

# **KEKB Status**

**since Feb. 2004**

**H. Koiso**

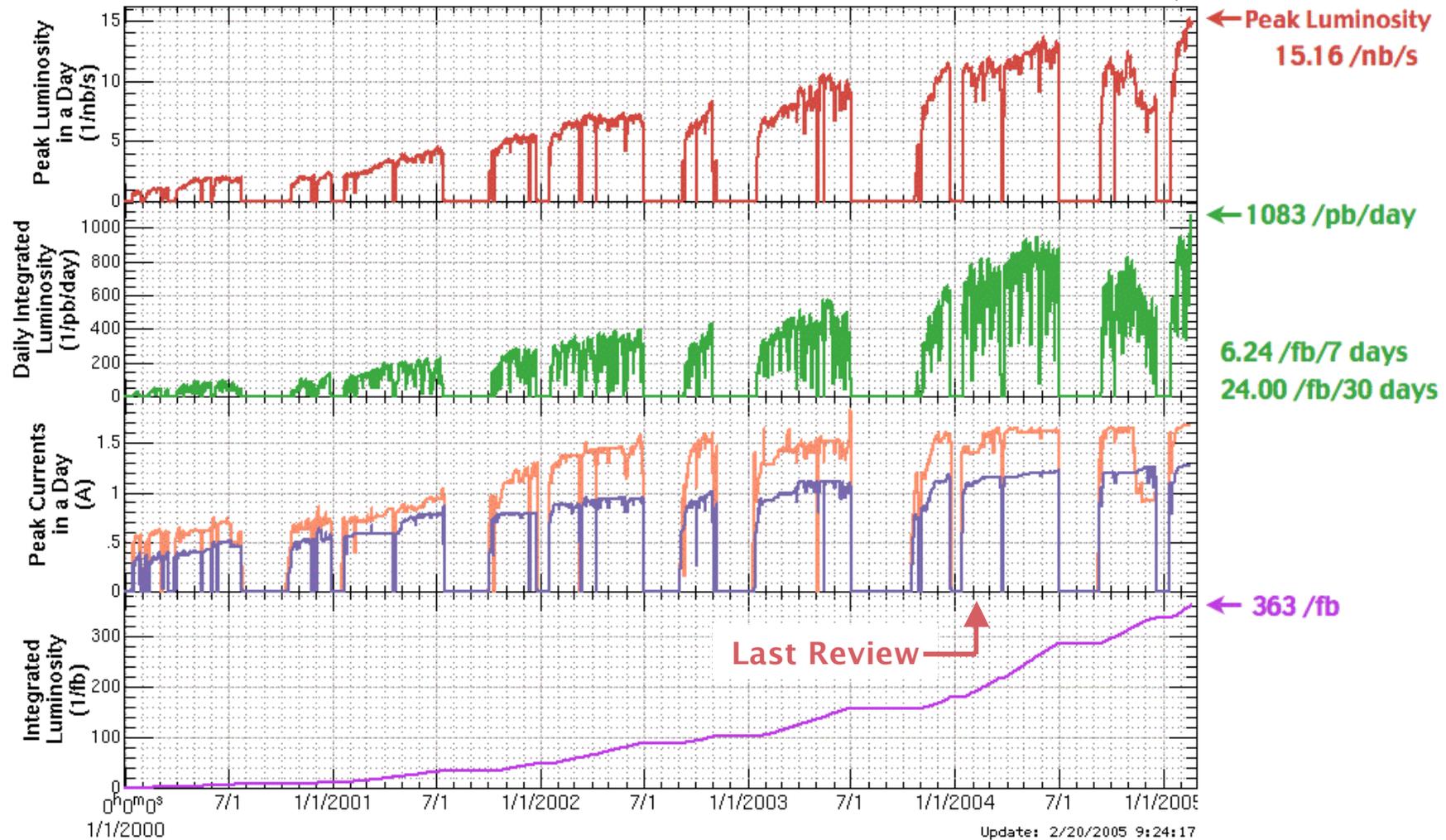
**Feb. 21, 2005 @ KEKB Review**

- **Achieved 15/nb/s**
- **Achieved 1/fb/day**
- **Plans**

# KEKB History

Luminosity of KEBK  
Jan. 2000 - Feb. 2005

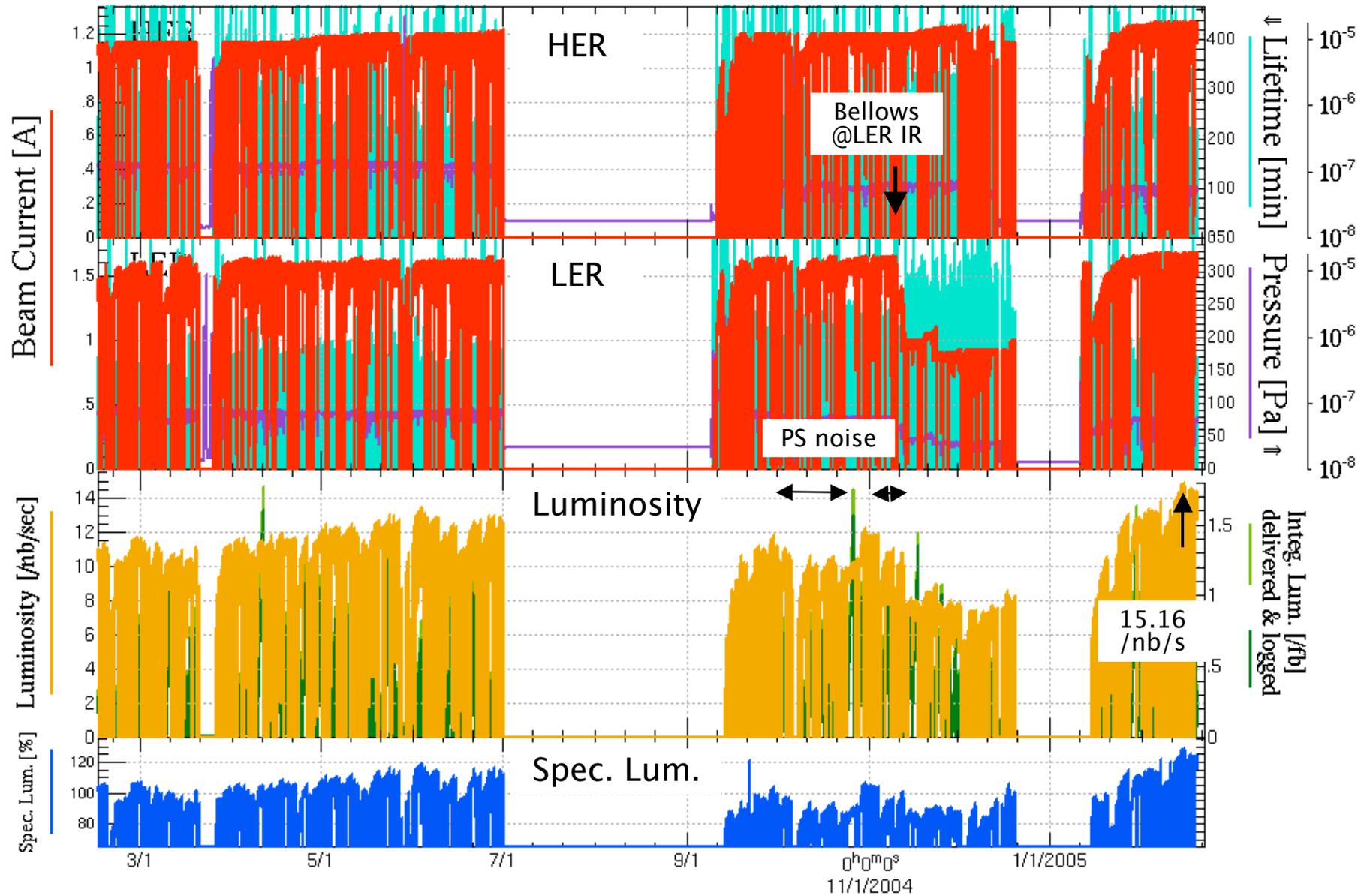
Continuous Injection™



# KEKB Performance Feb. 2004 – Feb. 2005

Peak Luminosity 14.930 [nb/sec] @02/15 02:56  
Integrated Luminosity 154136 [fb]

2/16/2004 0:00 - 2/22/2005 0:00 JST



# Luminosity Performance

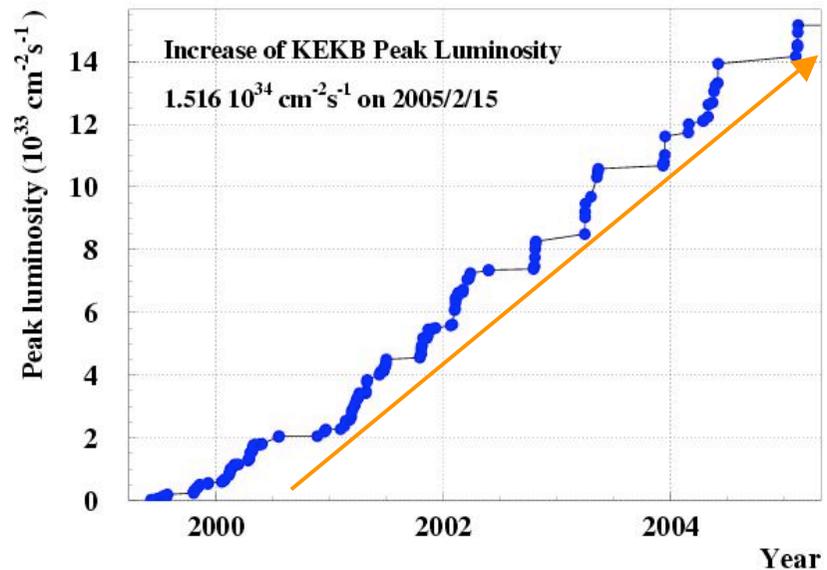
- Both peak and integrated luminosities have been improved.

$$L_{\text{peak}} = 11.61 \rightarrow 15.16/\text{nb}/\text{s}$$

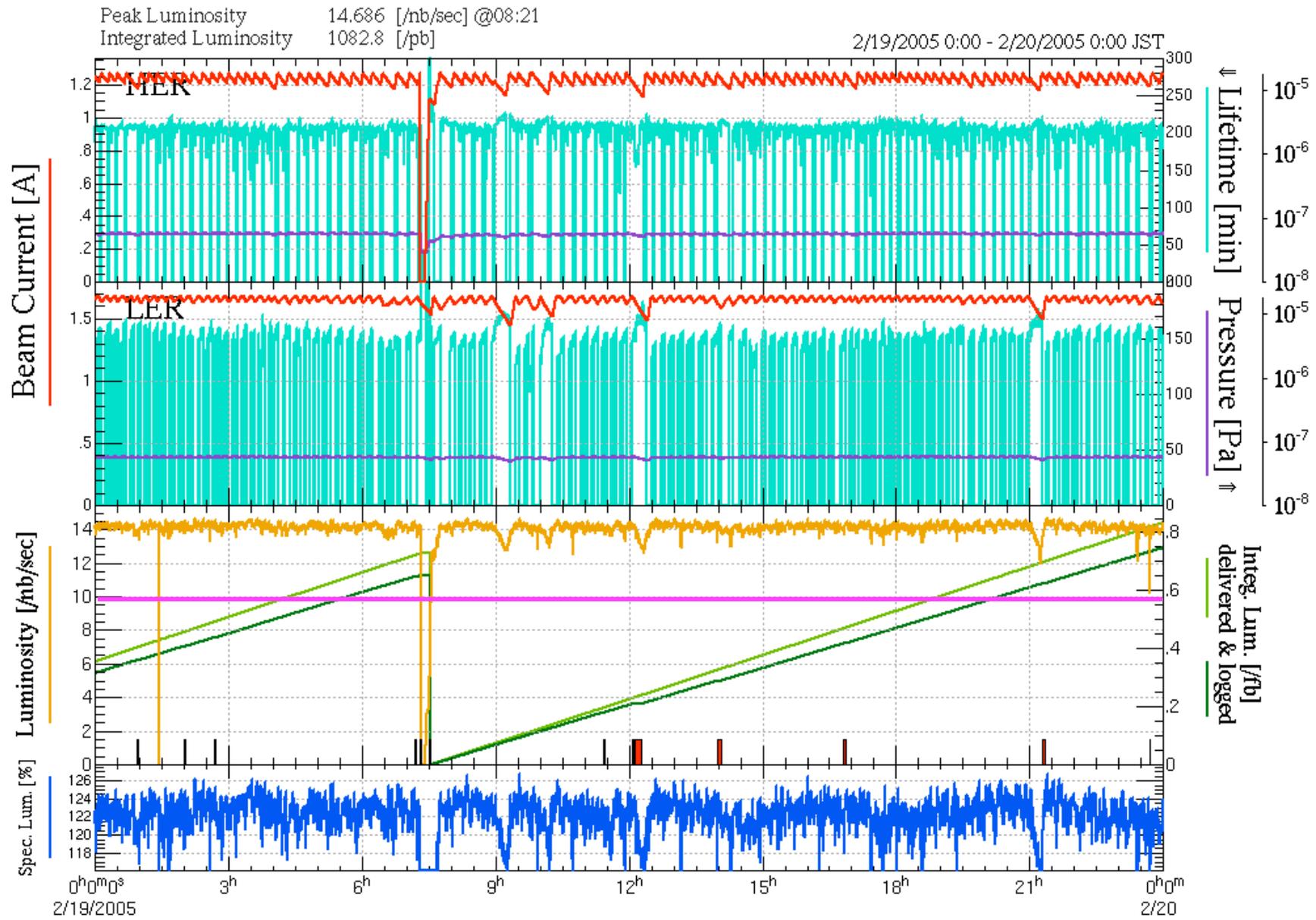
$$\int L/\text{day}, /7\text{days}, /30\text{days}$$

