

KEKB Status

since Feb. 2003

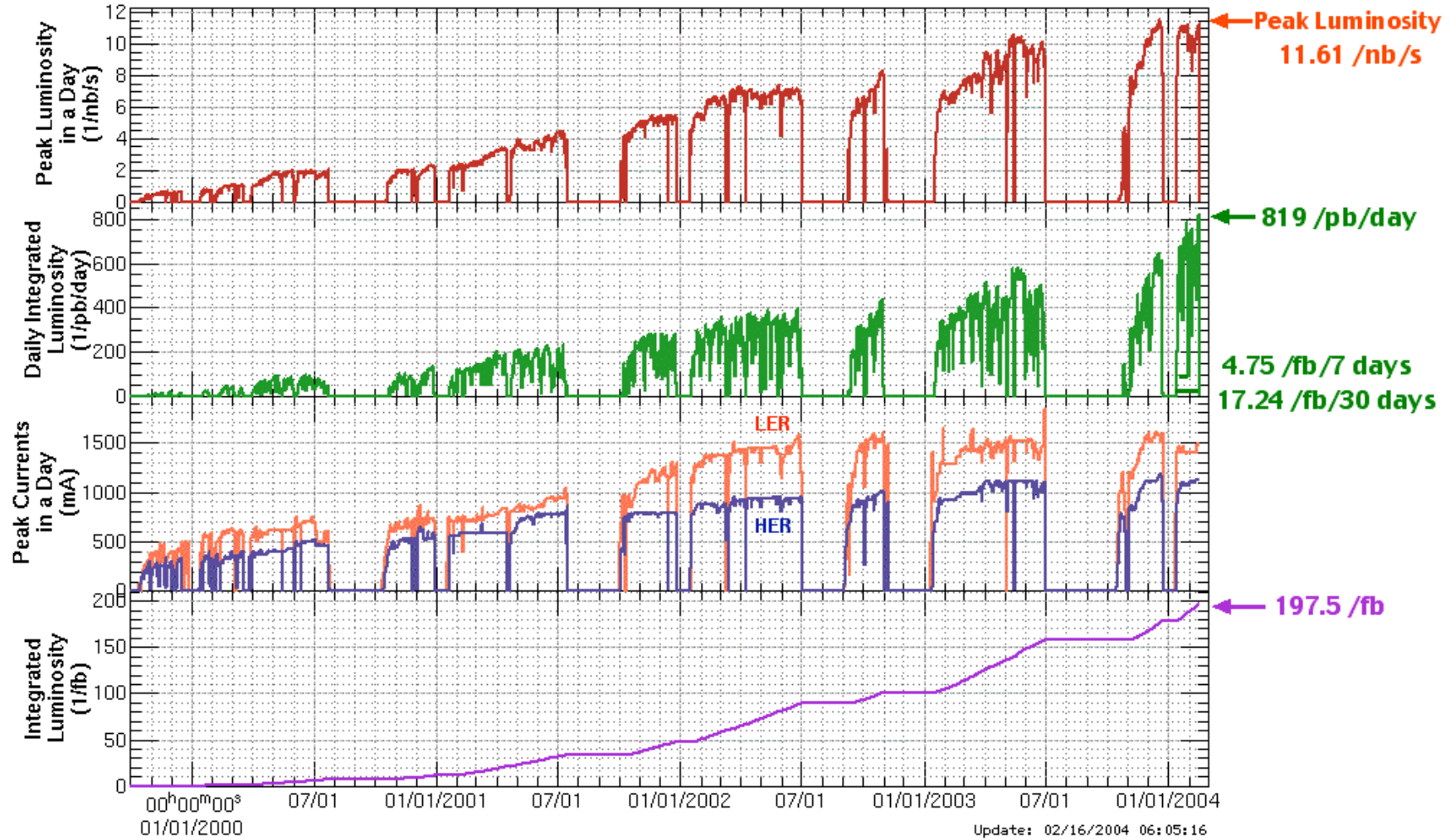
H. Koiso

Feb. 16, 2004 @ KEKB Review

- **Achieved 10/nb/s**
- **Continuous Injection**
- **Plans**

KEKB History

Luminosity of KEKB
Oct. 1999 - Feb. 2004



C-Yoke: (1) 800 m (2) 800 m Solenoid: 800 m 1250 m 1350 m 2150 m 2200 m 2250 m PM 25 m-50 m 2300 m

Luminosity Performance

- Peak luminosity has exceeded the design value of **10/nb/s**.

$$L_{peak} = 8.26 \rightarrow 11.61/nb/s$$

- Integrated luminosity /day, /7days, /30days are also improved much (almost doubled).

