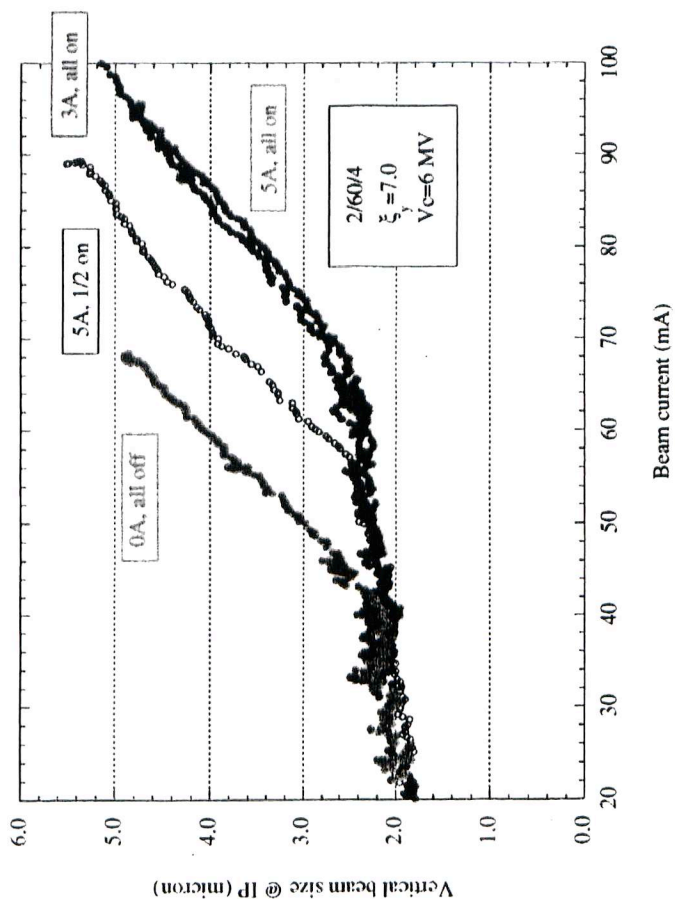
1. Introduction

- **A large number of solenoids were installed in LER in 2000 to remove the electron cloud which cause the blowup of vertical beam size.**
- **The blowup was relaxed after installation of solenoid.**
- **The effect of the solenoid on the luminosity was confirmed.**
- **The solenoid was added in 2001 to suppress the blowup further.**

Effect of solenoid



Effect of solenoid on vertical beam size (LER)



2. Solenoid winding

Solenoid

type	length (mm)	Diameter (mm)	turns	Bz (center) @ 5A (Gauss)
bobbin	150 - 650	148	250(typ.)	45
Bobbinless	40	220	190, 200	48
Bobbinless	40	250	200	43
Bobbinless	40	300	200	37

Power supply(P.S.)

	KEKB corrector P.S.	TRISTAN corrector P.S.	
Current(A)	5	3	10
units	616	40	24

Summary of solenoid winding work

1. 2000 September

Arc section, straight section (Cu chamber)

	Bobbin	
	length(mm)	number
	200	546
	100	185
	150	231
	190	135
	250	308
	300	662
	400	352
	500	273
	650	91
Total		2783

2. 2001 January

Arc section (Bellows+NEG)

	Bobbinless	Bobbin
East	508	0
South	434	0
West	504	0
North	504	0
Total	1950	0

3. 2001 April

Straight section (Bellows, Cu chamber)

	Bobbinless	Bobbin
Tsukuba	232	0
Fuji	22	0

Arc section (Cu chamber)

	Bobbinless	Bobbin
South	2	10

	Bobbinless	Bobbin
Total	256	10

4. 2001 September

Straight section (Bellows, Cu chamber)

	Bobbinless	Bobbin
Tsukuba	210	0
Oho	236	8
Fuji	316	20
Nikko	214	8

Arc section

	Bobbinless				Bobbin
	NEG	IP	Bellows+NEG	Others	
East	336	112	39	117	0
South	314	90	60	162	4
West	344	112	39	113	3
North	354	114	36	93	0

	Bobbinless	Bobbin
Total	3411	43

5. 2002 January

Straight section (Bellows, Cu chamber)

	Bobbinless	Bobbin
Nikko	15	0

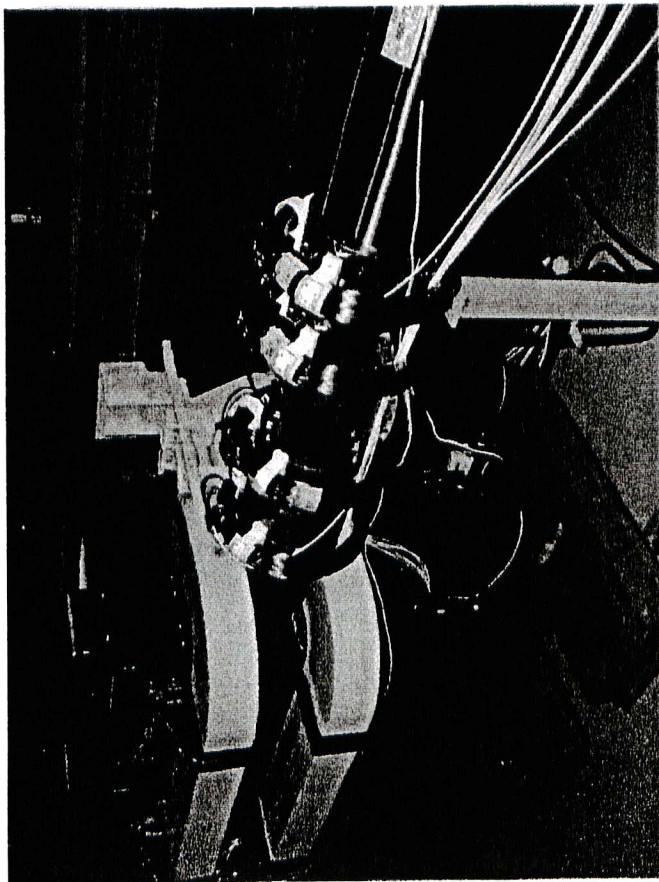
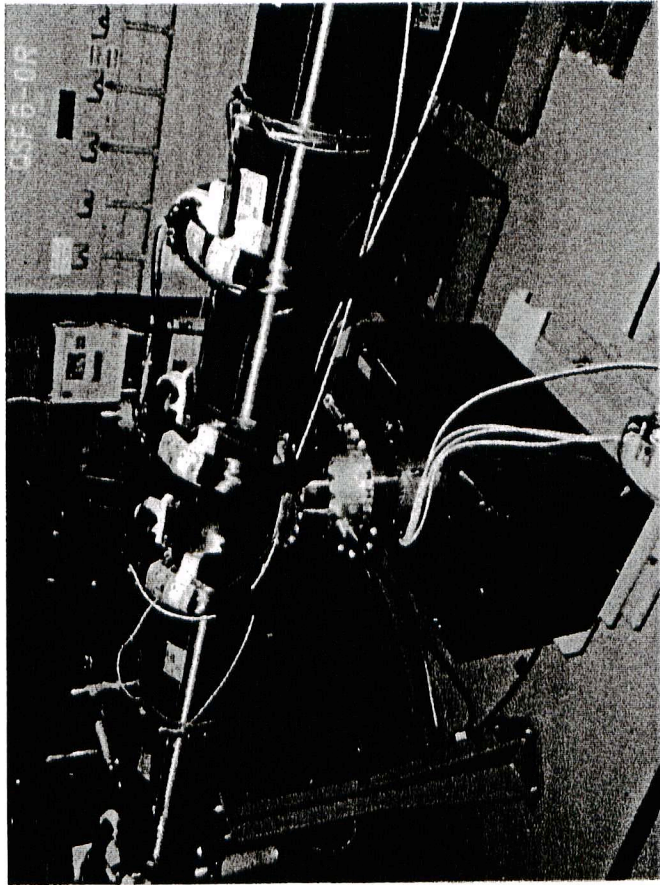
Arc section (Quad - Sext)