$$= 819/4745/17240 \rightarrow 1083/6242/23995 /\text{pb}$$

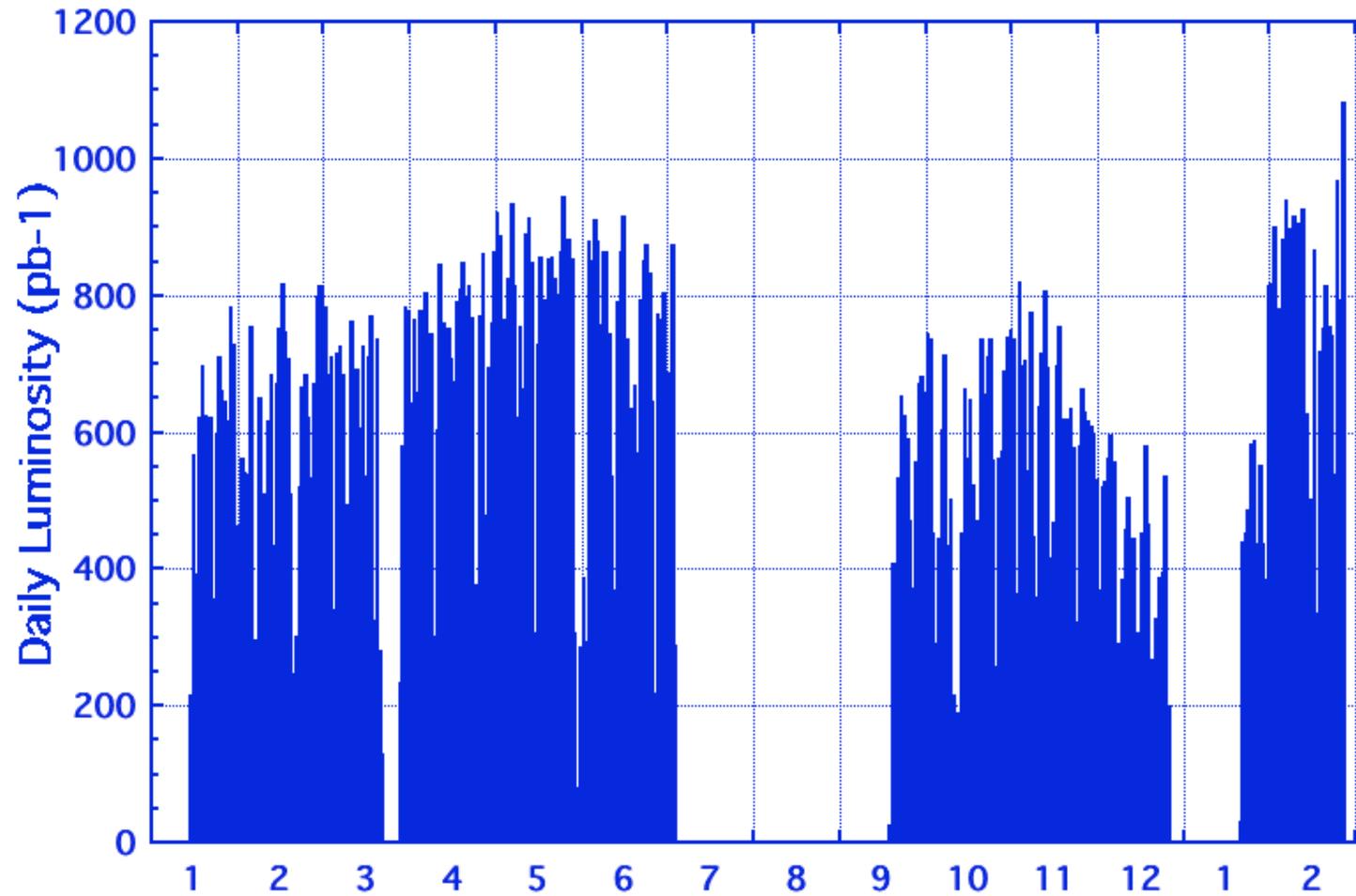
- Total luminosity  $197.5 \rightarrow 363.4/\text{fb}$
- Now we guarantee  $19.5 \rightarrow 25.8/\text{fb}/\text{month}$  to Belle.



# The Best Day 1082.8/pb



# Daily Luminosity since Jan. 2004



# Machine parameters

Date	2/15/2005		12/18/2003		
Ring	LER	HER		LER	HER
Horizontal Emittance	18	24	18	24	nm
Beam current	1636	1261		1503	1132
Number of bunches	1293		1281		
Bunch current	1.27	0.975		1.17	0.884
Bunch spacing	1.8 or 2.4 (3.77sp)		1.8 or 2.4 (3.77sp)		m
Bunch trains	1		1		
Horizontal size at IP $\sigma_x^*$	103	116		103	116
Vertical size at IP $\sigma_y^*$	2.1	2.1	2.3	2.3	$\mu\text{m}$
Emittance ratio $\varepsilon_y/\varepsilon_x$			5.5	3.4	%
$\beta_x^*/\beta_y^*$	59/0.54	56/0.62	59/0.58	56/0.7	cm
Beam-beam parameters					
$\xi_x/\xi_y$	0.118/0.081	0.074/0.056	0.104/0.069	0.071/0.053	
Beam lifetime at collision	160 @1503 mA	195 @1132 mA	125 @1503mA	216 @1132mA	min
Luminosity (Belle Csl)	15.16		11.61	/nb/s	
Luminosity records	(total)				
per day/7 days/30 days	1083/6242/23995 (363.4/fb)		819/4745/17240 (197.5/fb)		/pb

## Machine Parameters (cont'd)

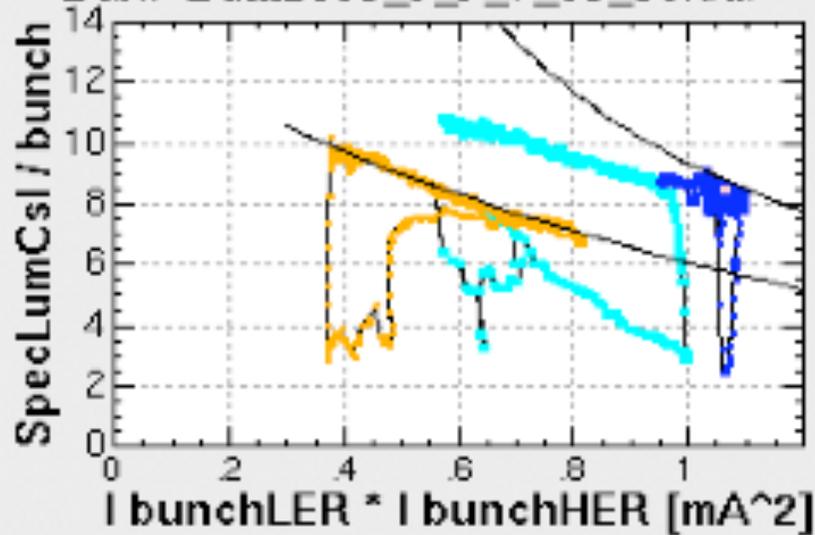
- **Bunch fill pattern/bunch spacing**
  - 3.77 (49/13) + “Breakwater”
  - 3.5 (49/14) Specific luminosity was degraded by 5~10%.
  - 3.06 (49/16) in Dec. 2004
- **Stored currents**
  - LER ~1500 → 1674 mA
  - HER 1187 → 1270 mA world's highest with SCC
- **RF Voltage**
  - LER 8 MV
  - HER 13MV(7 SCCs, before July 2004), 15 MV (8 SCCs)

# Luminosity (3.77 v.s. 3.5)

Y. Funakoshi

Reference: Lum2002\_3\_28\_5\_22\_9.dat

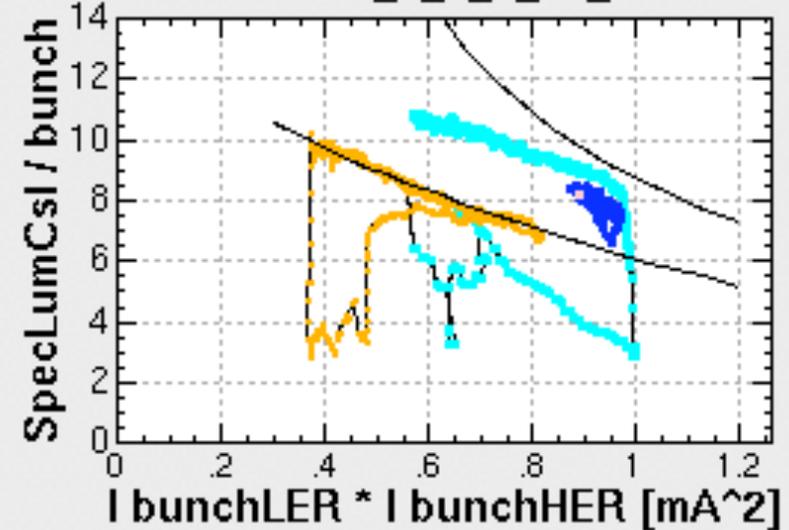
Best: Lum2003\_5\_9\_7\_13\_30.dat



**3.77**

Reference: Lum2002\_3\_28\_5\_22\_9.dat

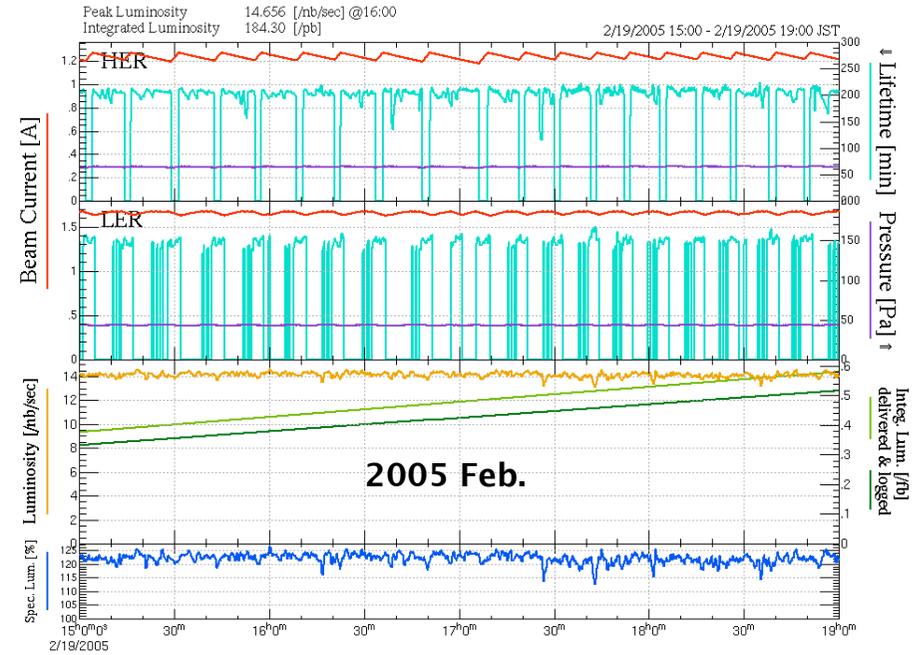
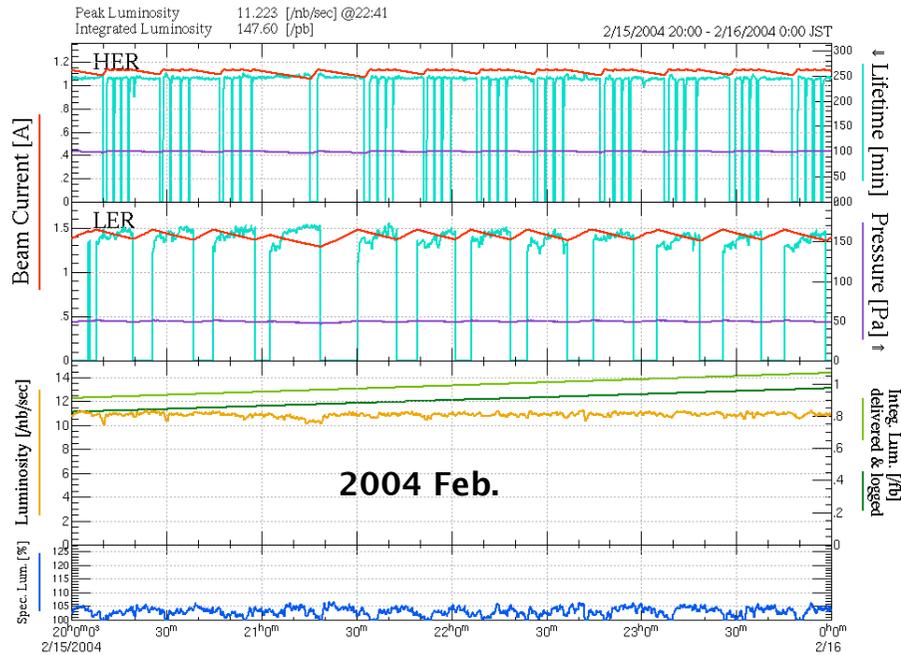
Best: Lum2003\_5\_9\_7\_13\_30.dat