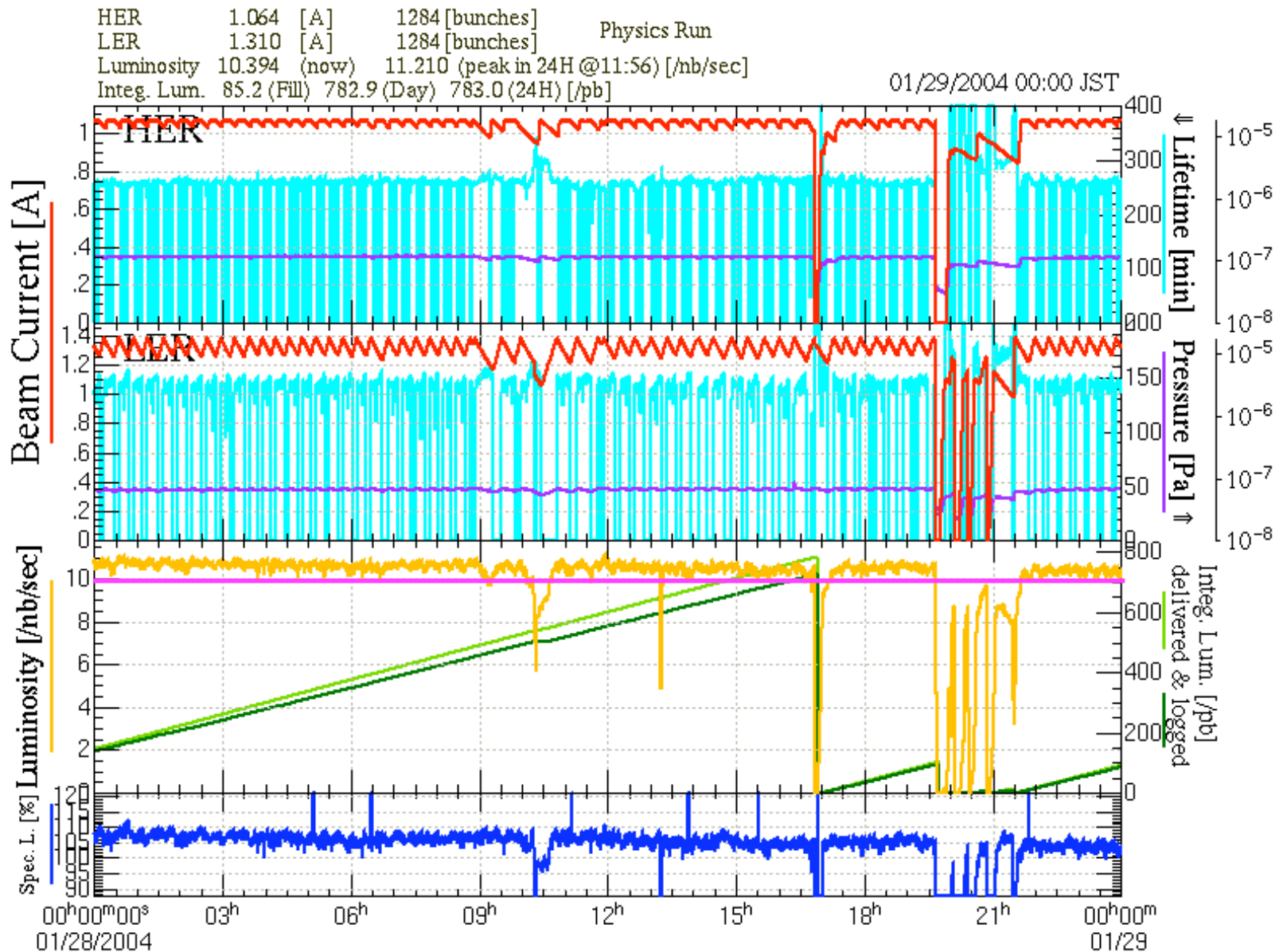
$$434/2579/ 8783$$

$$\rightarrow 819/4745/17240 /pb$$

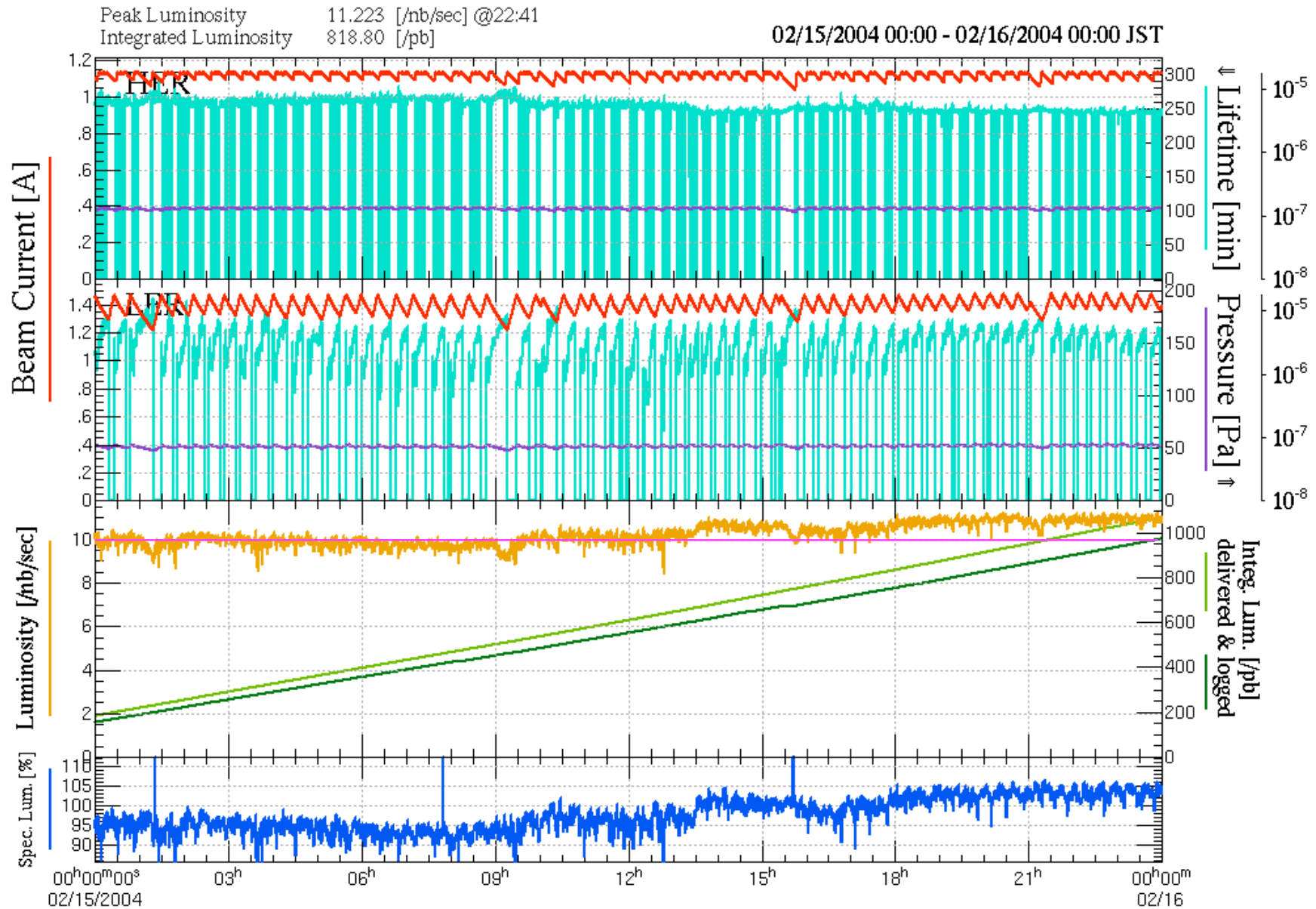
$$(1.89 / 1.84 / 1.96)$$

- Total luminosity **197.5/fb**
- Now we guarantee **19.5/fb/month** to Belle.
- We have been successfully operating in **Continuous Injection Mode (CIM)** since Jan. 2004.