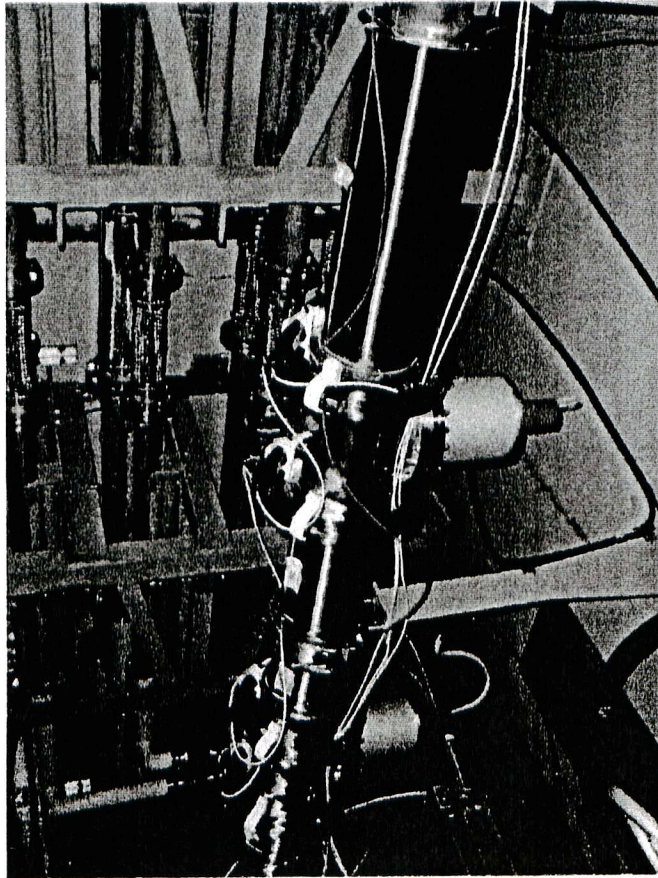
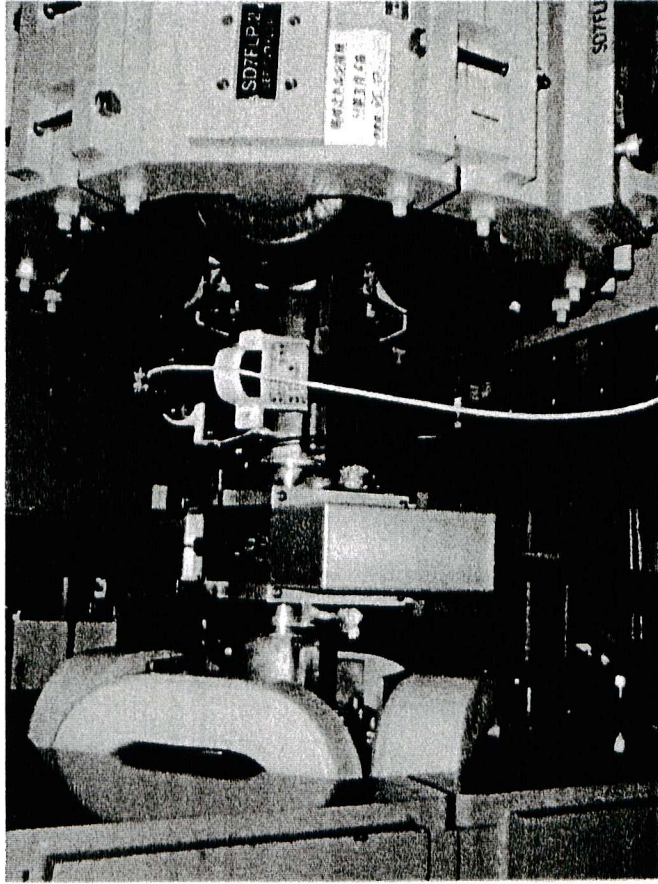
	Bobbinless	Bobbin
East	26	0
South	26	0
West	26	0
North	26	0

	Bobbinless	Bobbin
Total	119	0

Grand total

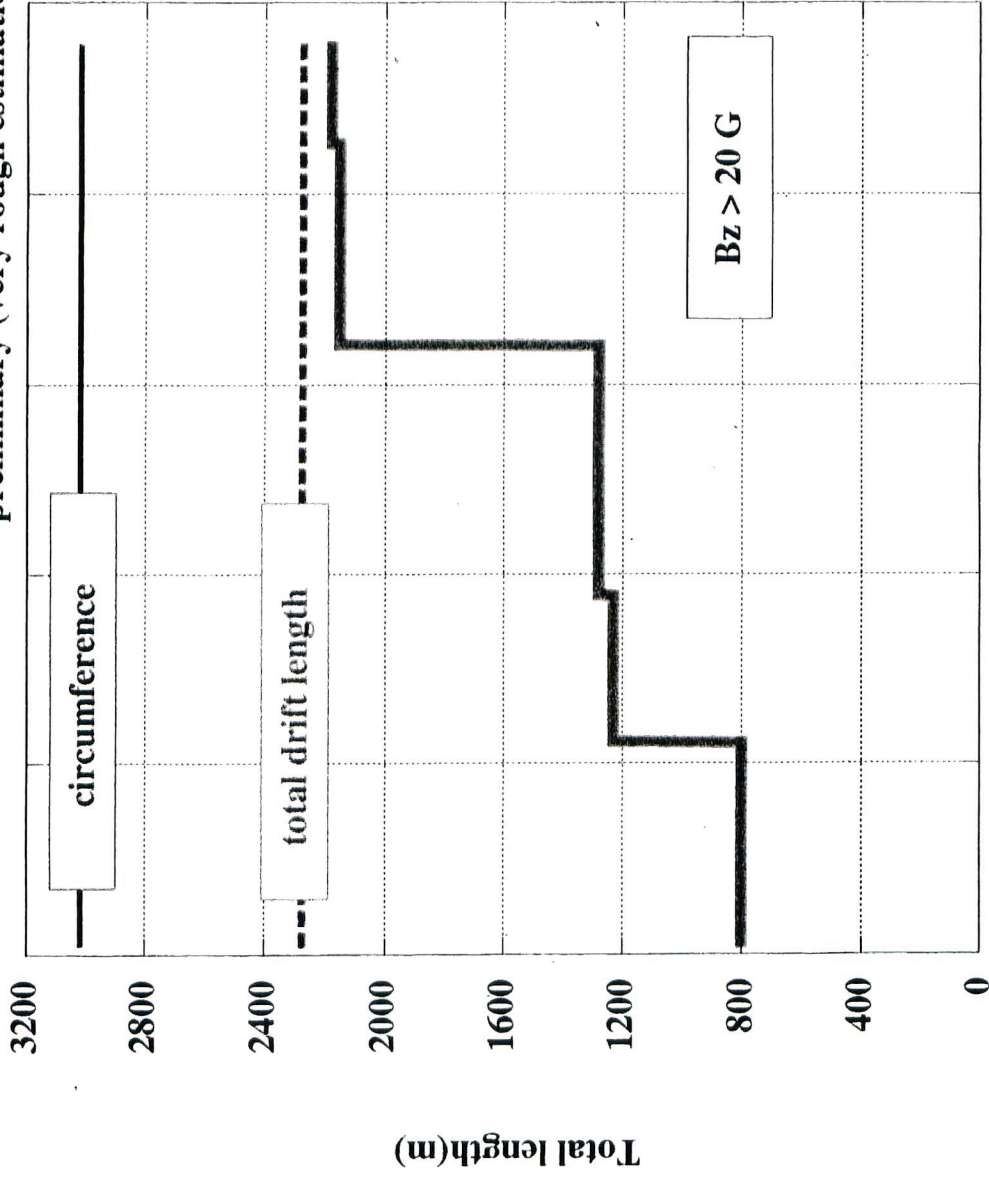
	Bobbinless	Bobbin
Total number	5736	2836





Total length of solenoid

preliminary (very rough estimation)