**3.5**

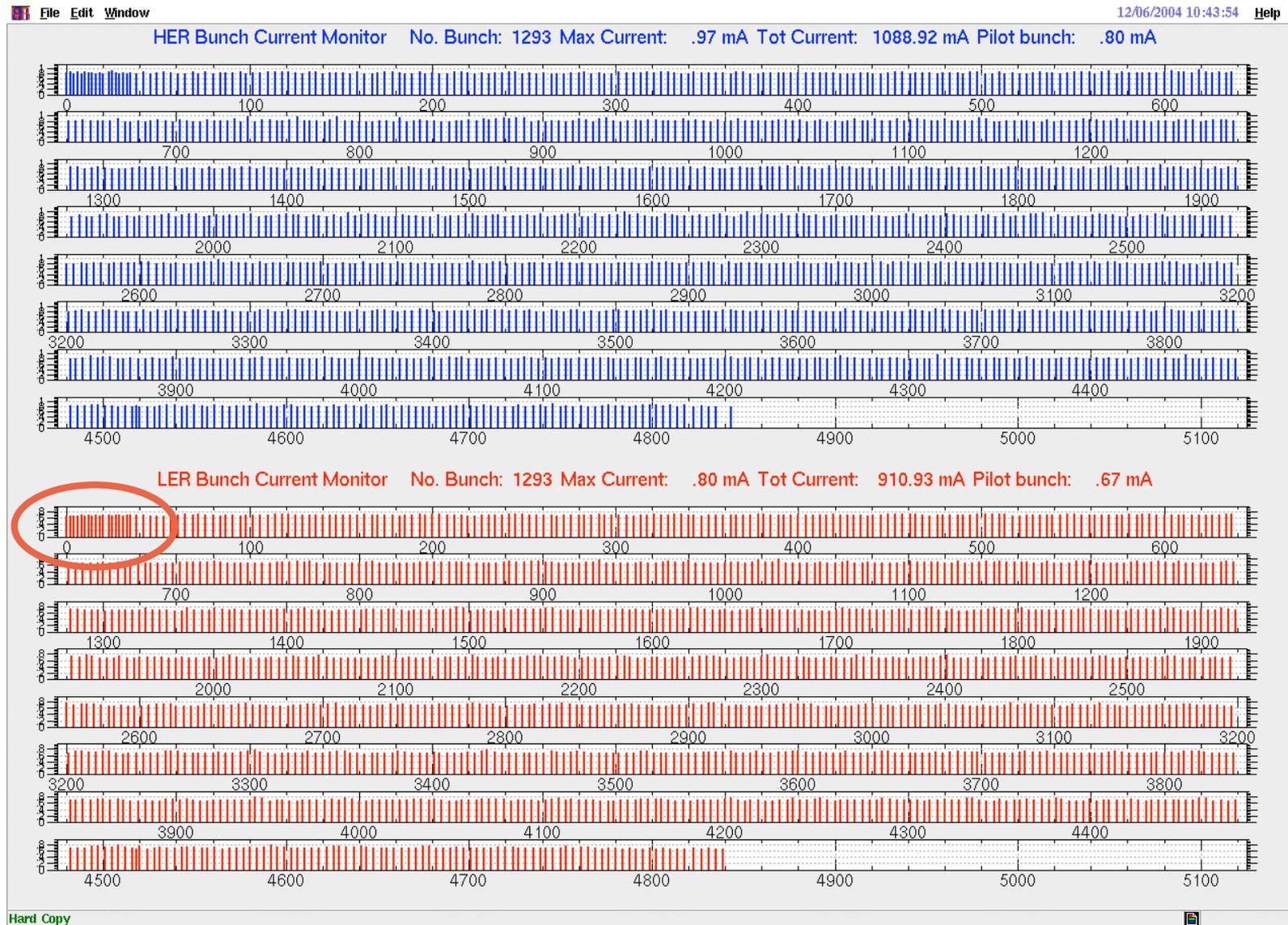
Needs More Study!

# Continuous Injection Mode



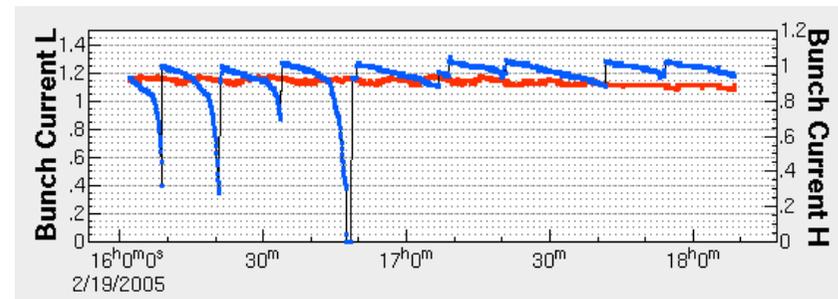
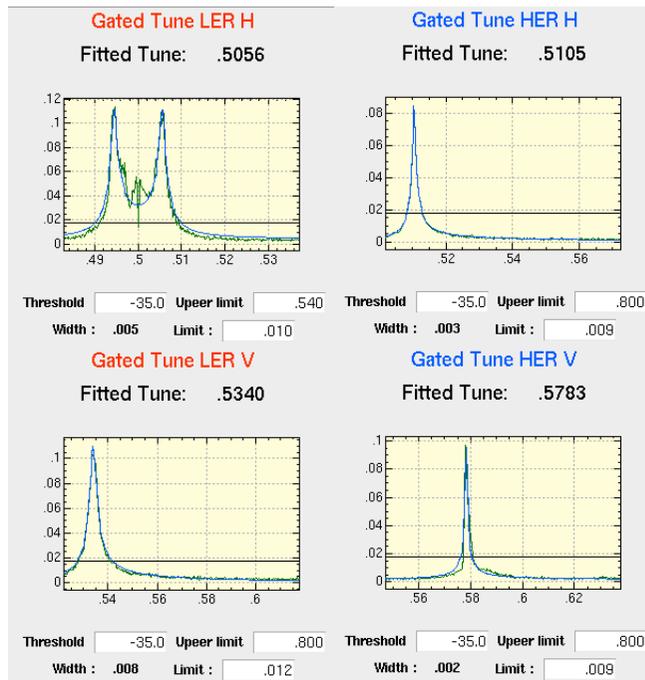
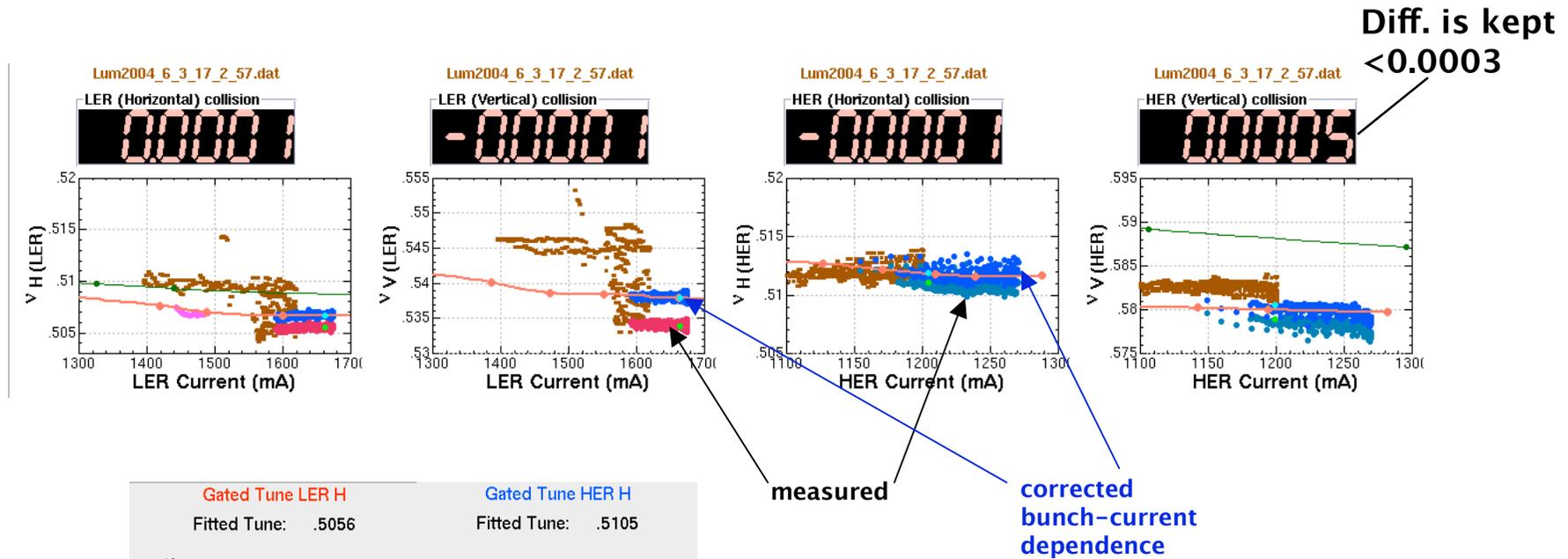
- 3.5 msec veto at injection.
- 10 Hz injection. → 25 and 50 Hz are also available.
- e<sup>+</sup>/e<sup>-</sup> mode change in every 20 min. → 5–10 min.
- Heating of the septum chamber limited LER current. → No clear limit for LER current in < 1800 mA.

# “Breakwater bunches”



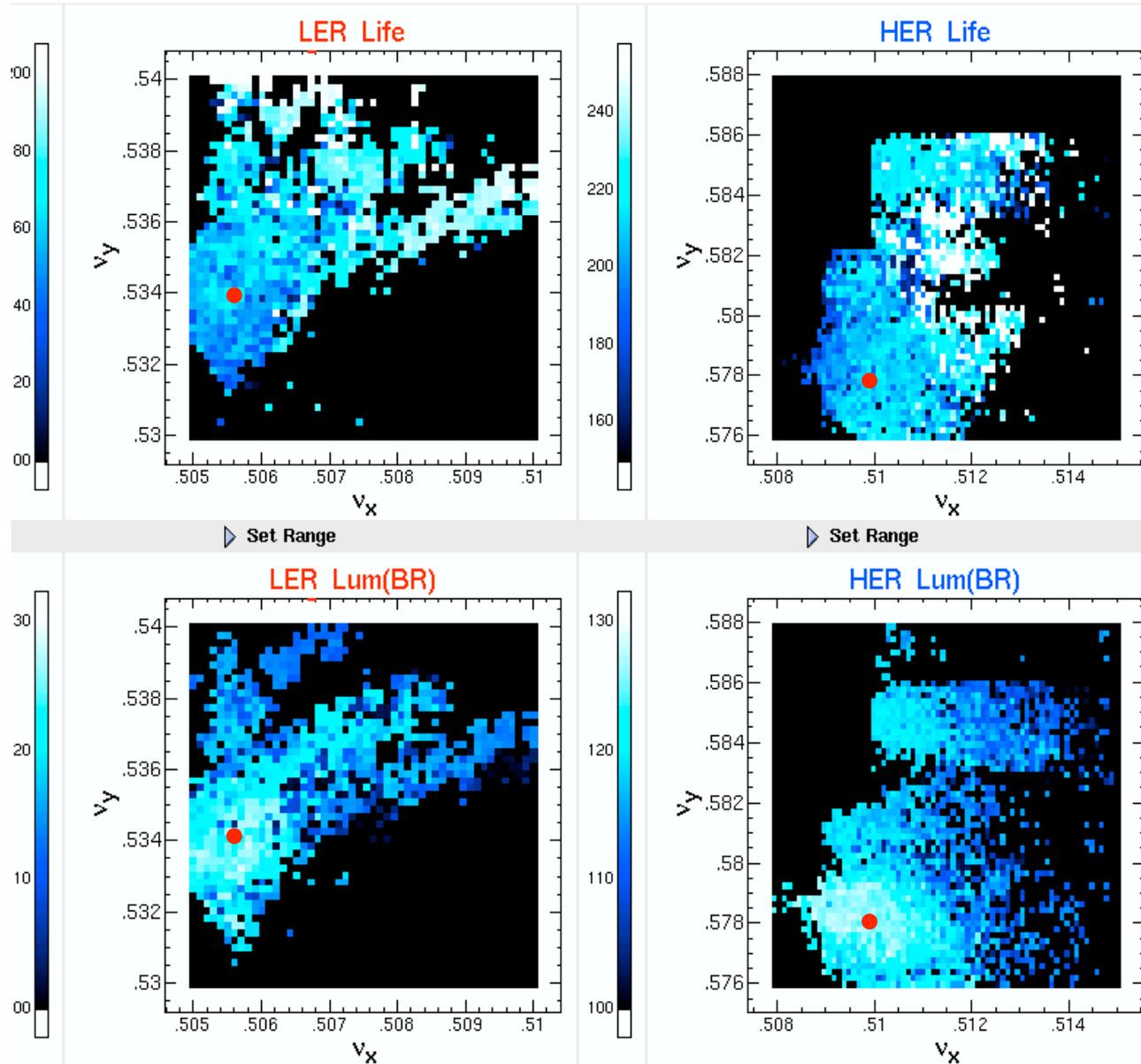
“Breakwater bunches” enables the lower vertical tune.