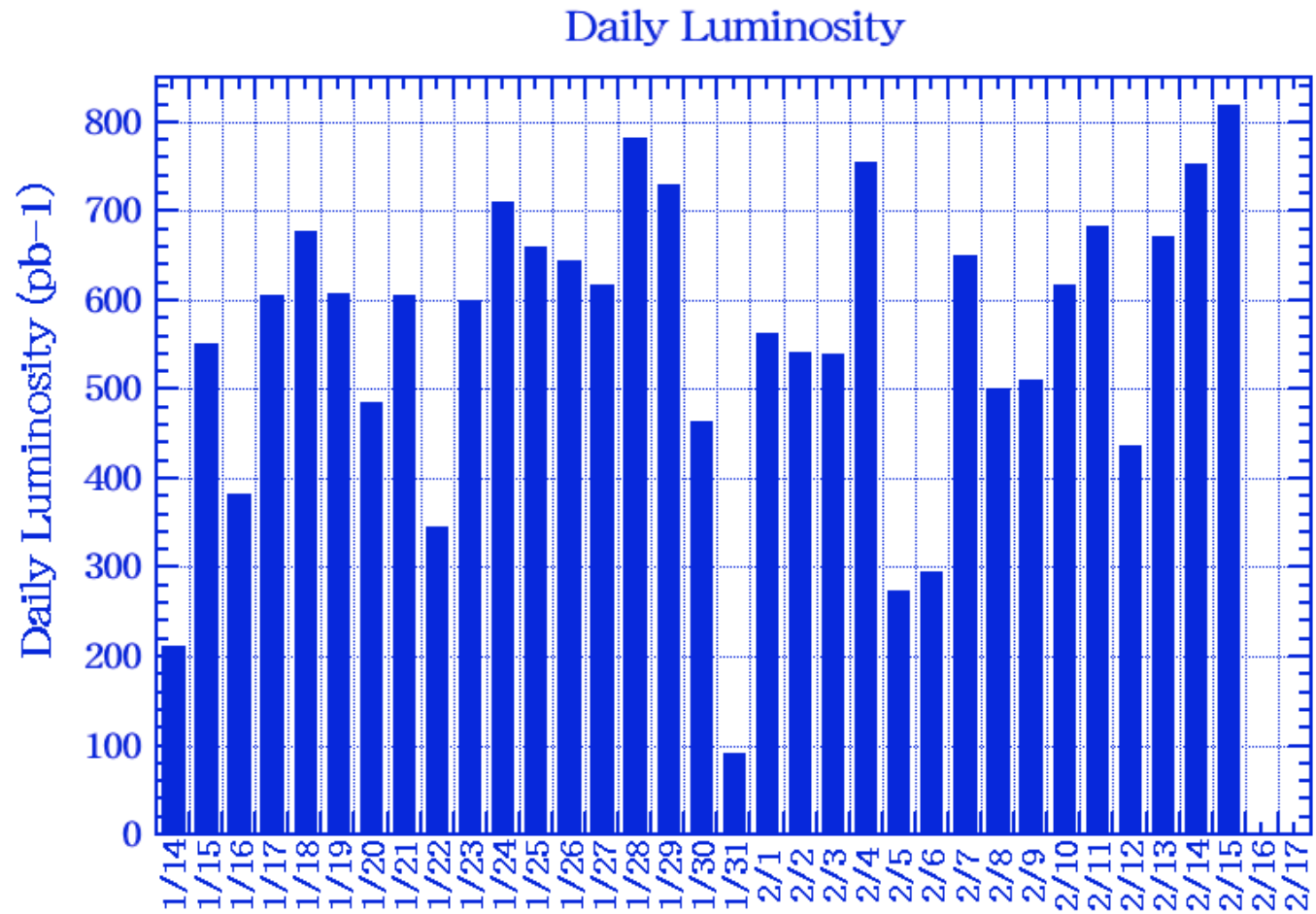
The Second Best Day 783.0/pb



The Best Day 818.8/pb



Daily Luminosity since Jan. 2004



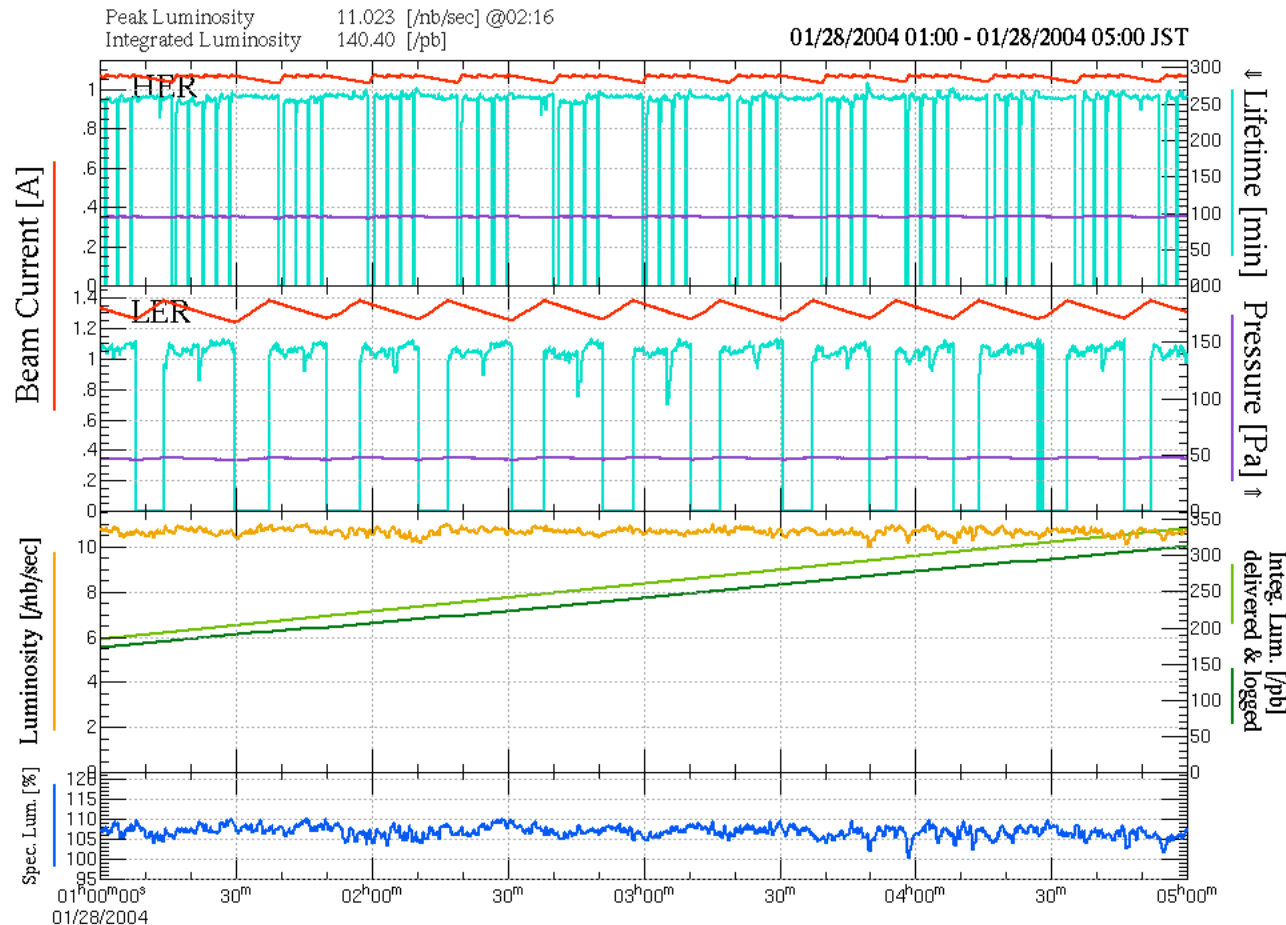
Machine parameters

Date	12/18/2003		10/29/2002		
Ring	LER	HER		LER	HER
Horizontal Emittance	18	24	18	24	nm
Beam current	1503	1132		1454	949
Number of bunches	1281		1184		
Bunch current	1.17	0.884		1.23	0.80
Bunch spacing	1.8 or 2.4 (3.77sp)		1.8 or 2.4 (4.08sp)		m
Bunch trains	1		1		
Horizontal size at IP σ_x^*	103	116		103	121
Vertical size at IP σ_y^*	2.3	2.3	2.9	2.9	μm
Emittance ratio $\varepsilon_y/\varepsilon_x$	5.5	3.4	7.5	5.0	%
β_x^*/β_y^*	59/0.58	56/0.7	59/0.62	61/0.7	cm
Beam-beam parameters					
ξ_x/ξ_y	0.104/0.069	0.071/0.053	0.090/0.053	0.078/0.045	
Beam lifetime at collision	125 @1503 mA	216 @1132 mA	68 @1454mA	197 @949mA	min
Luminosity (Belle Csl)	11.61		8.26		/nb/s
Luminosity records	(total)				
per day/7 days/30 days	819/4745/17240 (197.5/fb)		434/2579/8783 (109.7/fb)		/pb

Machine Parameters (cont'd)

- **Bunch fill pattern/bunch spacing**
 - 4.08 (49/12) -> 3.77 (49/13) (April 2003-)
 - 3.5 (49/14) Could not use due to heating of IP bellows and LER ante-chamber in June 2003.
- **Stored currents**
 - LER 1861mA
 - HER 1187mA world's highest with SCC
- **RF Voltage**
 - LER 8 MV (LER)
 - HER 13 -> 15 MV Oct. 2003: Added 2 ARESs
 - -> 14 MV Jan. 2004: Removed 1 SCC
 - due to vacuum leak