Sep. 00 Jan. 01 Apr. 01 Sep. 01 Jan. 02

Date

2. Effect of solenoid

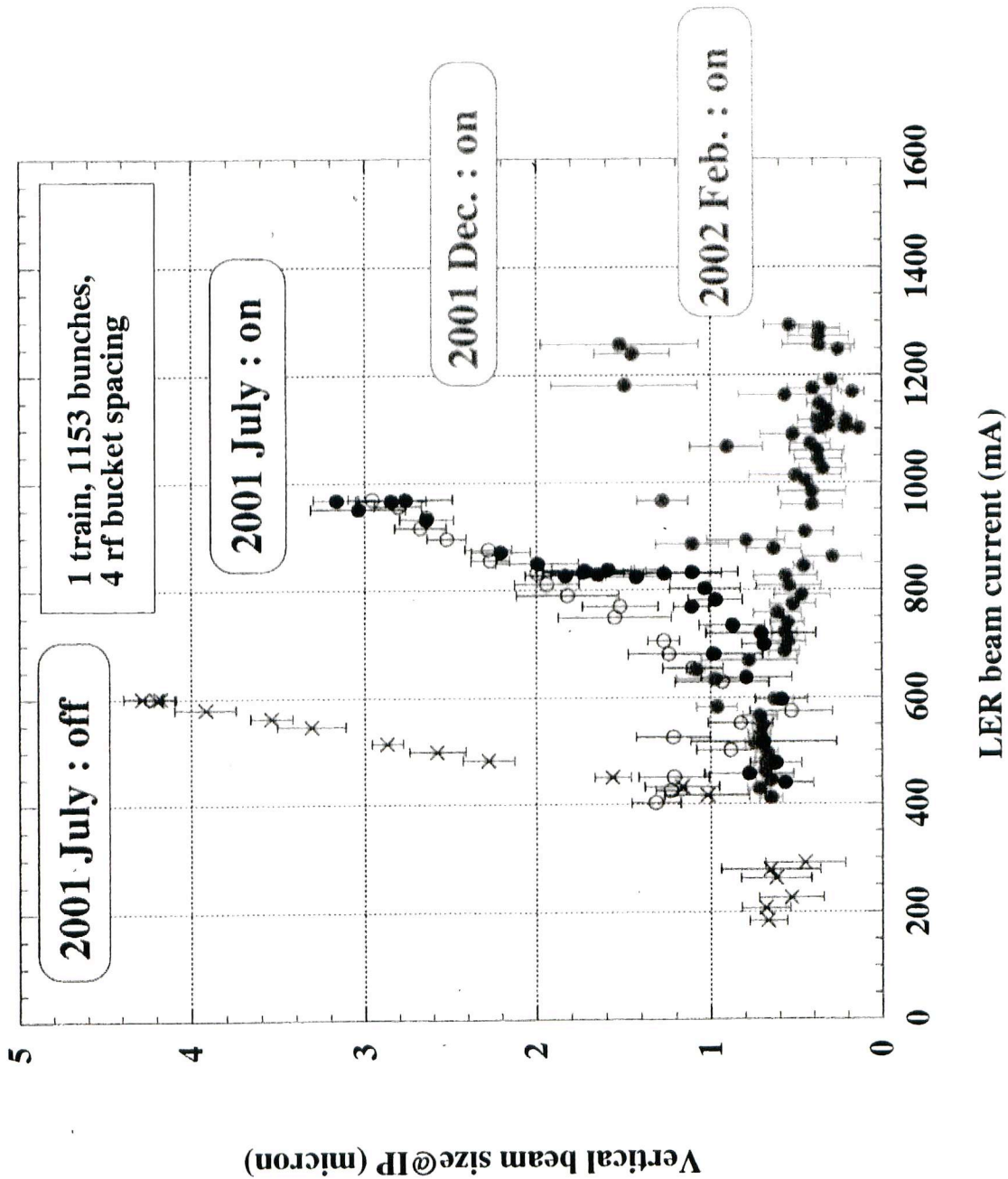
1) Beam blowup

A. Single beam measurement by interferometer

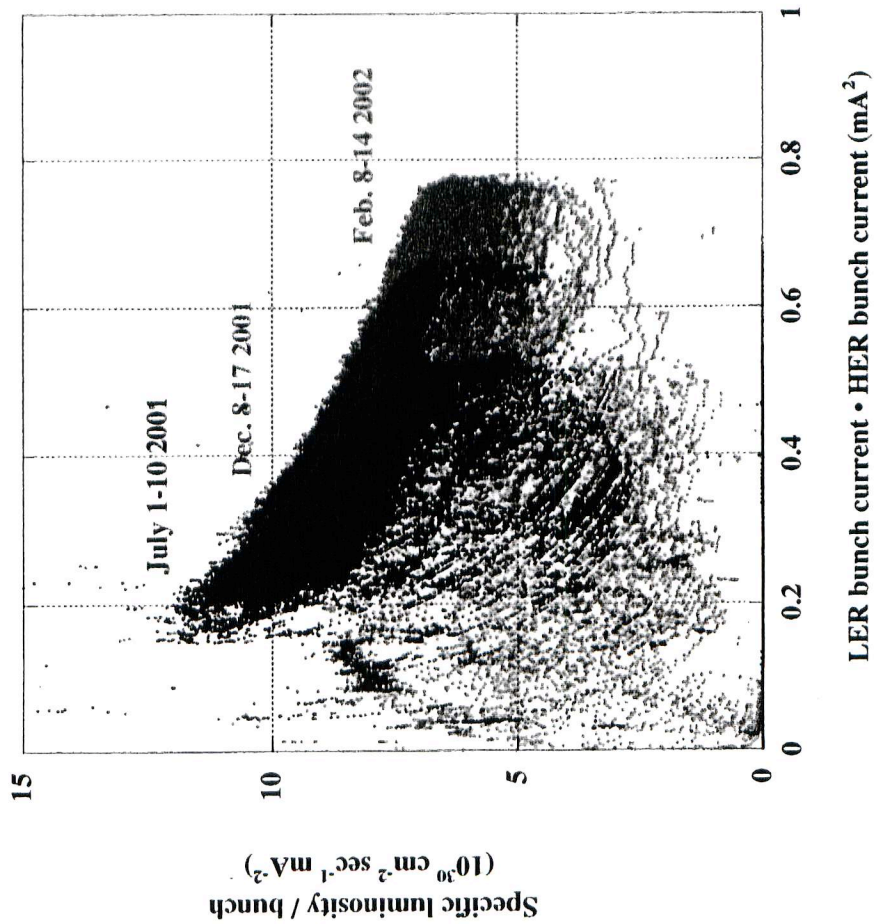
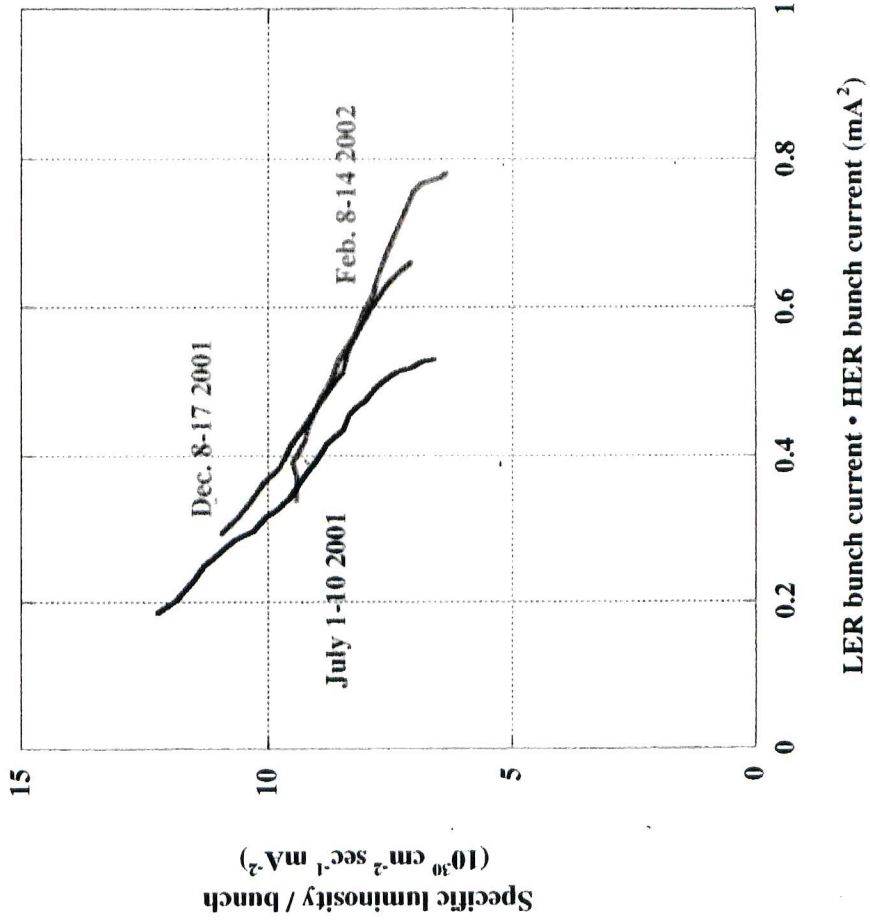
- **Blowup of beam size was not observed up to 1300mA with 4 rf bucket spacing fill pattern after 5th installation of solenoid.**