# Tune Feedback

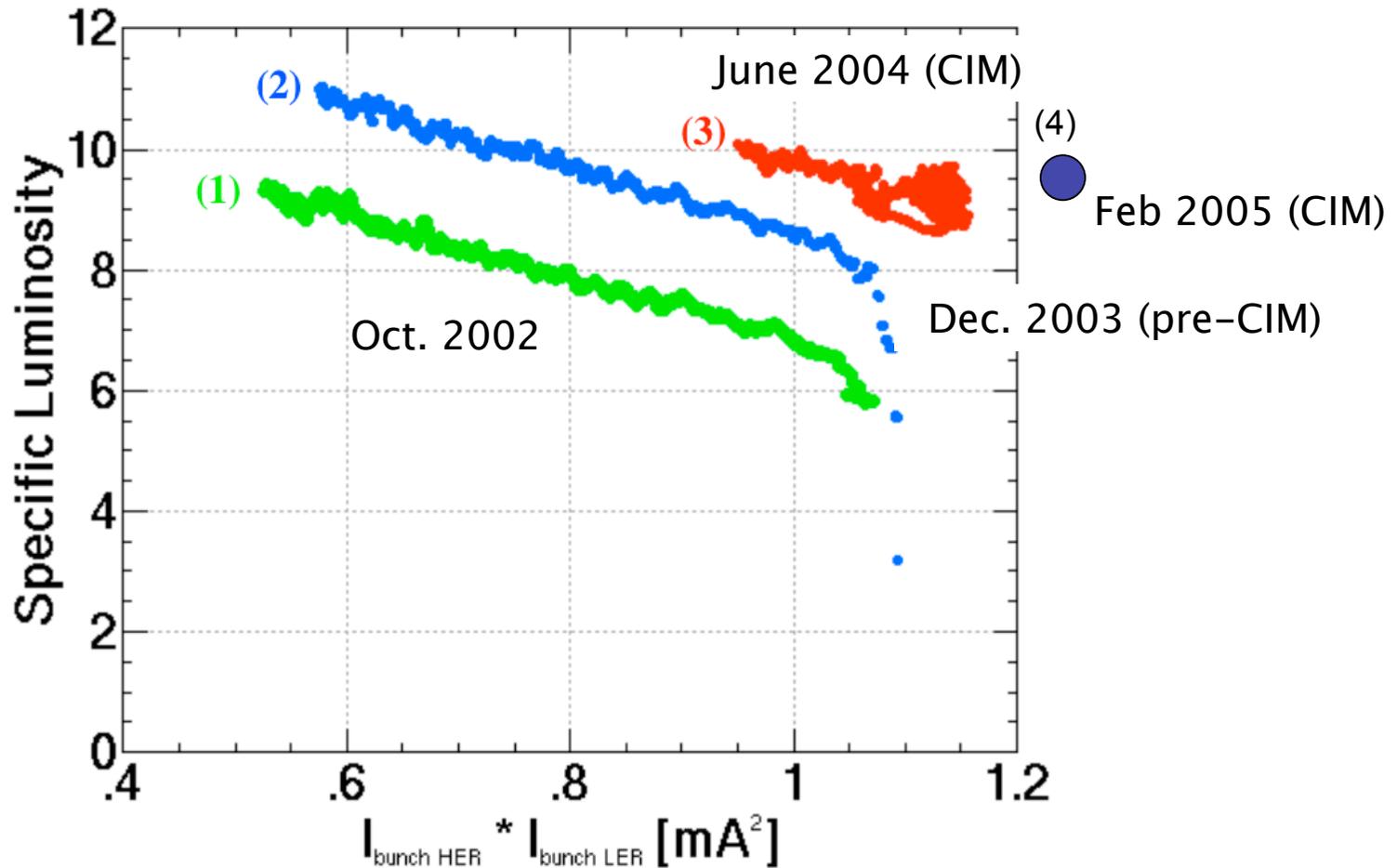


Works very well

# Working Point Survey

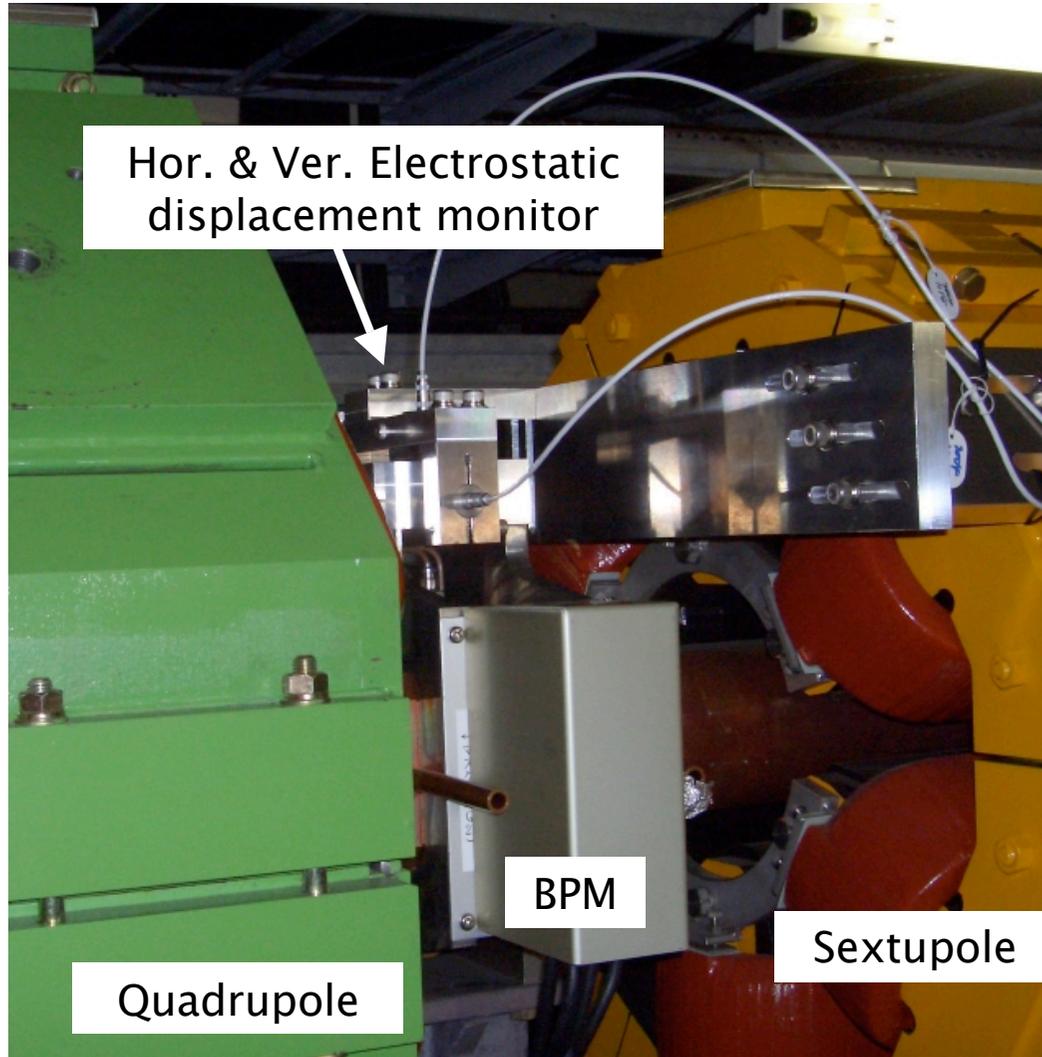


# Progress in the Specific Luminosity



**Both the specific luminosity and the average operating currents are improving.**

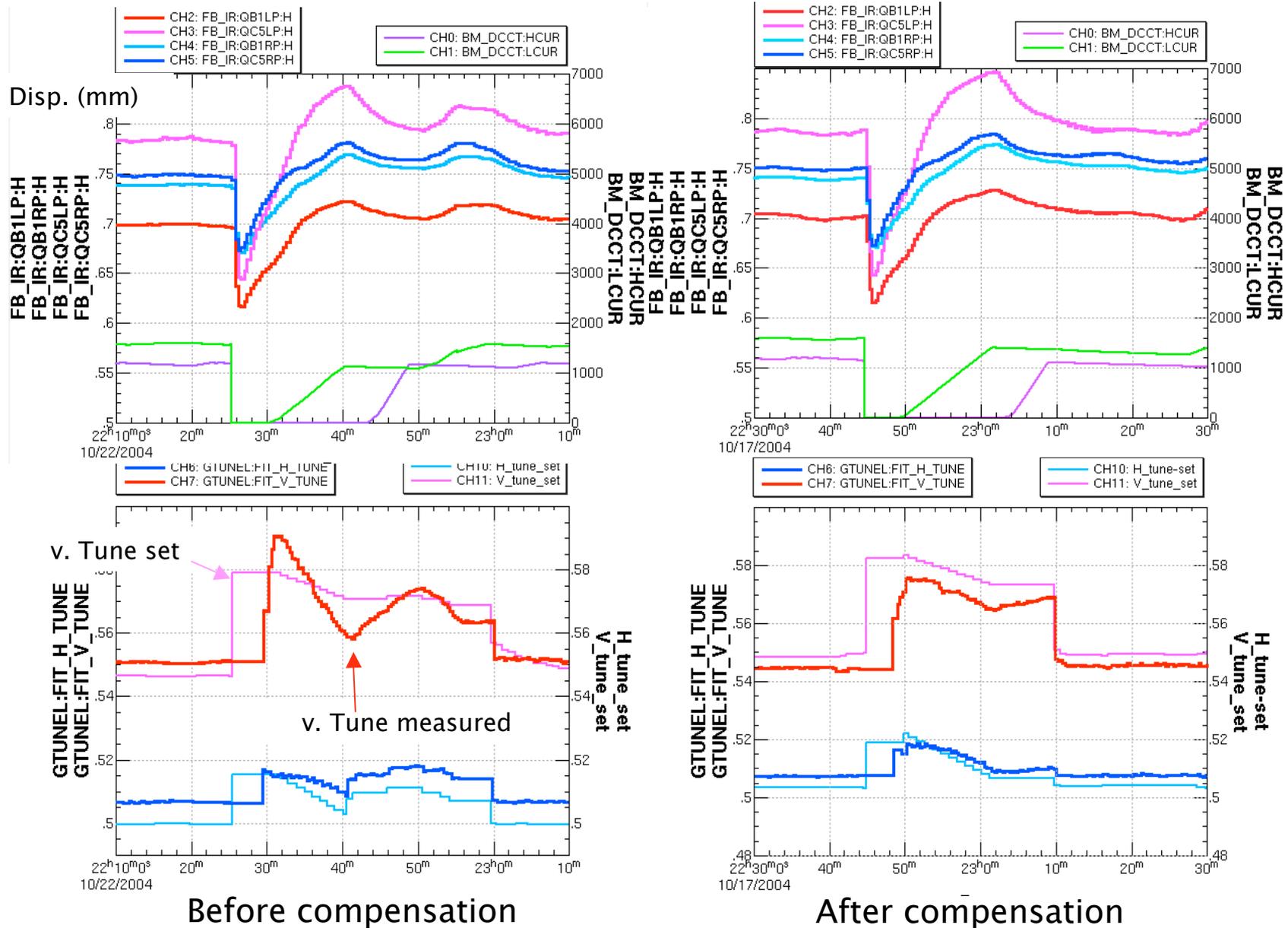
## Detection & compensation of BPM motion relative to sextupole magnet



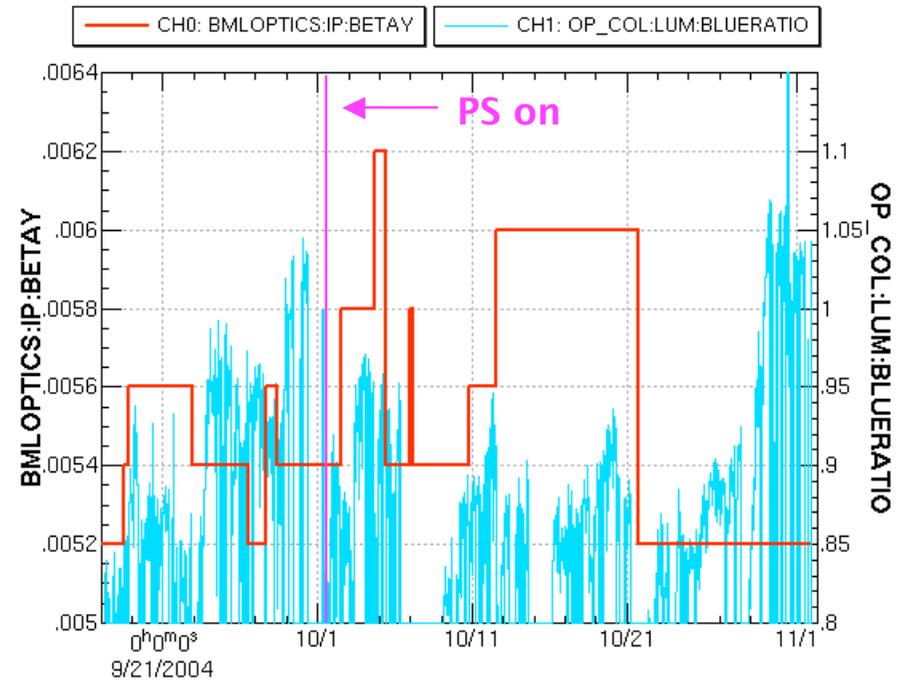
M. Tejima, M. Arinaga, et al

- Heating of beam pipe pushes BPMs and magnets, causing displacement of BPMs relative to sextupoles.
- Electrostatic gauge was attached to sextupoles in **LER local chromaticity correction section** to measure the BPM displacement.
- Correction is added to BPM reading to stabilize orbit relative to sextupole center.
- Very good result.
- Necessary for all sextupoles in future.
- Must be compatible with sextupole movers.

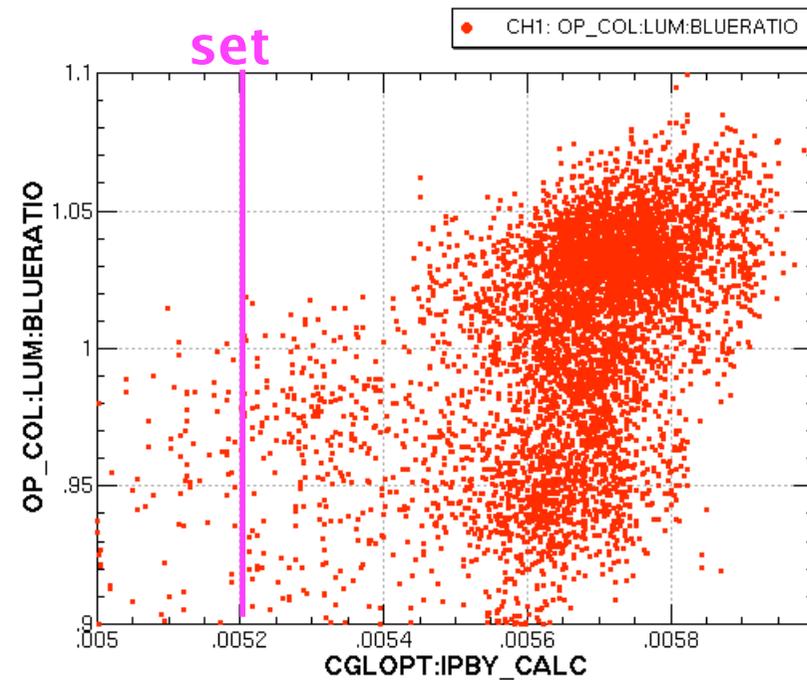
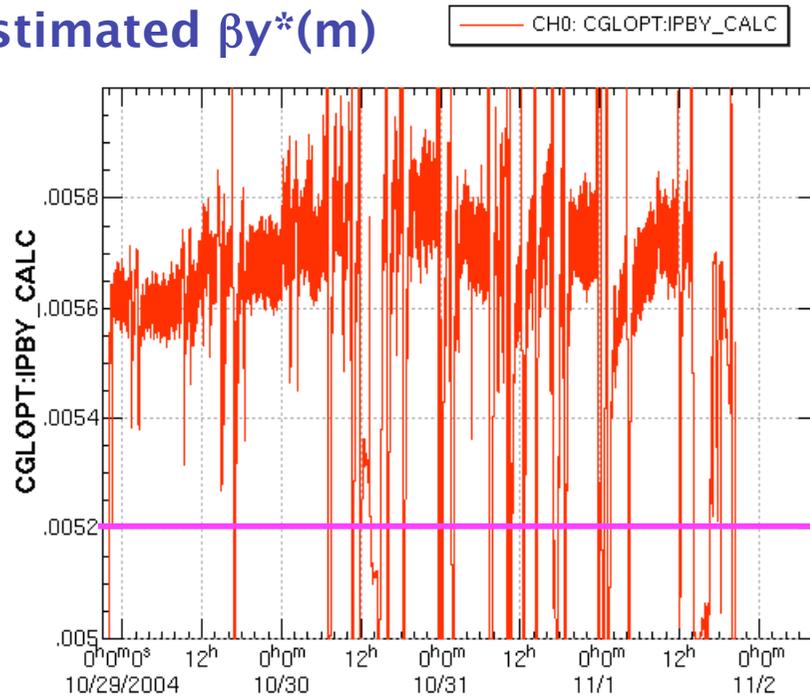
# BPM gauge was effective to suppress the tune drift.