Continuous Injection Mode

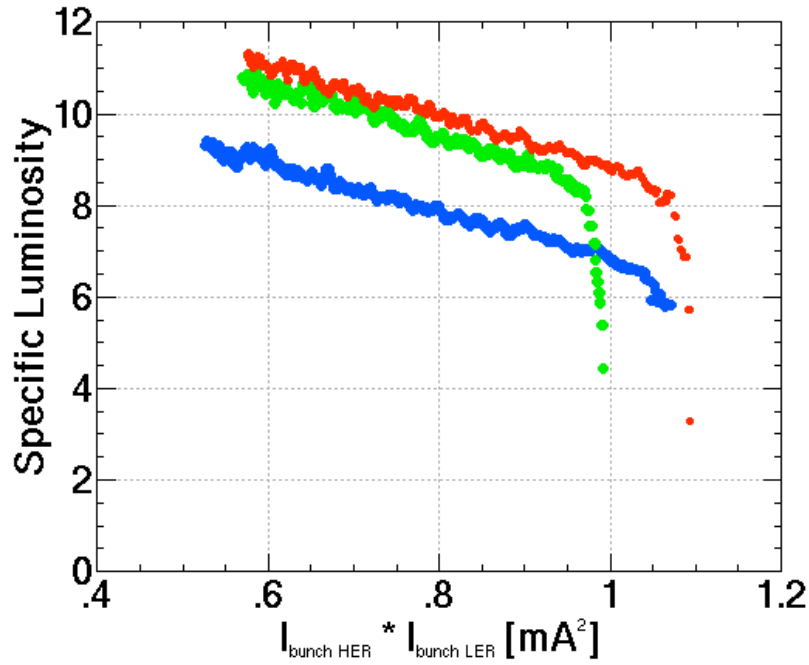


- Continuous data taking during injection
- 3.5msec veto at injection
- 10Hz injection
- $e^+ \leftrightarrow e^-$ change in every 20 min.
- 3~4 times to HER, once to LER

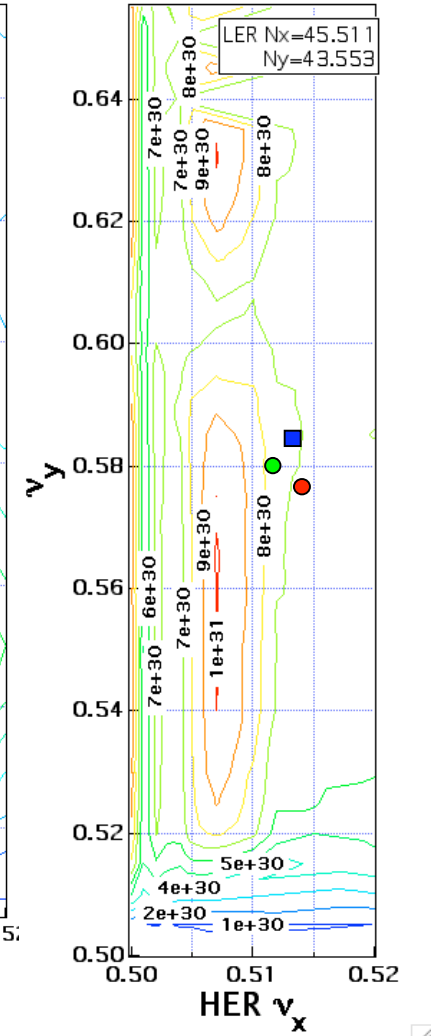
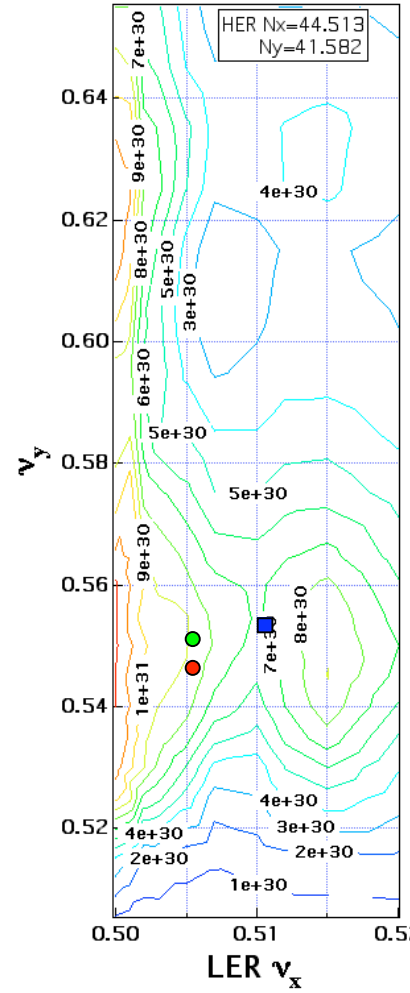
$$10/\text{nb/s} \times 86400\text{sec} = 864/\text{pb/day}$$

LER current is limited due to heating of the septum chamber and HER vertical size blow-up.