B. Luminosity measurement

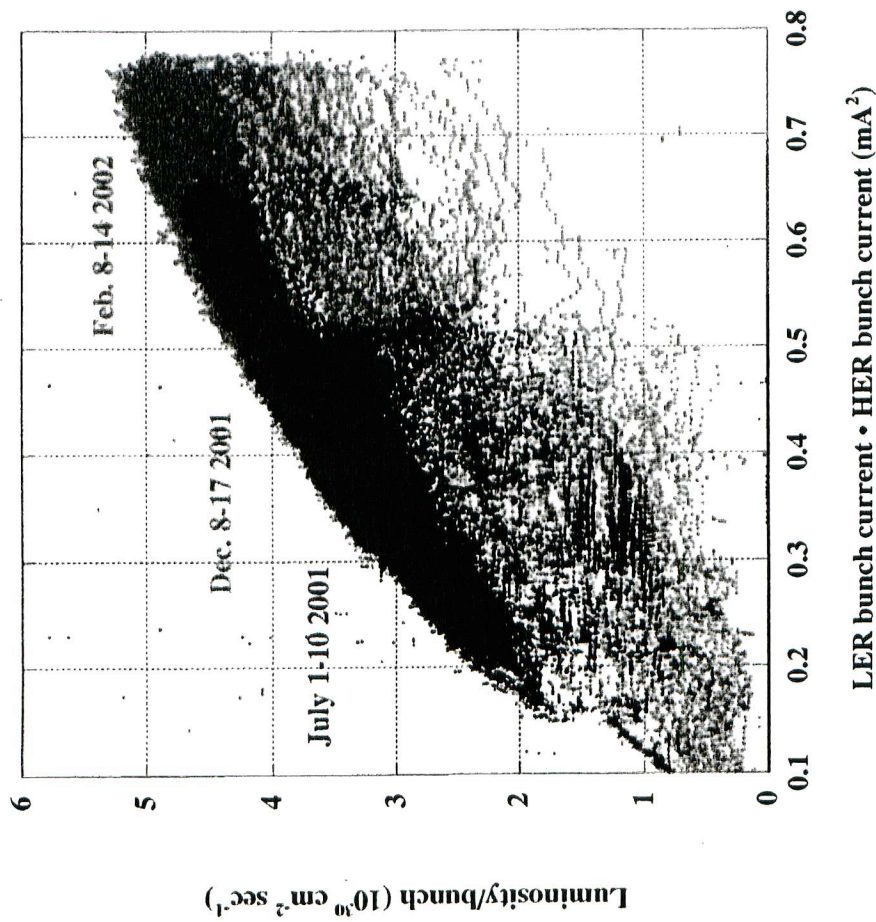
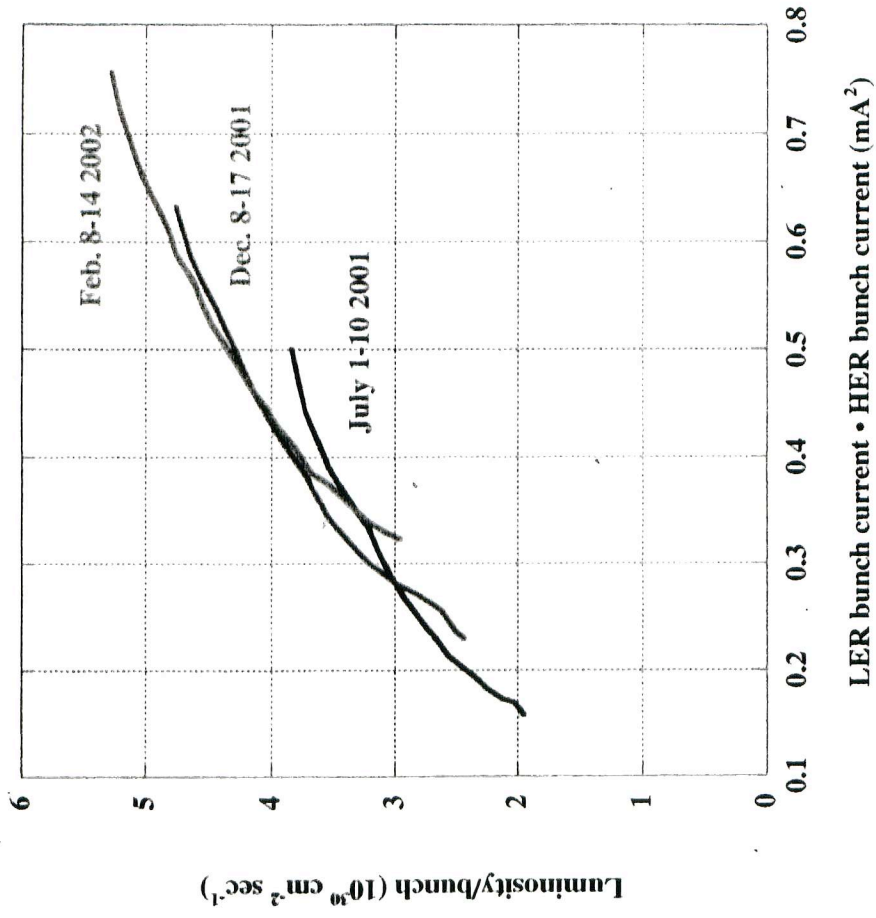
- **Specific luminosity and luminosity/bunch were improved after 4th installation of solenoid.**



Envelope



Envelope



2) Coupled bunch instability

- **Coupled bunch instability(CBI) in LER was studied with the Bunch Oscillation Recorder.**

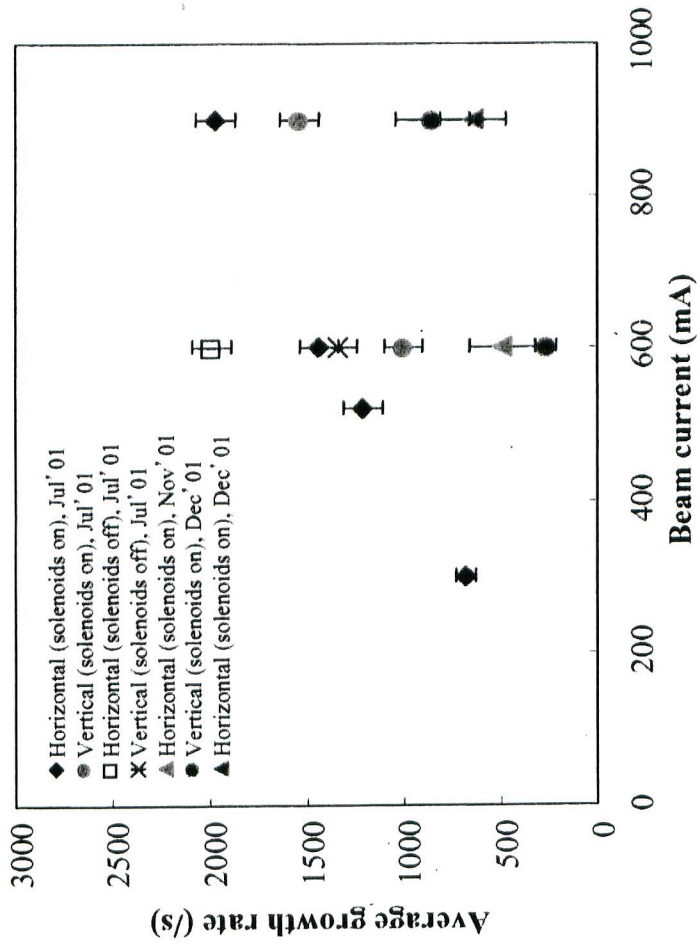
A. Growth rate

- **It was confirmed that growth rate of CBI was reduced when the solenoid was excited.**
- **Growth rate was reduced by about half after 4th installation of solenoid.**