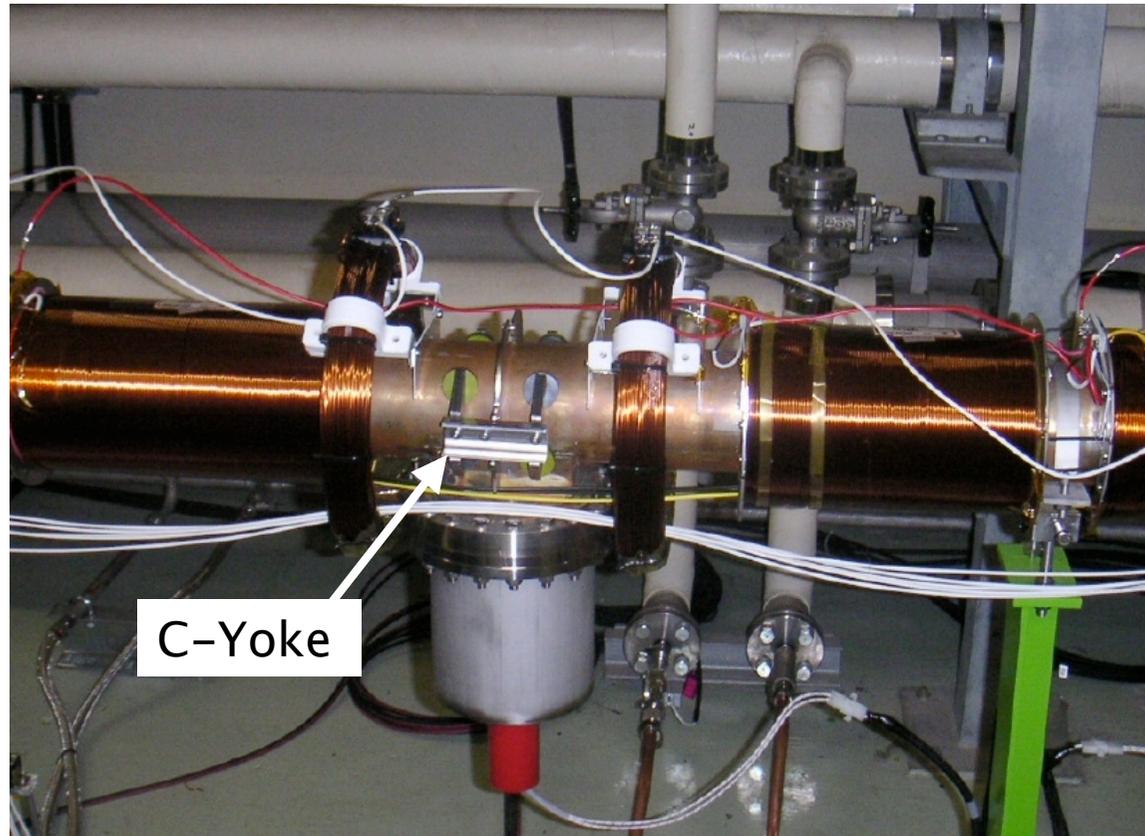
# Drift of $\beta y^*$ due to BPM motion



## Estimated $\beta y^*(m)$



# Permanent magnets (“C-Yoke”) in LER

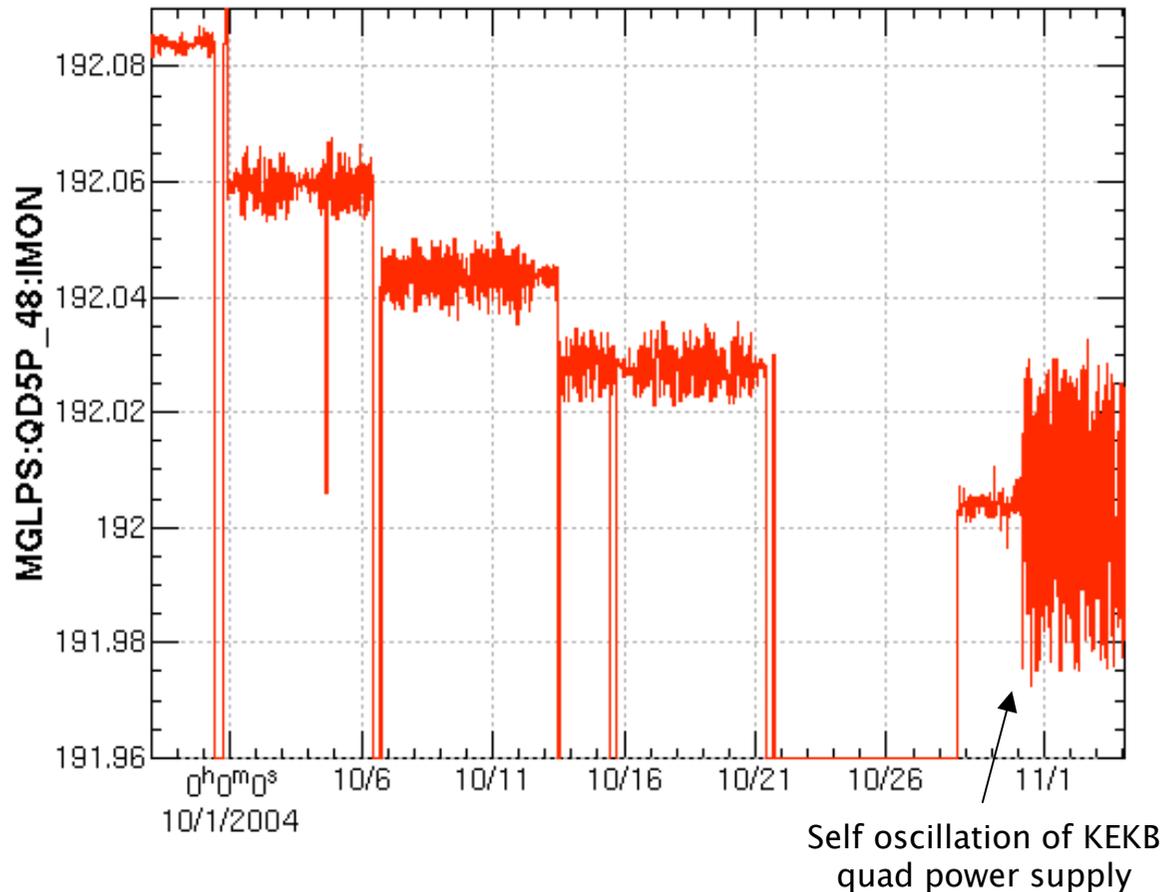


- 1,600 sets of C-Yokes were installed in LER at gaps of solenoids.
- Effects are not yet noticed.

M. Suetake and H. Fukuma

# Noise from KEK Proton Synchrotron(PS)

PS 12 GeV, 2.2 sec (for K2K)



- Power supplies for KEKB quadrupoles were affected by PS, probably through magnetic flux change.

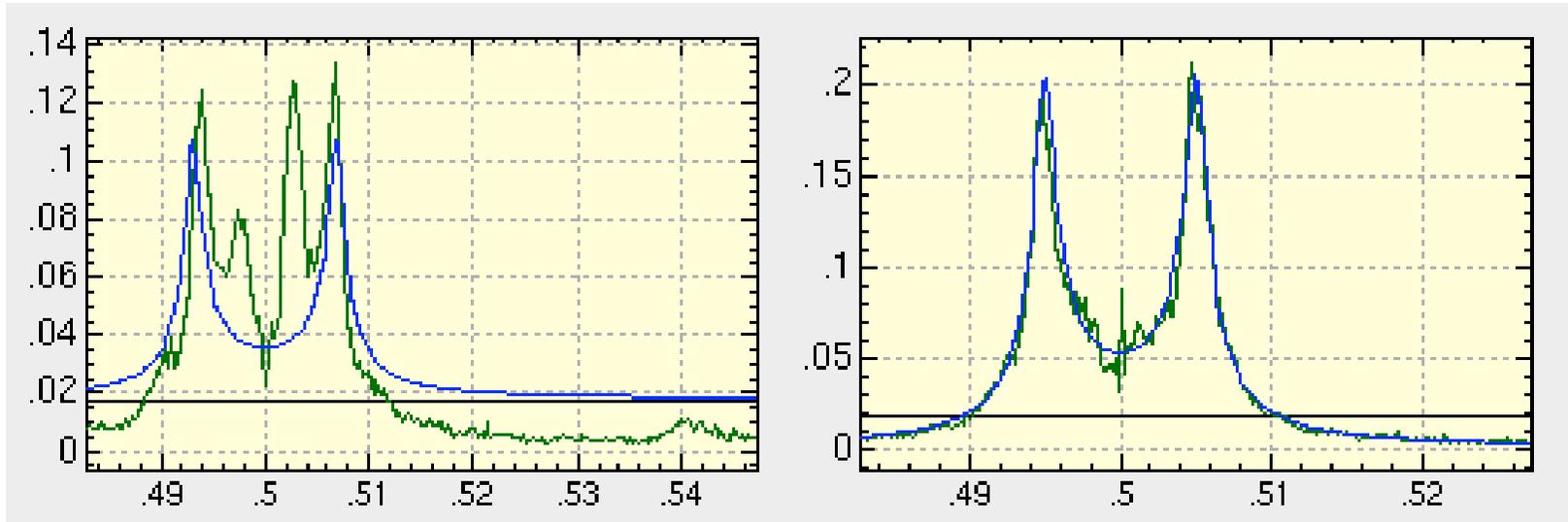
- Tunes of KEKB rings were modulated.

- Improved by making the power supplies' response faster, but...

$$\Delta\nu_y \sim 0.0033 \text{ (p-p)}$$

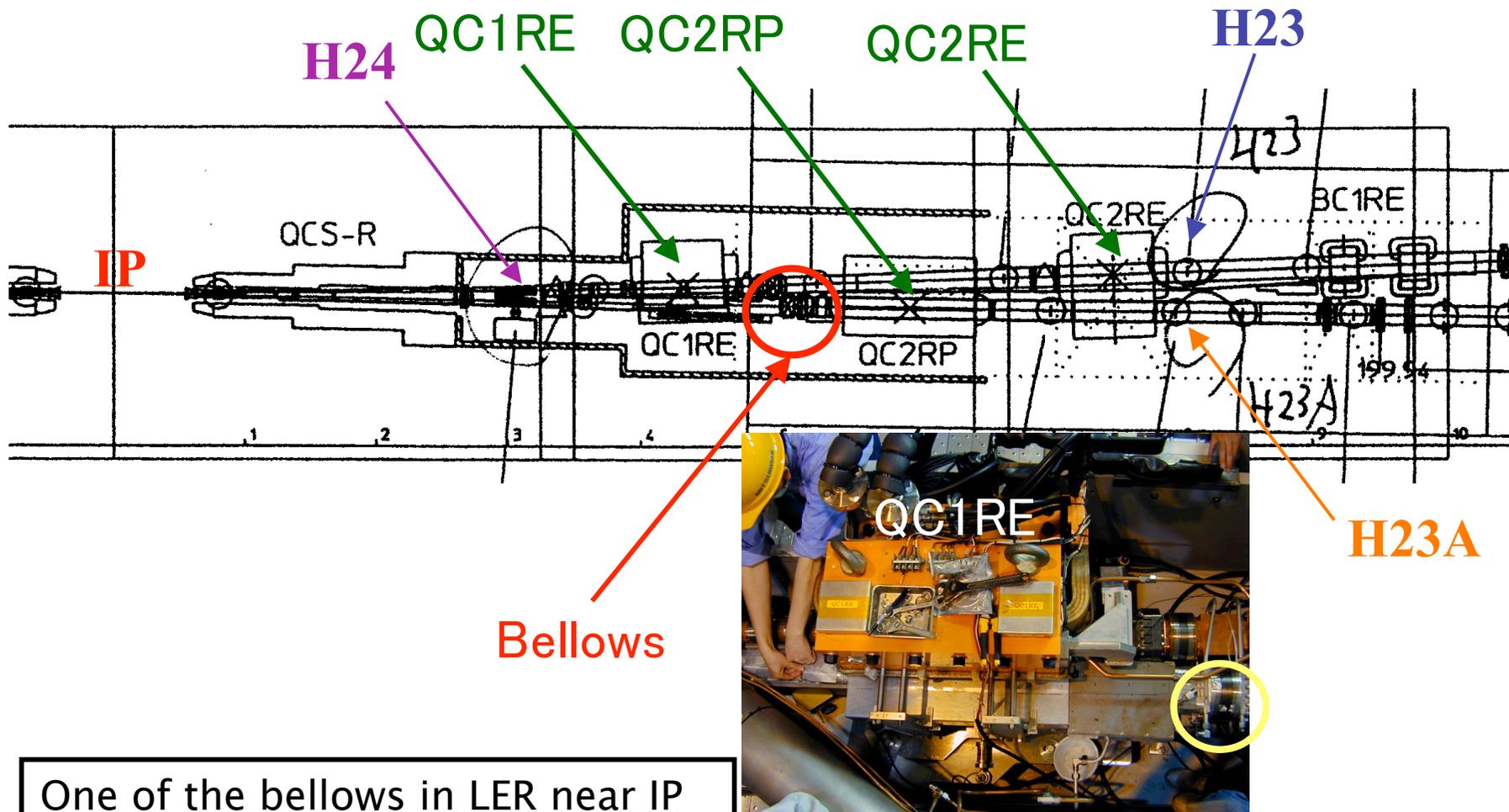
- Later PS went shut down by failure in the electro-magnetic horn.