Specific Luminosity



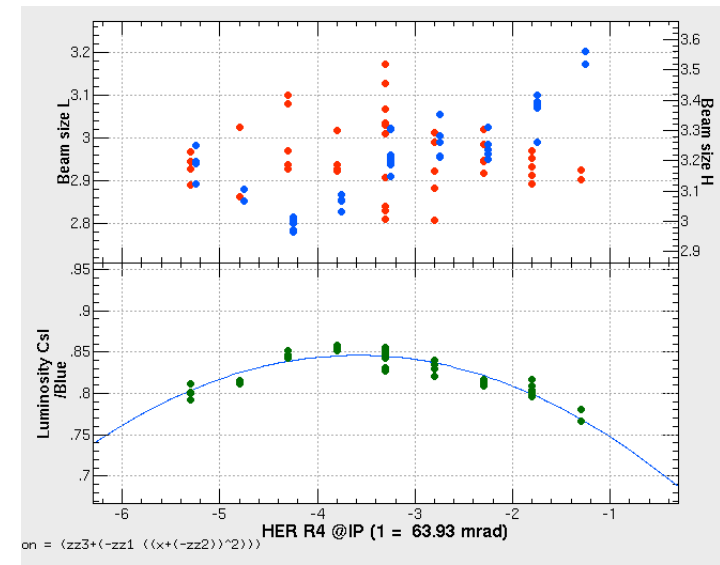
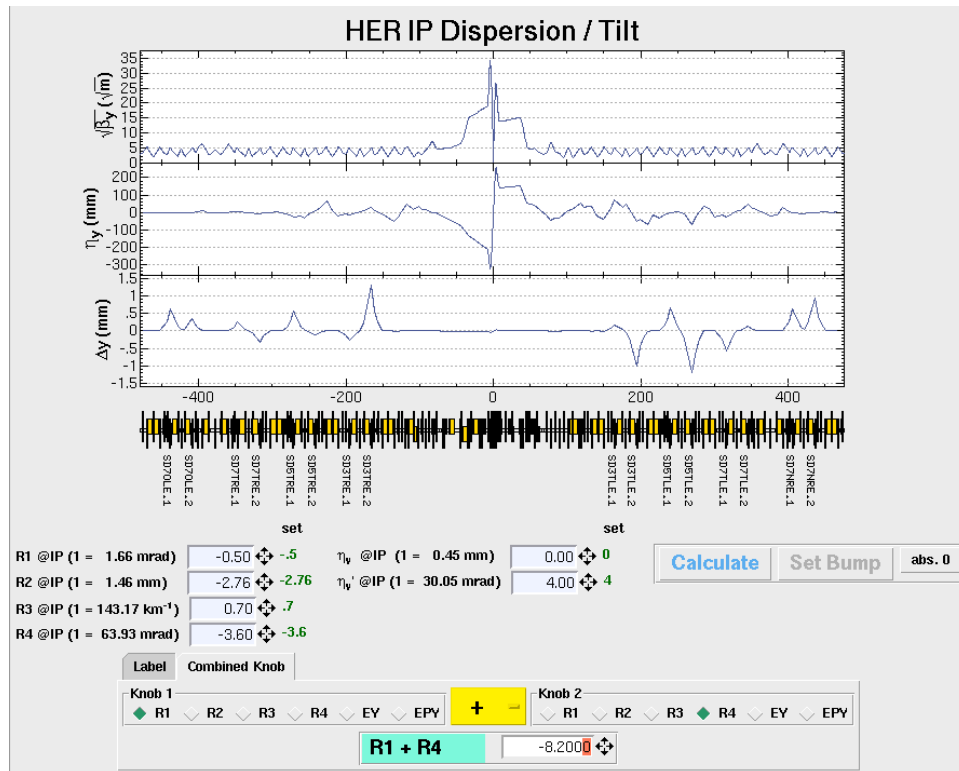
Specific luminosity has been improved by 25%.



- 10/29/2002
- 5/9/2003
- 12/18/2003

Simulations M.Tawada, et al.