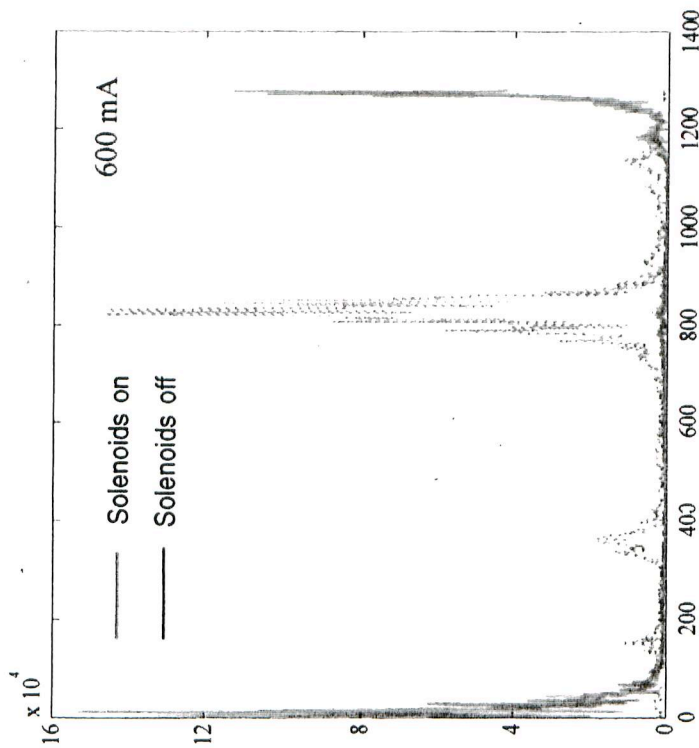
B. Mode spectrum

- **Mode spectrum of CBI was obtained by FFT.**
- **Mode spectrum was changed when the solenoid was excited.**
- **Simulation study of CBI caused by electron cloud is in progress. Some results show similar mode spectrum as observed**

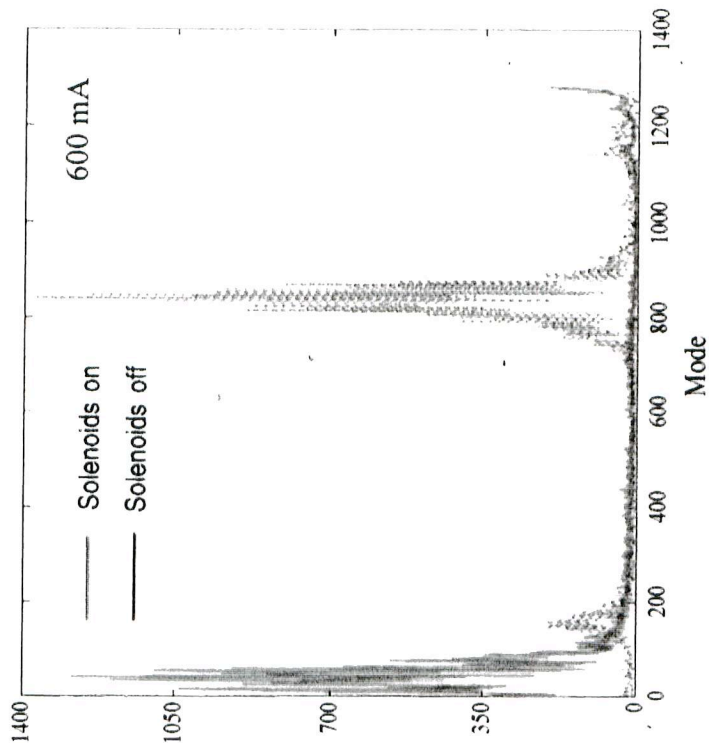
LER



Mode Spectra in LER

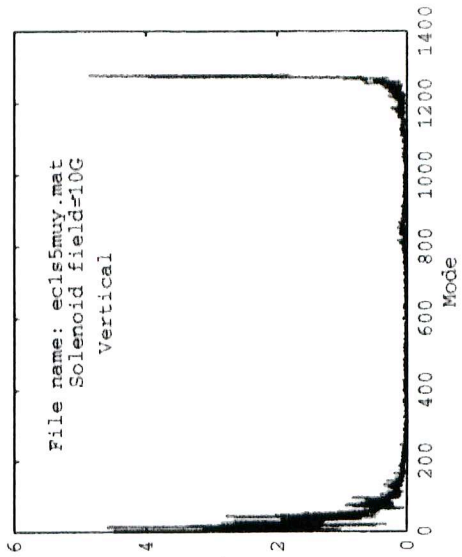
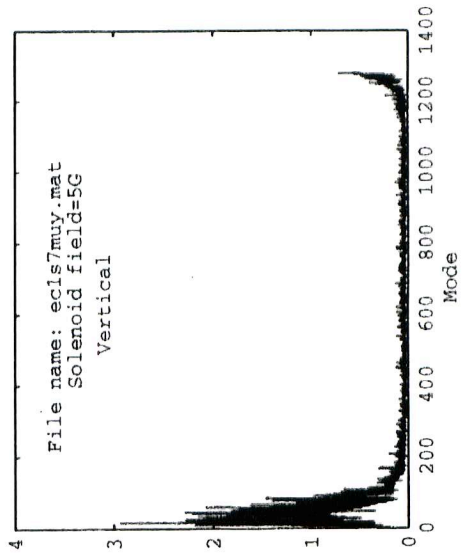
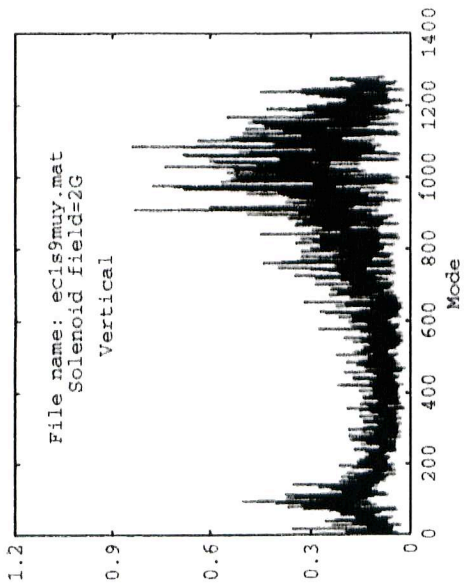
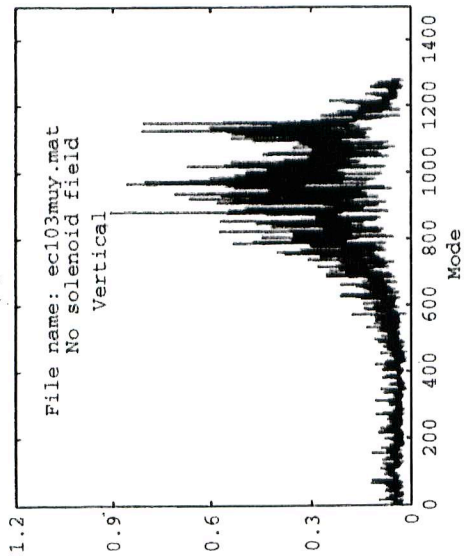


Horizontal



Vertical

Parameters: (Secondary electron production is included)
Fill pattern: 1/1153/4 Beam current: 600mA Emittance x/y: 1.8E-08/3.6E-10 Tune x/y: 45.5153/43.569