# Tune modulation by PS



- **Horizontal tune of LER was modulated by PS (left). The luminosity degraded by more than 10%.**
- **After fastening the response of quad power supplies, the modulation was reduced (right).**
- **The luminosity was recovered by this fix.**

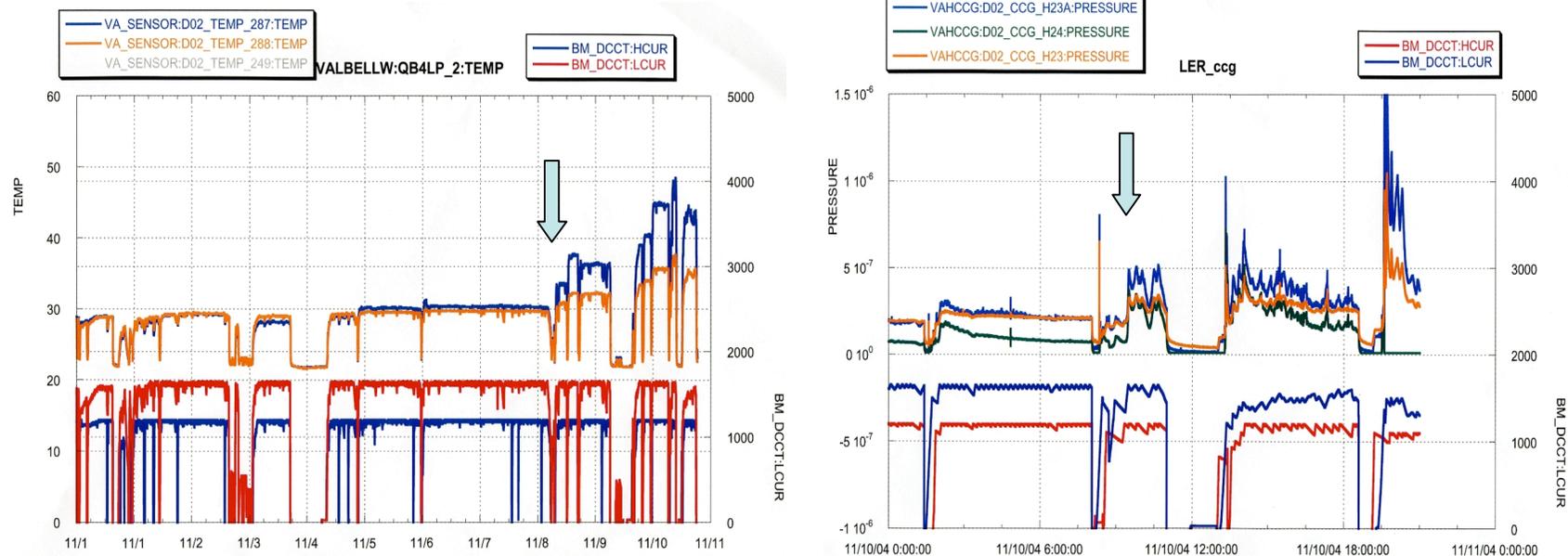
# Trouble of LER IR Bellows



One of the bellows in LER near IP was damaged around Nov. 3.

K. Kanazawa,  
Y. Suetsugu et al

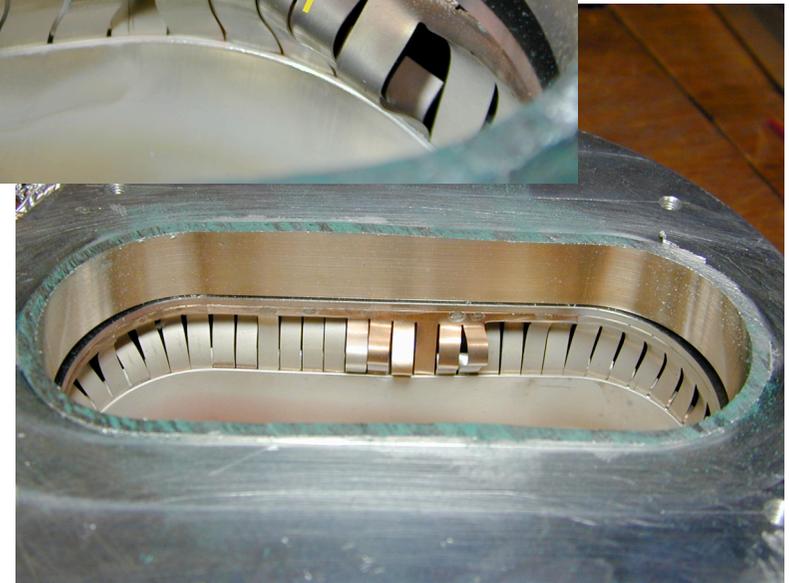
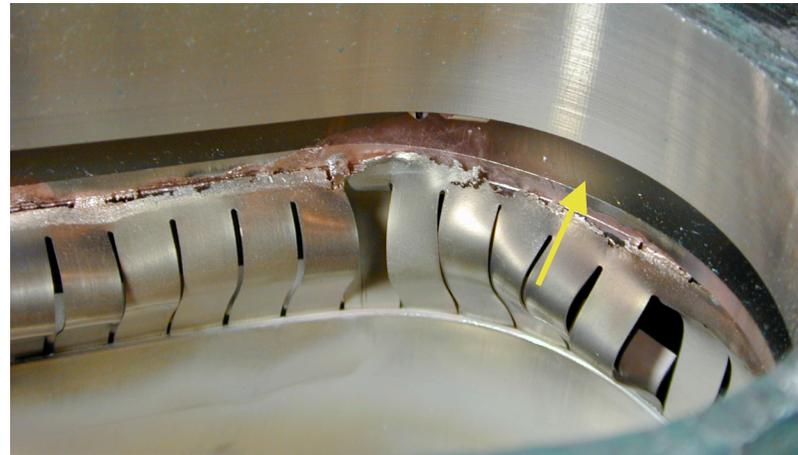
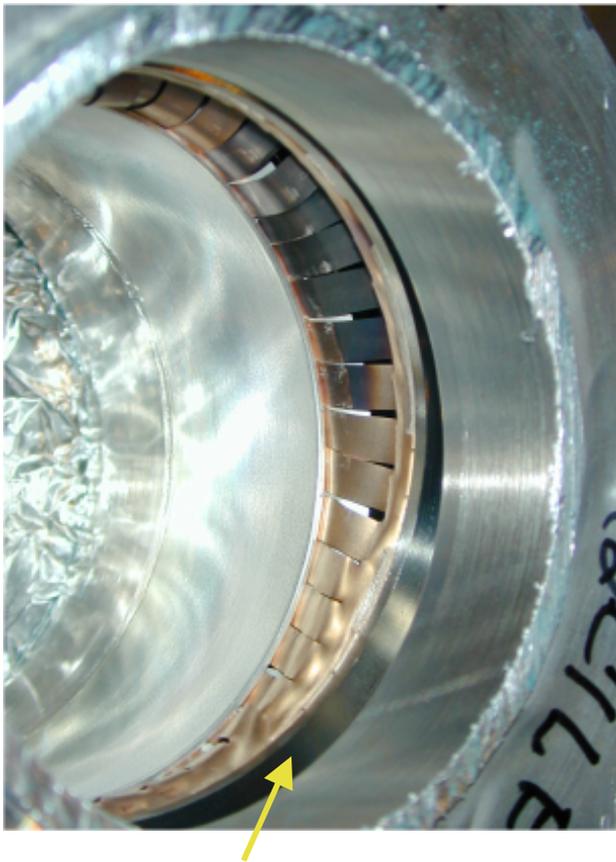
# IR Bellows



- Both temperature (left) and pressure (right) rose at high current.
- Since then, LER current has been limited to below 900 mA (was 1650 mA before).
- Operating at very bad current ratio degrades the specific luminosity.
- The bellows were fixed during the winter shutdown.

# Similar Troubles at IP Bellows

- HER QC1LE bellows in March 2004.
- LER QC1RE bellows in Nov. 2004.
- They were replaced to new bellows with more welding points to fix fingers.



The RF contact was separated from the chamber.

K. Kanazawa,  
Y. Suetsugu et al

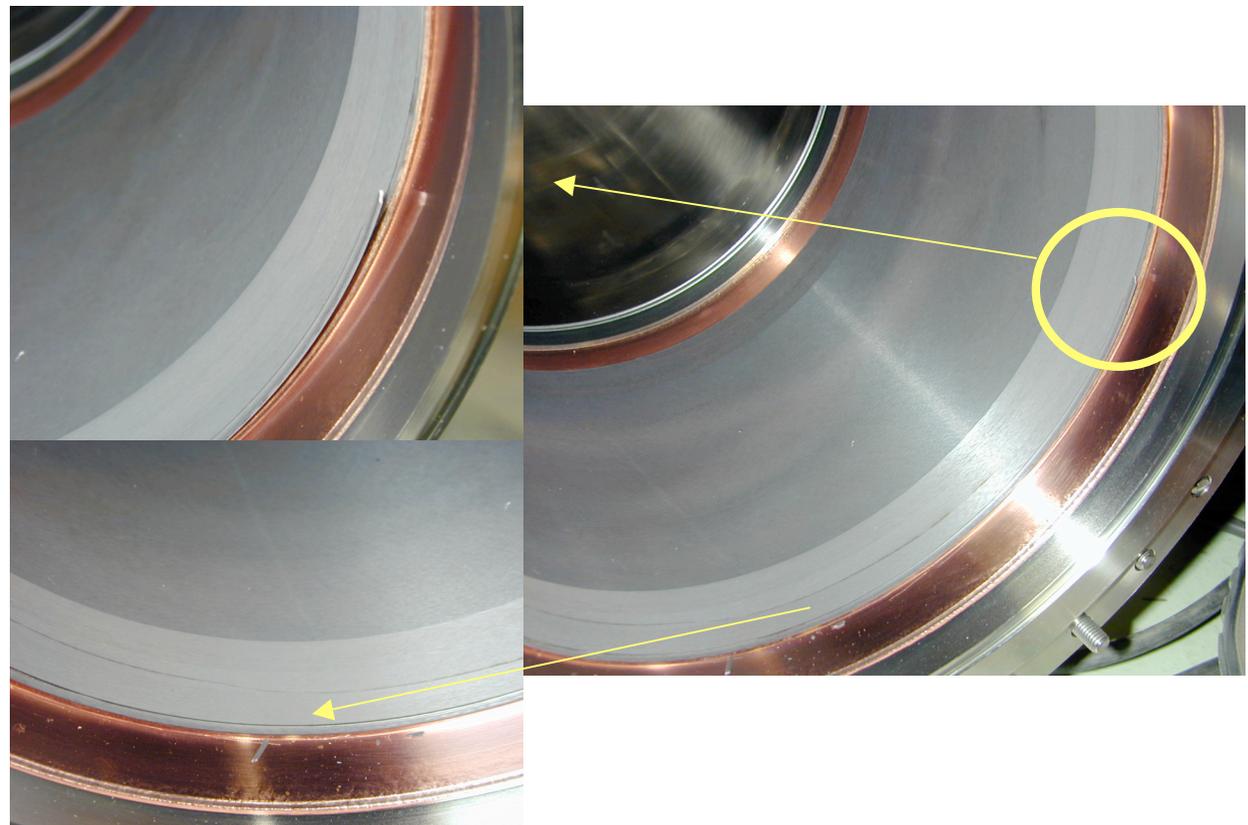
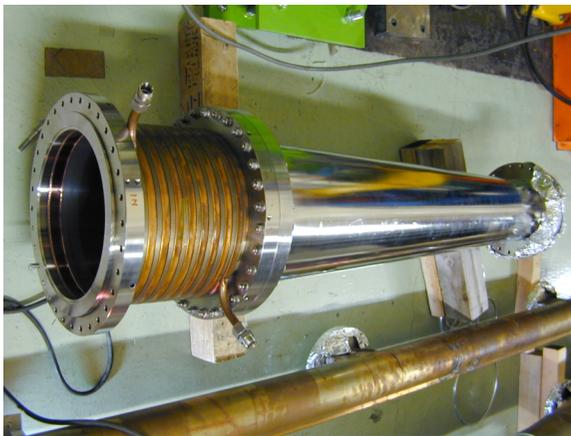
# Replacement of Vacuum Chamber in HER IR

- Replaced on both R&L sides
- cavity structure → straight
- HOM absorbers were damaged.