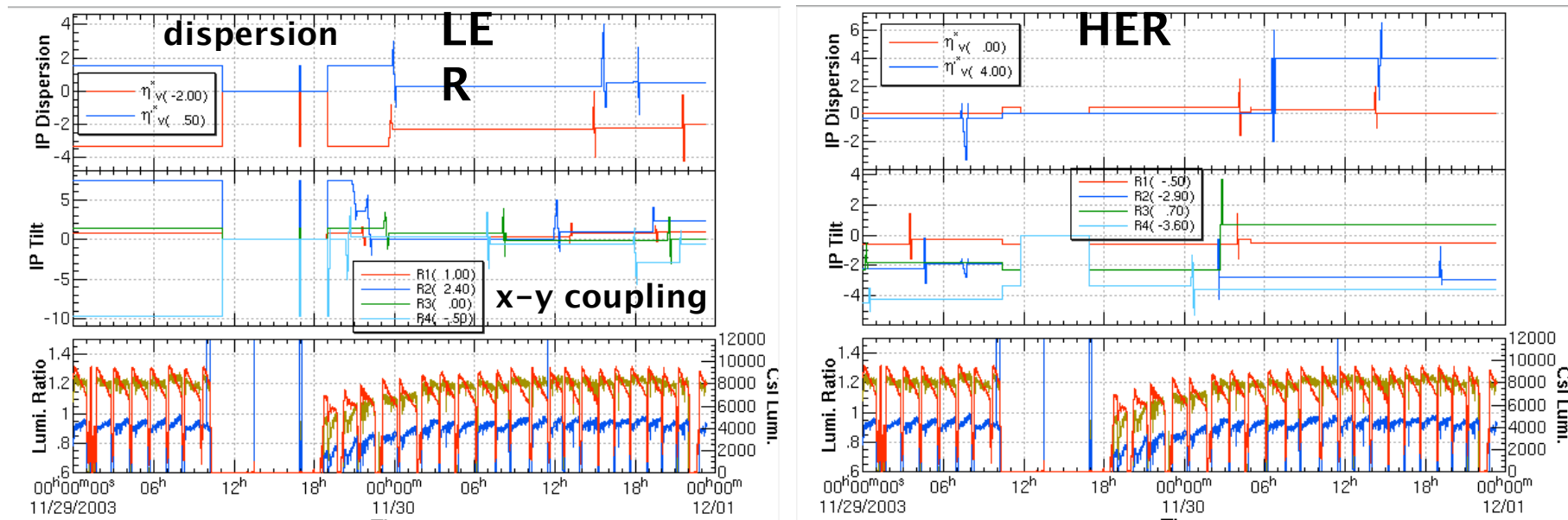
IP Knobs



scan

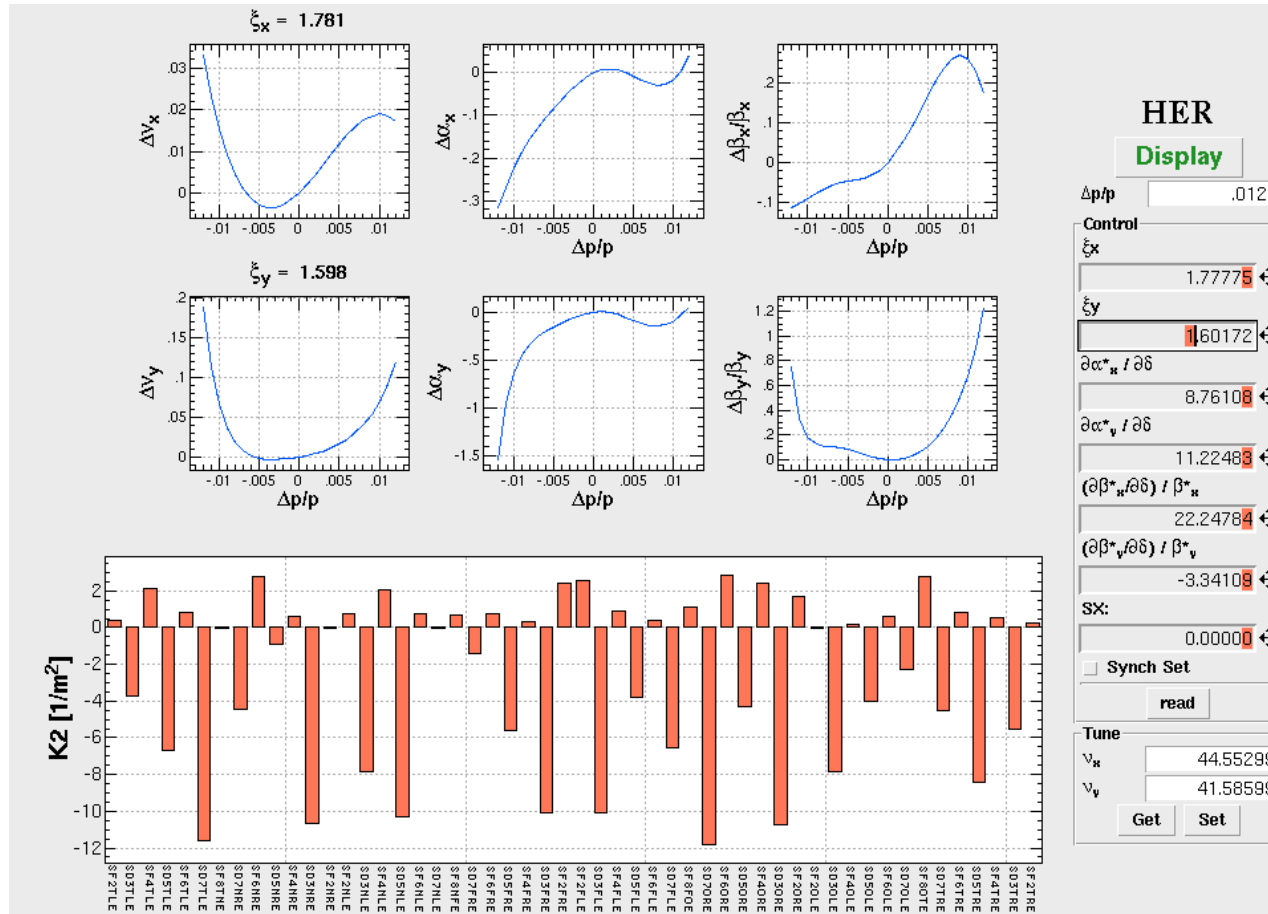
- 8 vertical bumps at SD sextupoles in each side of IP.
- Vertical dispersion and its angle, x–y coupling components are independently adjustable. R1,R2,R3,R4,EY, and EPY
- Knobs to adjust vertical waists (fudge factors of QCS and QC1), longitudinal collision point (rf room phase) are also available.

Luminosity Tuning with IP Knobs



- Luminosity is improved by 20–30% by tuning with IP knobs.
- Luminosity looks recovered quickly after the optics correction when we start tuning at the previous optimum values.