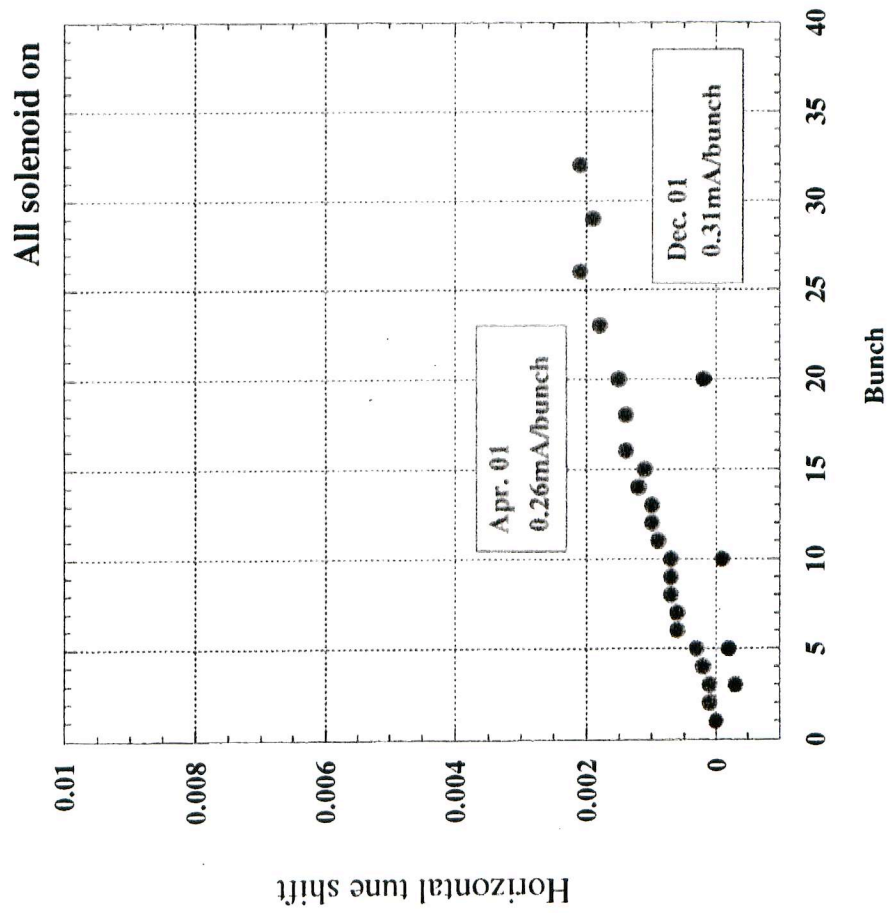
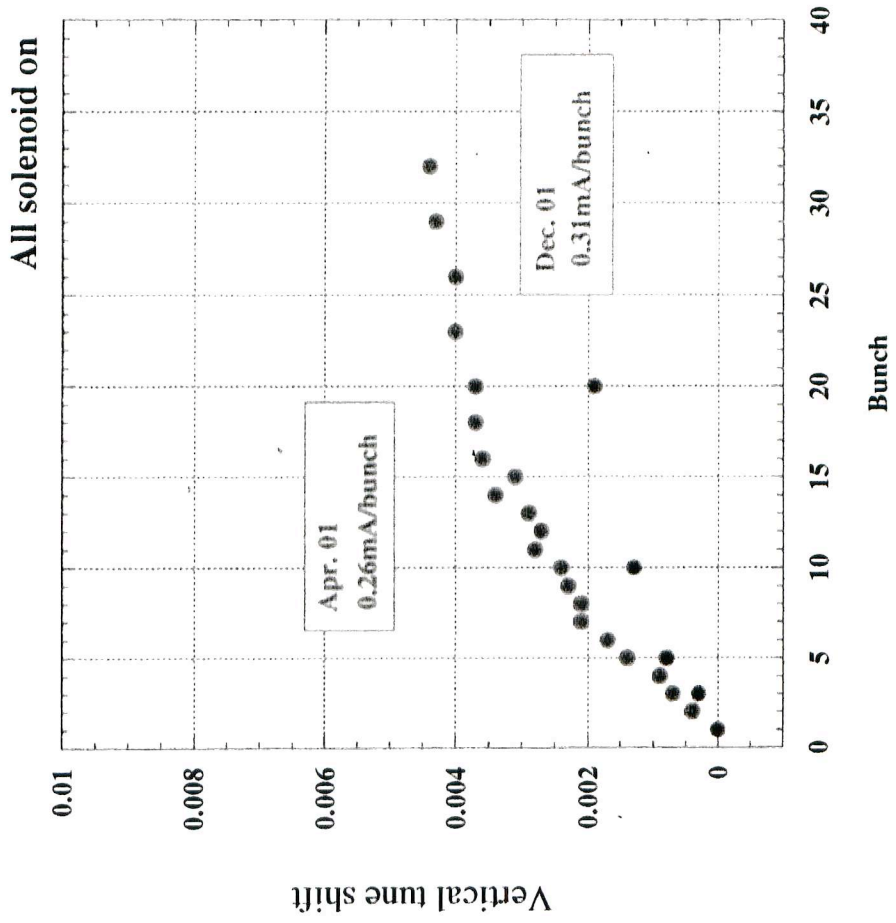


3) Tune shift

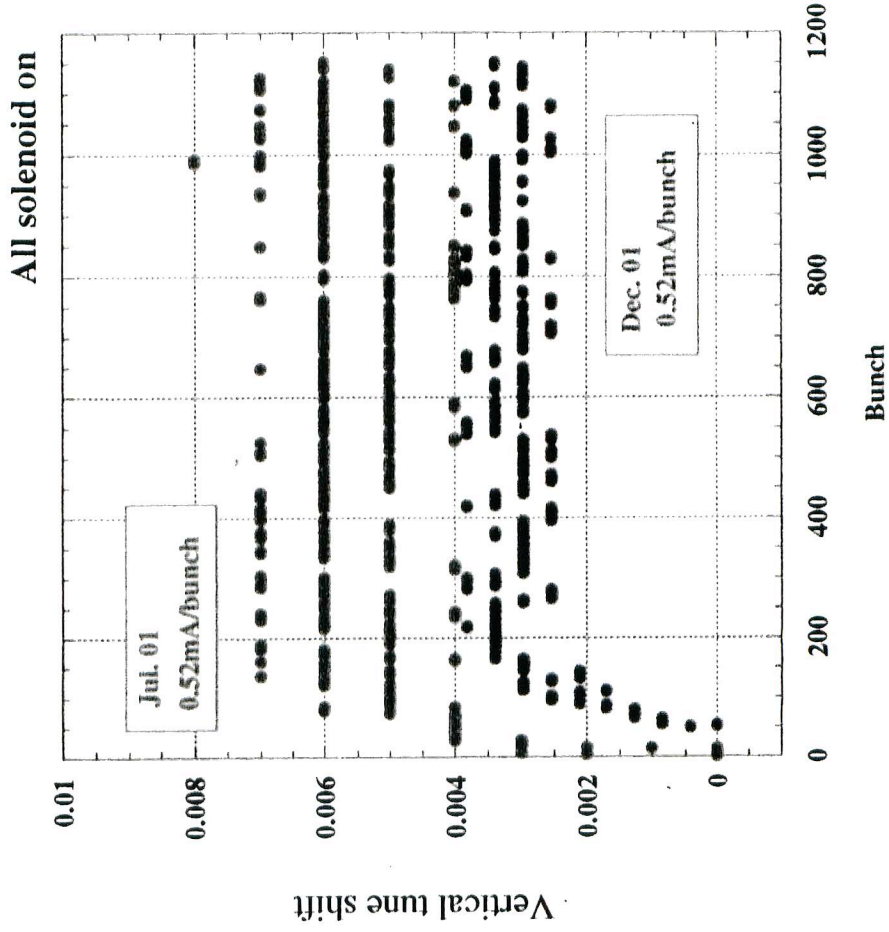
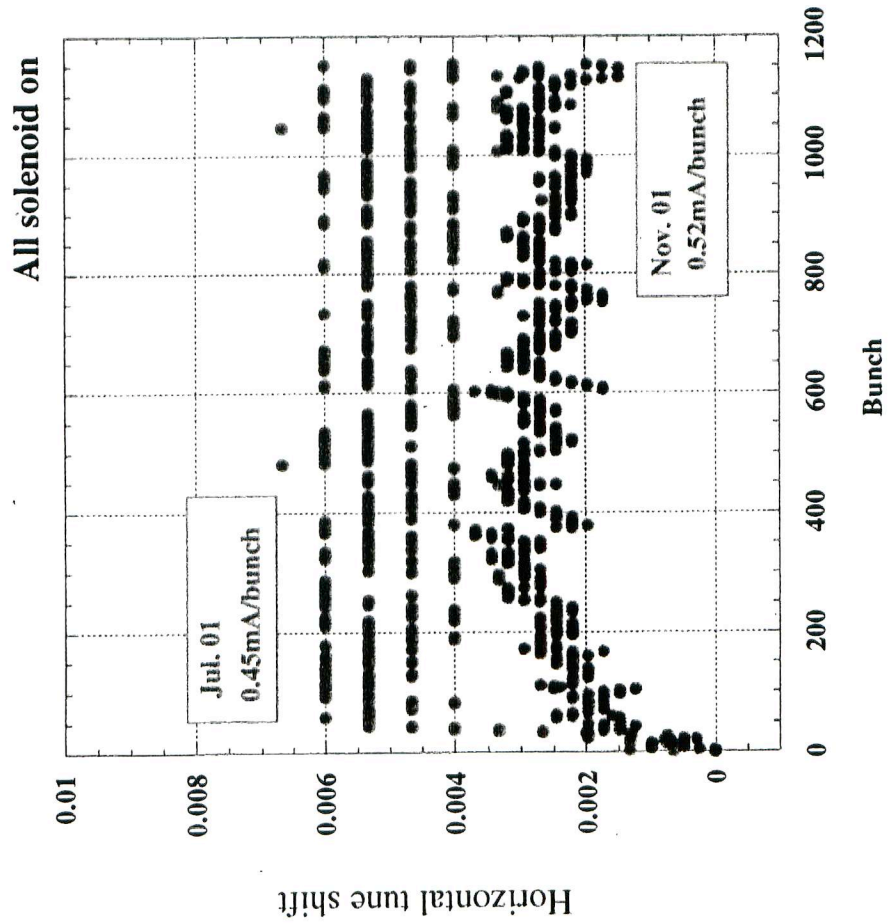
- **Tune shift along the train measured by gated tune meter(GTM) was reduced after 4th installation of solenoid.**
- **The tune shift obtained from bunch-oscillation after turn off the bunch feedback system was also reduced after 4th installation of solenoid.**