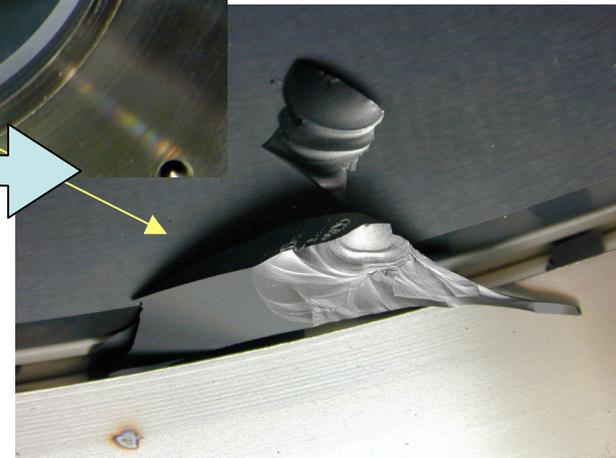
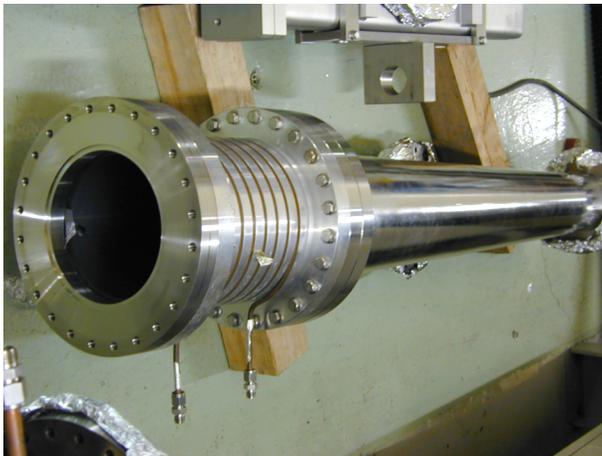
drift space reserved for a crab cavity

# Damaged HOM Absorber – Ferrite

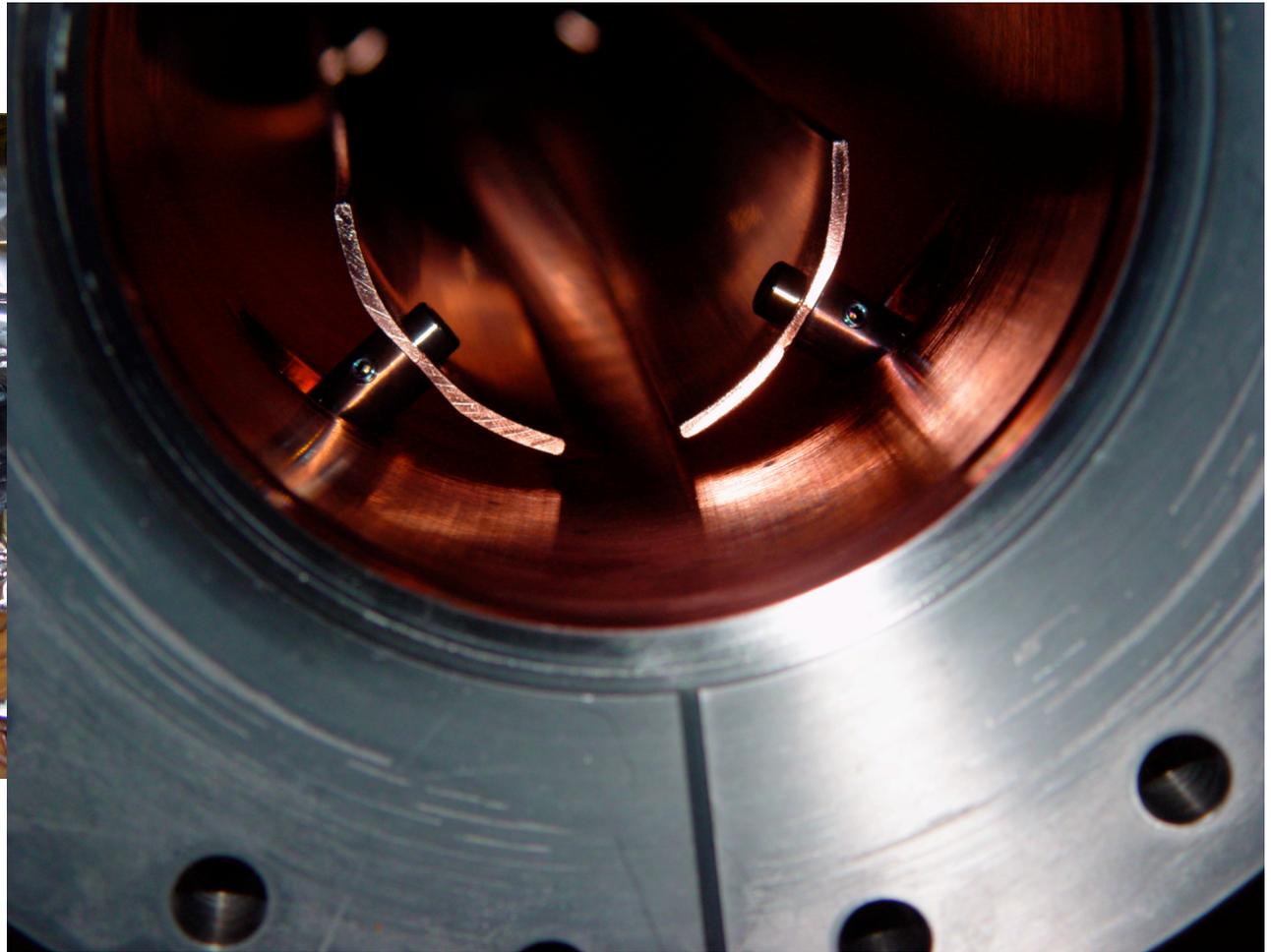


Y. Suetsugu, et al.

# Damaged HOM Absorber – SiC



## Troubles on Transverse Feedback Kicker

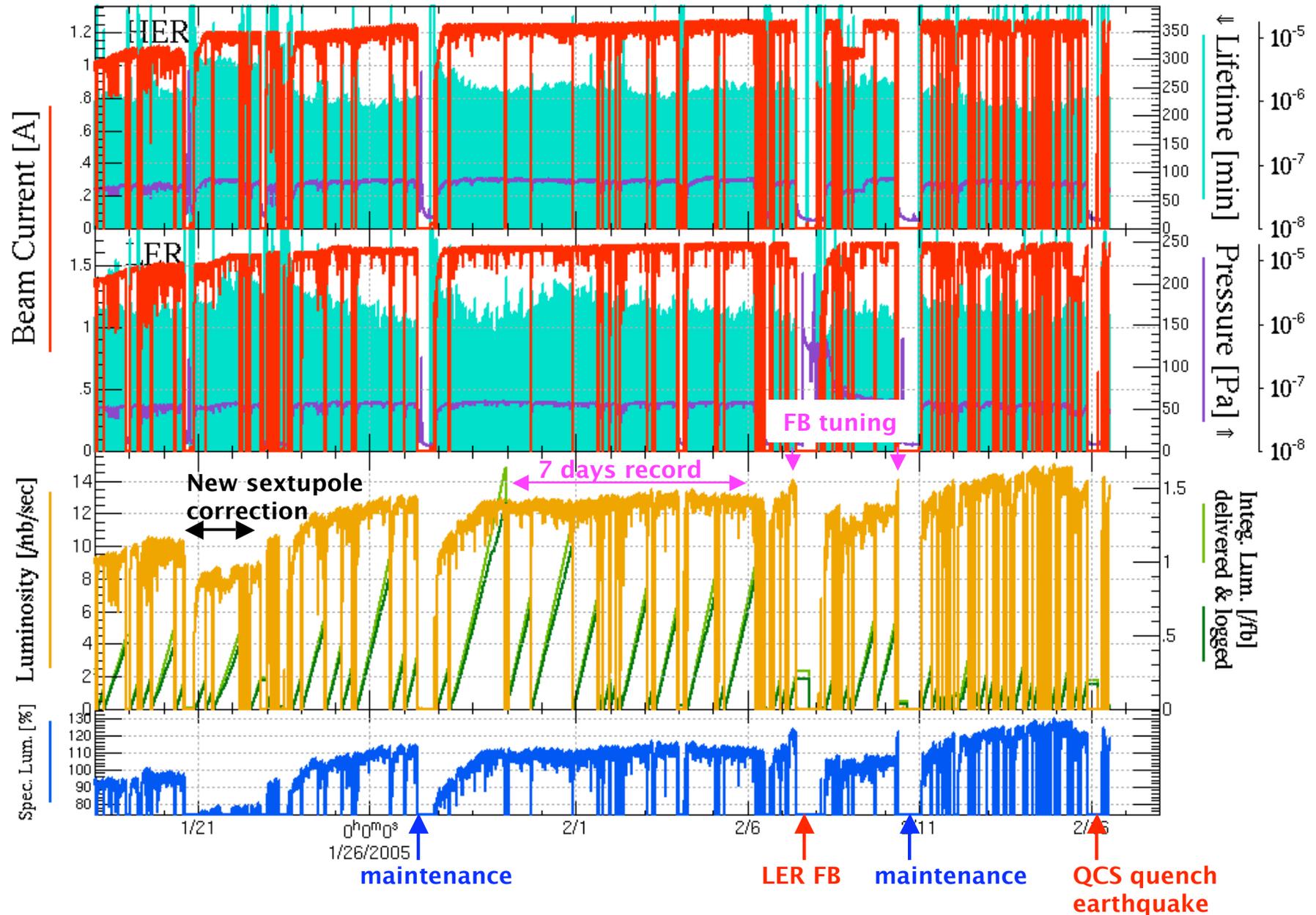


**Two Cu electrodes on the down side were damaged.  
They were replaced to new SUS electrodes with Cu coating.  
Feed through connectors were also replaced.**

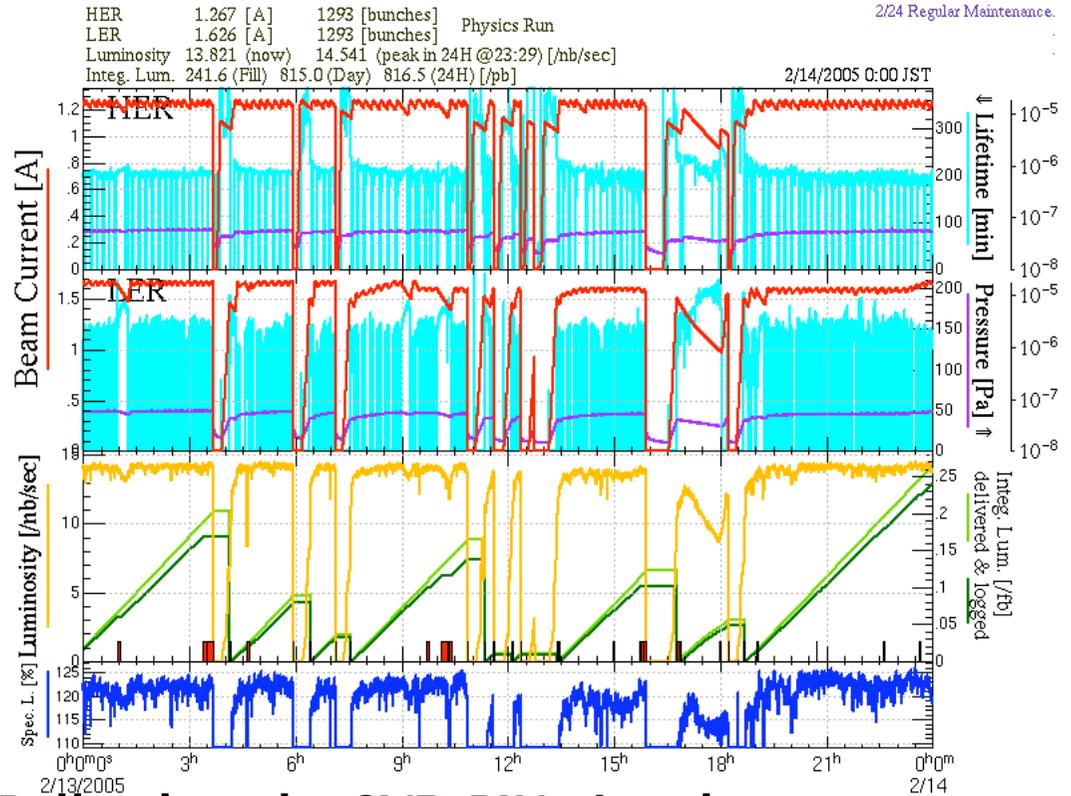
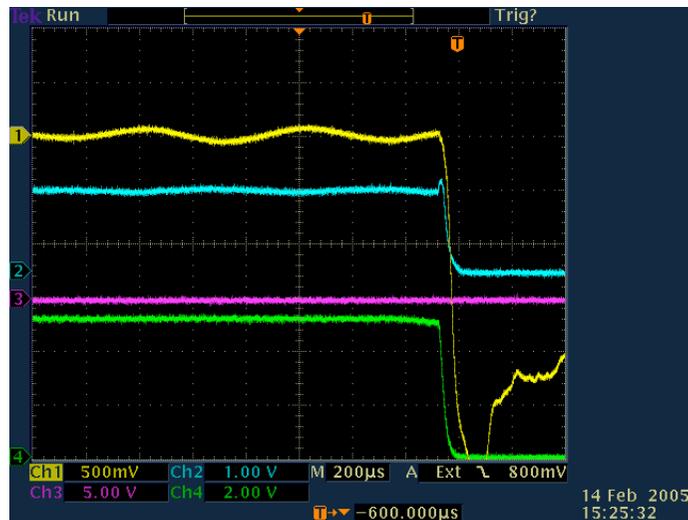
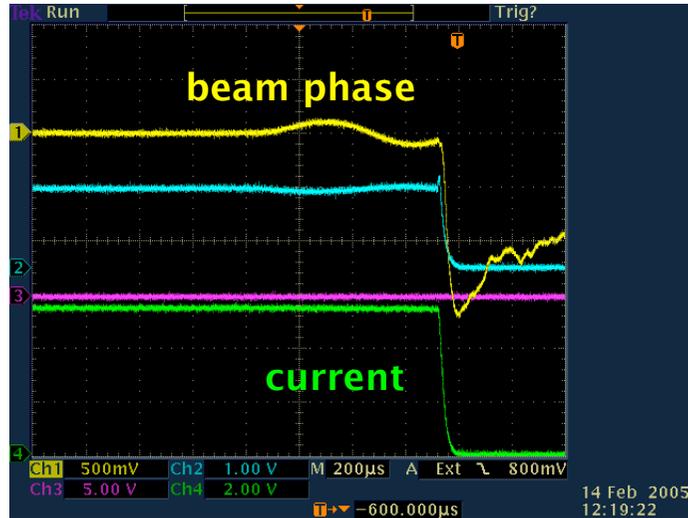
# Recent Performance