Tune shift measured by gated tune meter (T. Ieiri)

4 rf bucket spacing



Tune shift obtained from BOR data (S. S. Win)

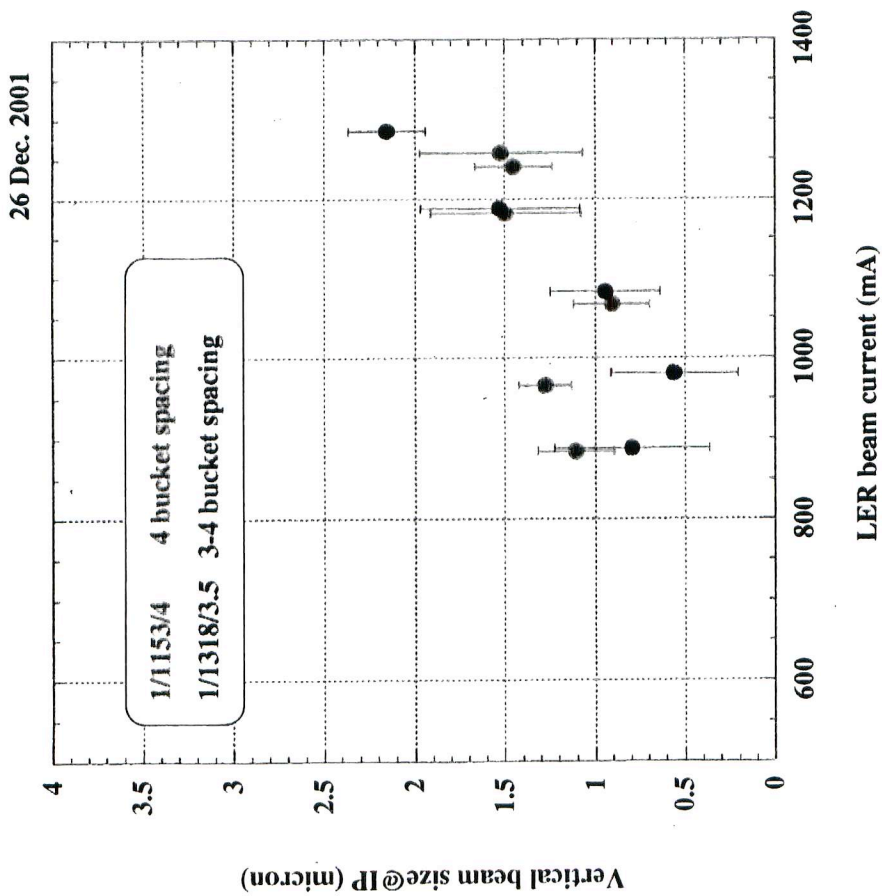
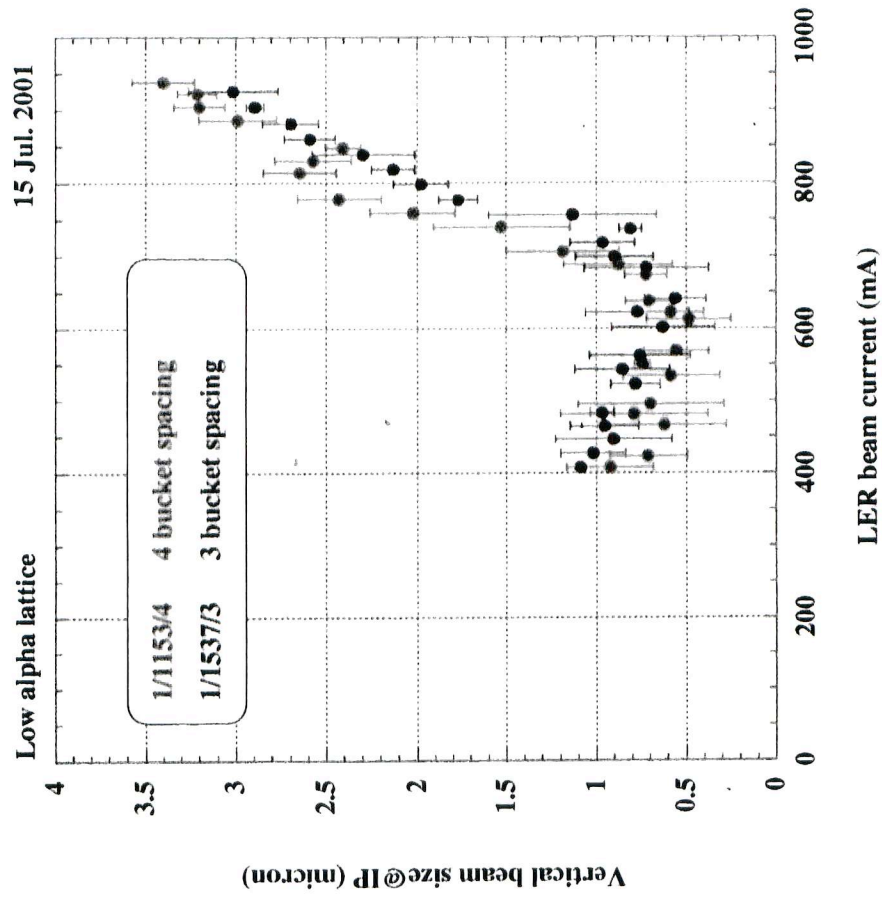


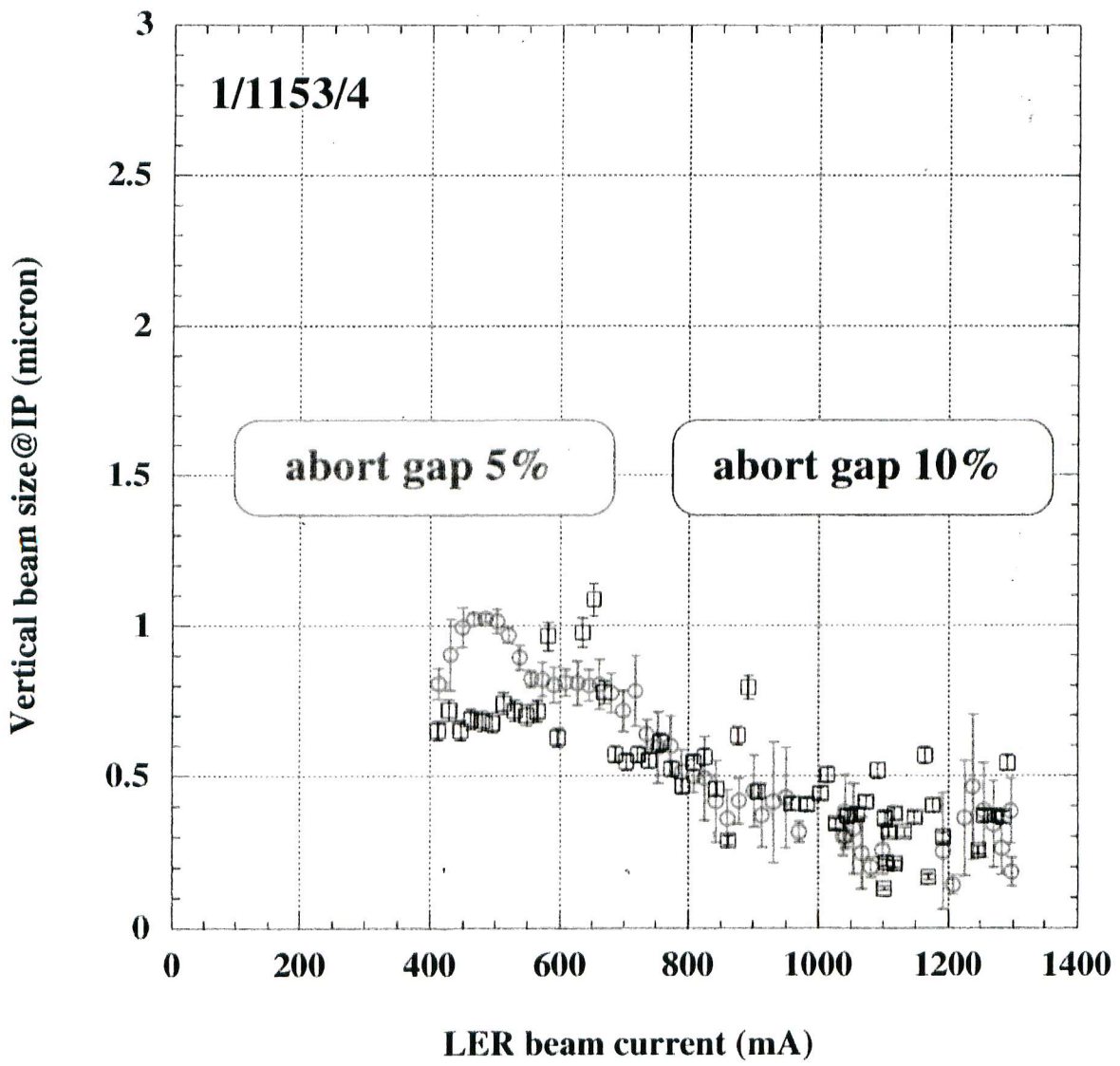
4. Others

1) Effect of bunch spacing

- **Vertical beam size was compared between 3 and 4 buckets spacing fill. Fill pattern was arranged to give a same line charge density of the beam (fill pattern: 1/1537/3 and 1/1153/4).**

⇒ Result showed that blow-up curves were almost same in two fill patterns.





2) Low momentum compaction(alpha) lattice

- Low alpha lattice was tried to see the effect of bunch length on luminosity in July 2001.

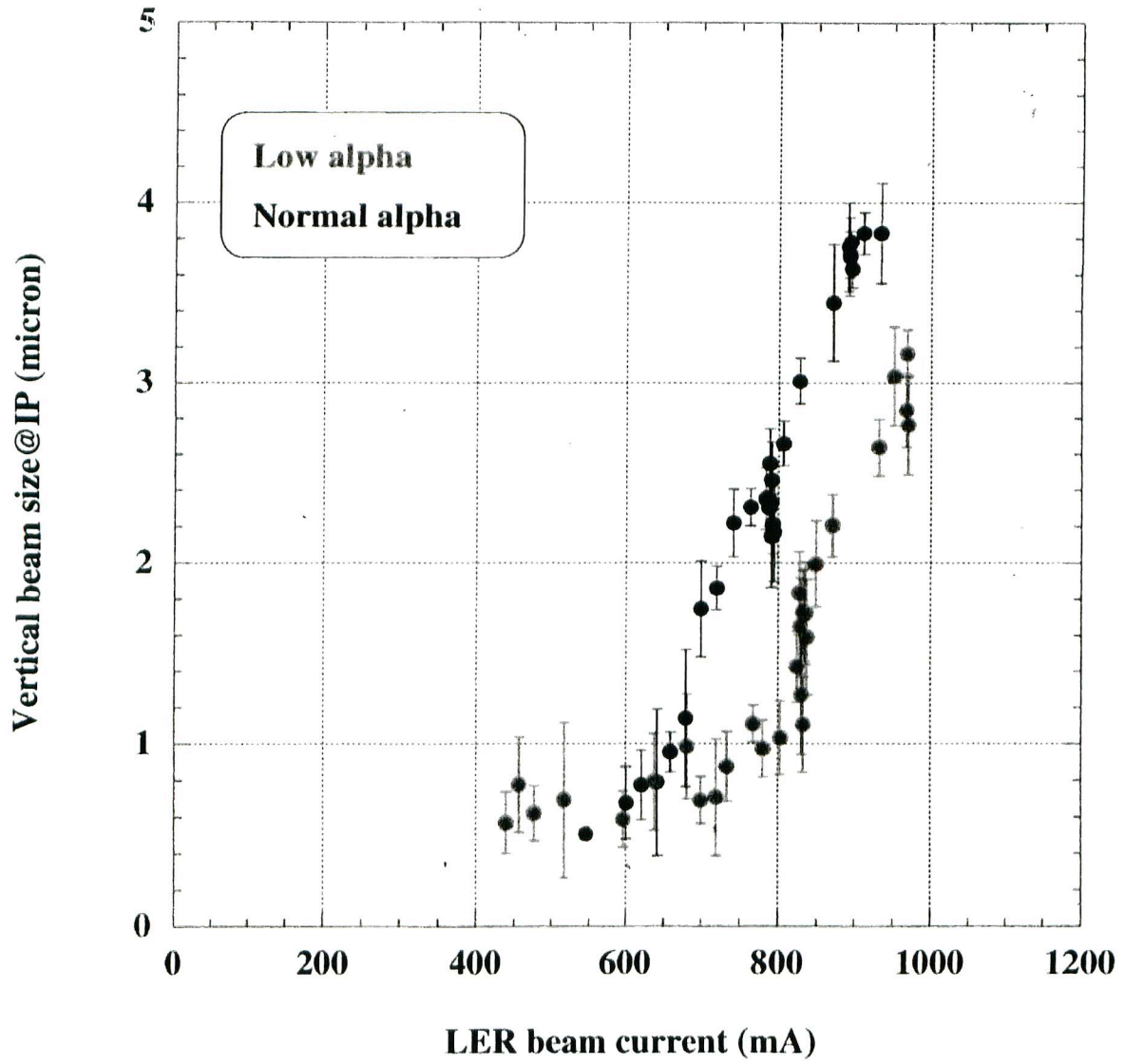
Beam parameters

	Normal alpha	Low alpha
Alpha (10^{-4})	3.41	2.78 (-20%)
Bunch length (mm)	5.5	5.0 (-10%)
Synchrotron tune	0.021	0.019 (-10%)

- Threshold current of the blow-up was slightly decreased in the low alpha lattice.

1/1153/4 4 bucket spacing

15 Jul. 2001



5. Summary

1) Solenoids were added in LER last year.

Now solenoid covers about 95% of drift region in LER.

2) Blowup of beam size was not observed up to 1300mA with 4 rf bucket spacing fill pattern after last installation of solenoid.

3) The effect of solenoid can be seen by a) tune shift and b) growth rate and mode spectrum of coupled bunch instability.