Peak Luminosity 15.056 [nb/sec] @02/14 22:20  
 Integrated Luminosity 20368. [pb]

1/18/2005 0:00 - 2/18/2005 0:00 JST



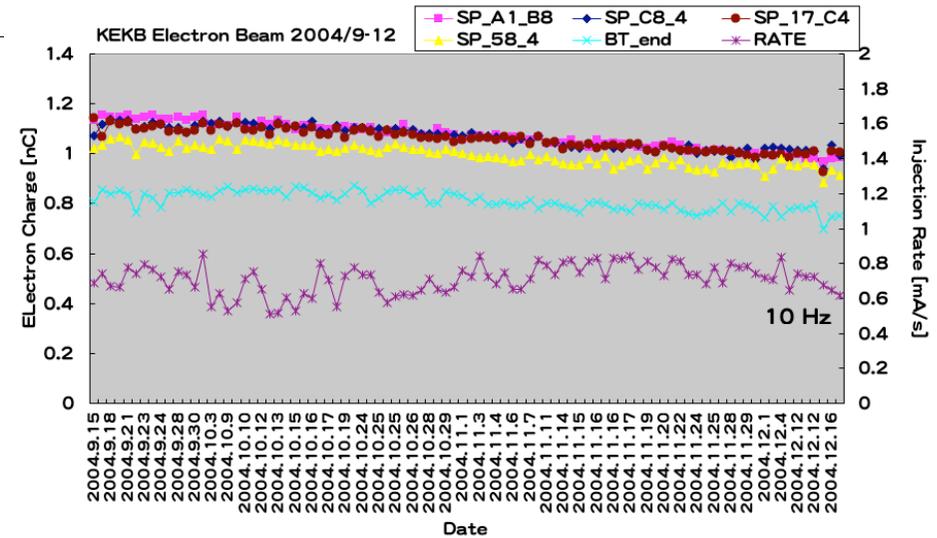
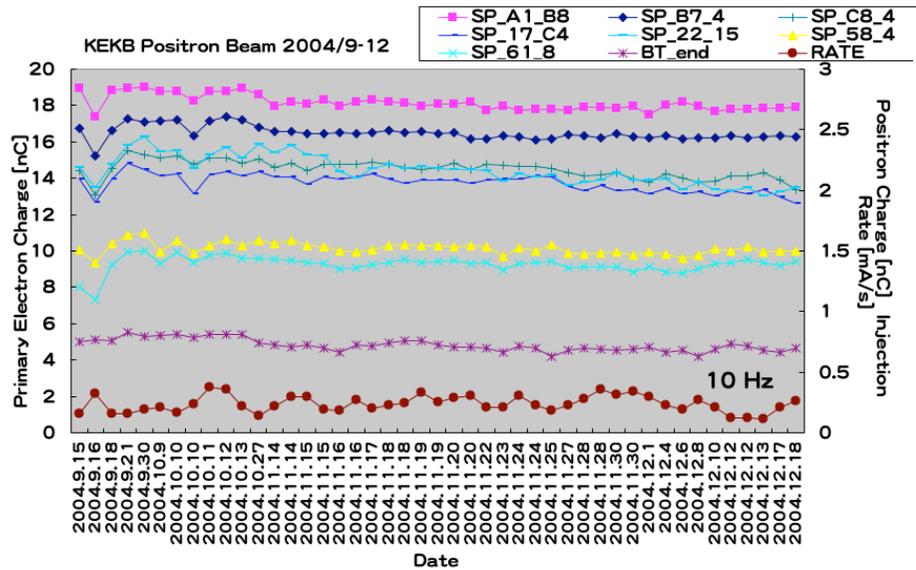
# Strange Abort Rush in LER



- Belle abort by SVD PIN signals
- Beam loss
- Phase oscillation – caused by energy loss?
- No transverse oscillation
- No pressure burst

Dust? Disappeared after the earthquake on Feb. 16?

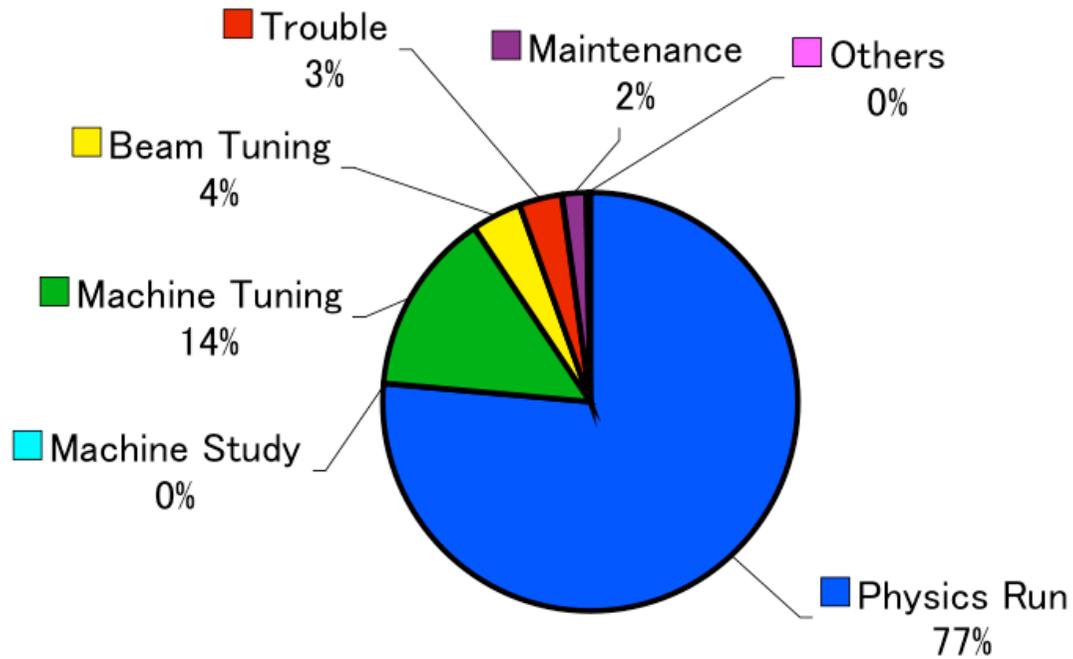
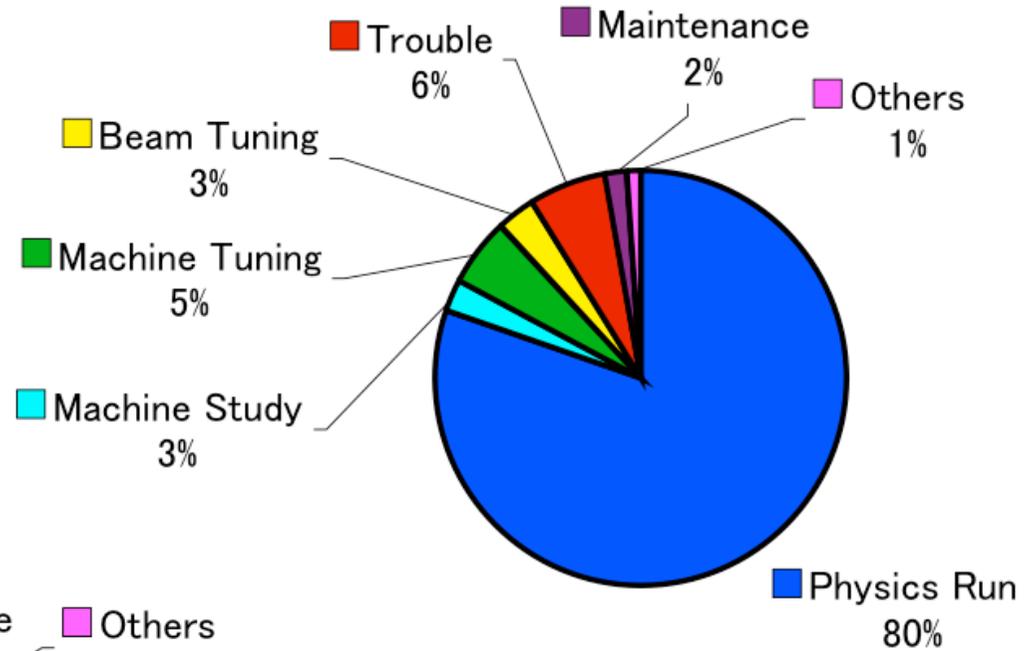
# Injector Performance



- 2 bunch/pulse e<sup>+</sup> injection scheme are always applied.
- The injection rate from Linac to the rings are stable.



# Operation Statistics



# Plans

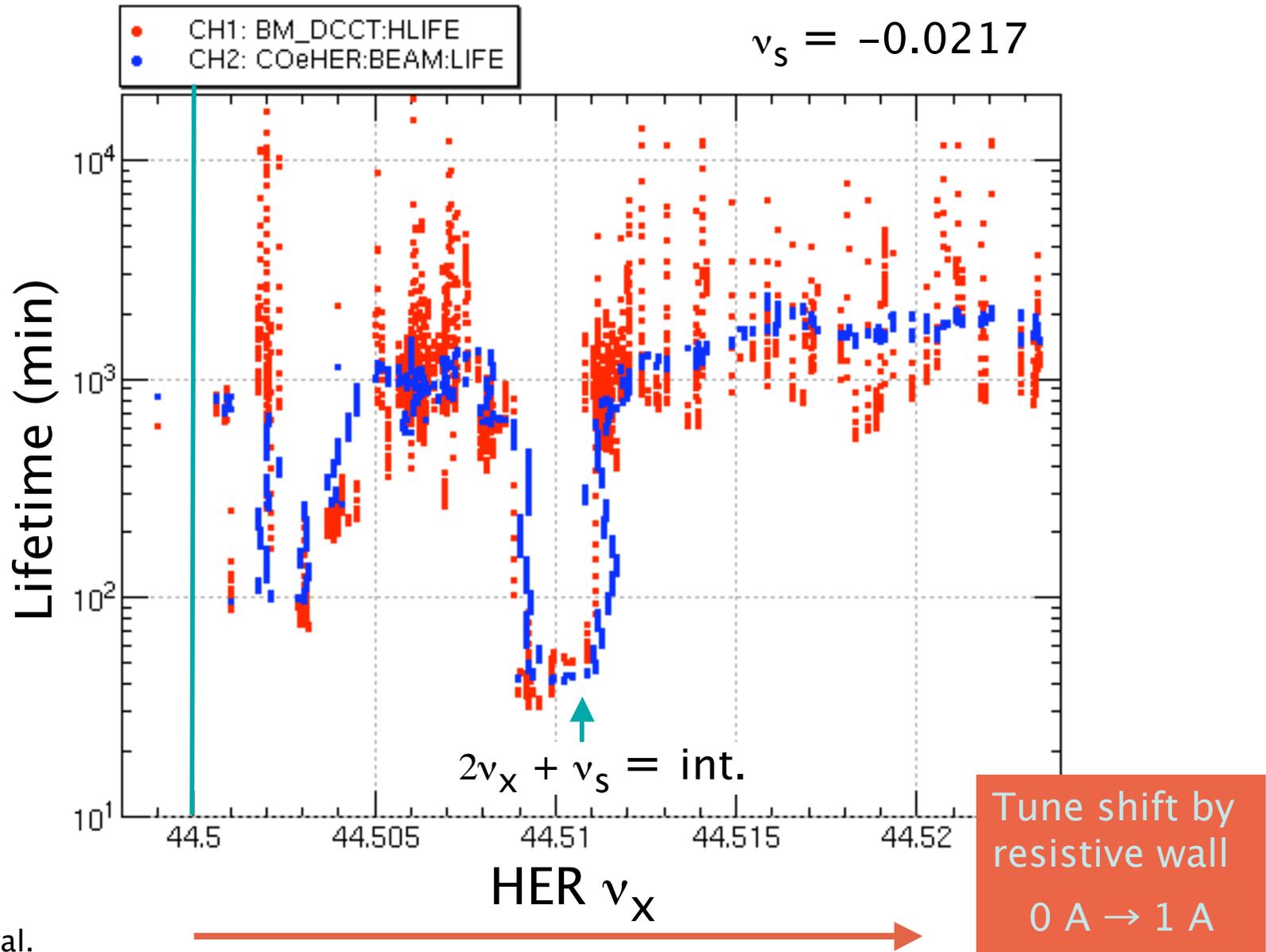
## Higher Currents

- HER current is gradually being increased.  
1270 → 1300 mA → . . .
- LER current  
1674 → ~1800mA  
Limit depends on luminosity performance.

## Higher Specific Luminosity

- Optimize  $\beta_{x/y}^*$  in both rings
- Better choice of tunes and chromaticity corrections
  - Larger dynamic aperture
  - Weaken the effect of the synchro-betatron resonance  
 $\nu_x + \nu_s = \text{integer}$  ( $\nu_x = .511$  at  $V_c = 13$  MV)

# Synchrotron-betatron resonance in HER



# Plans (cont'd)

## More Bunches

- 3.5 spacing

**We will install crab cavities in both rings in Jan. 2006.**

- One cavity in Nikko straight section in each ring
- Achieve  $\xi_y > .1$  with crab cavities

## Luminosity before Crab Cavities

- Total integrated luminosity  $> 500/\text{fb}$
- $25.8/\text{fb}/\text{month}$ 
  - =  $0.86/\text{fb}/\text{day} \times 30 \text{ days}$
- $> 200/\text{fb}/\text{year}$