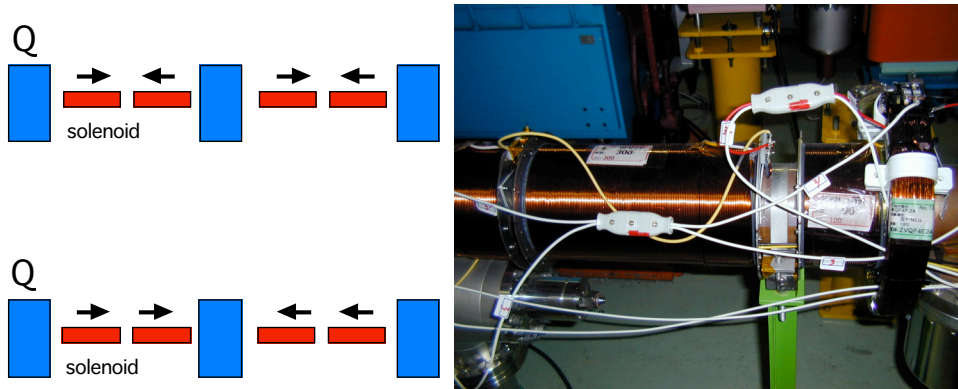
Sextupole Adjustment



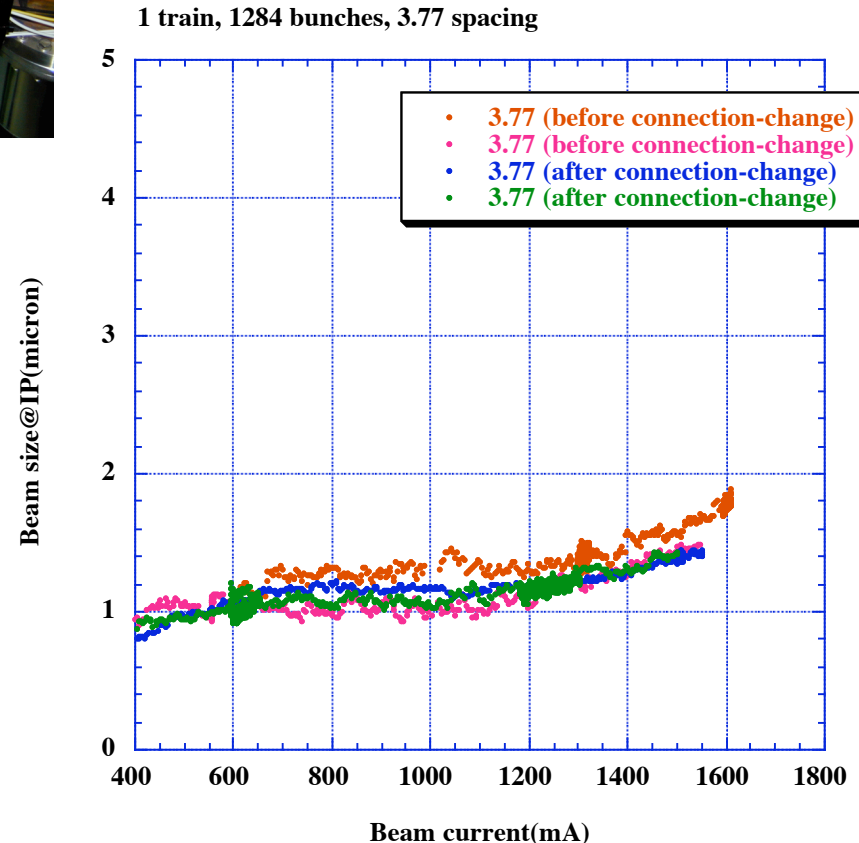
- many degrees of freedom: 52+2(LER) families
- Takes time to optimize.

Electron Clouds in LER

H. Fukuma, et al.



- Connection of solenoids was changed at ~ 300 points to eliminate field-free region in drifts.
- Beam size were almost unchanged.
- No problems in x-y coupling correction.
- LER is operated in the new connection.

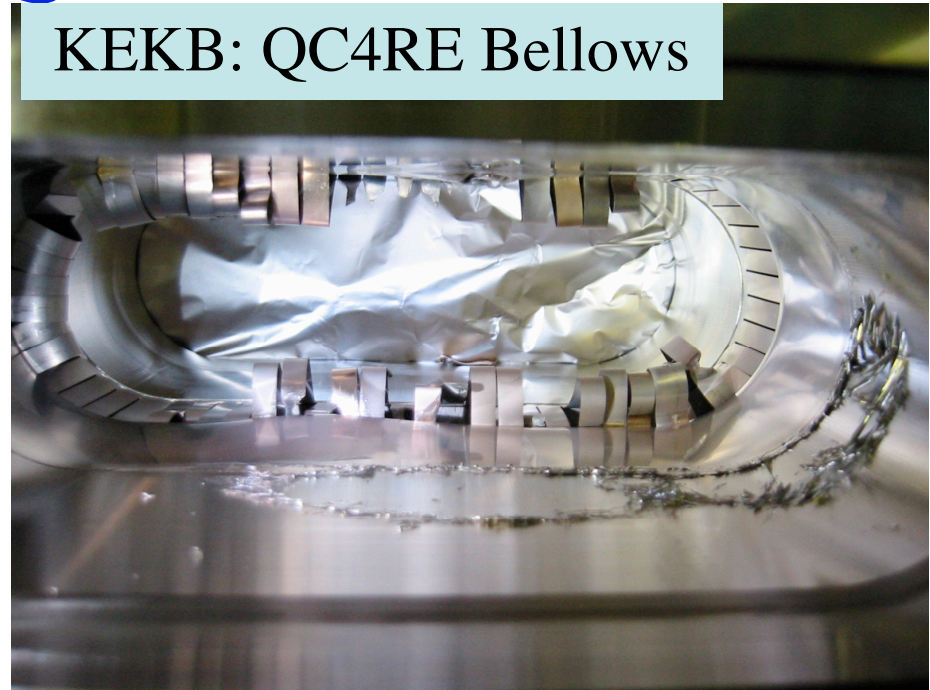


Fight for High Current

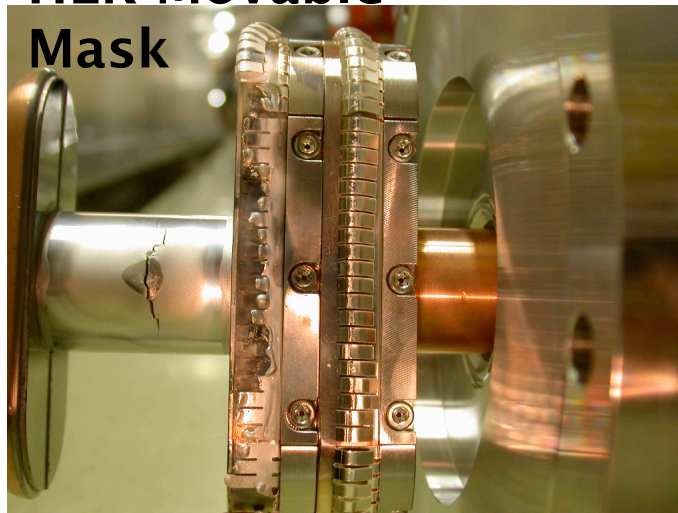
- Heating of components by synchrotron light and HOM
- Discharge and melt down
- Vacuum leak

These damaged components were replaced.

KEKB: QC4RE Bellows



HER Movable Mask



LER Septum Chamber



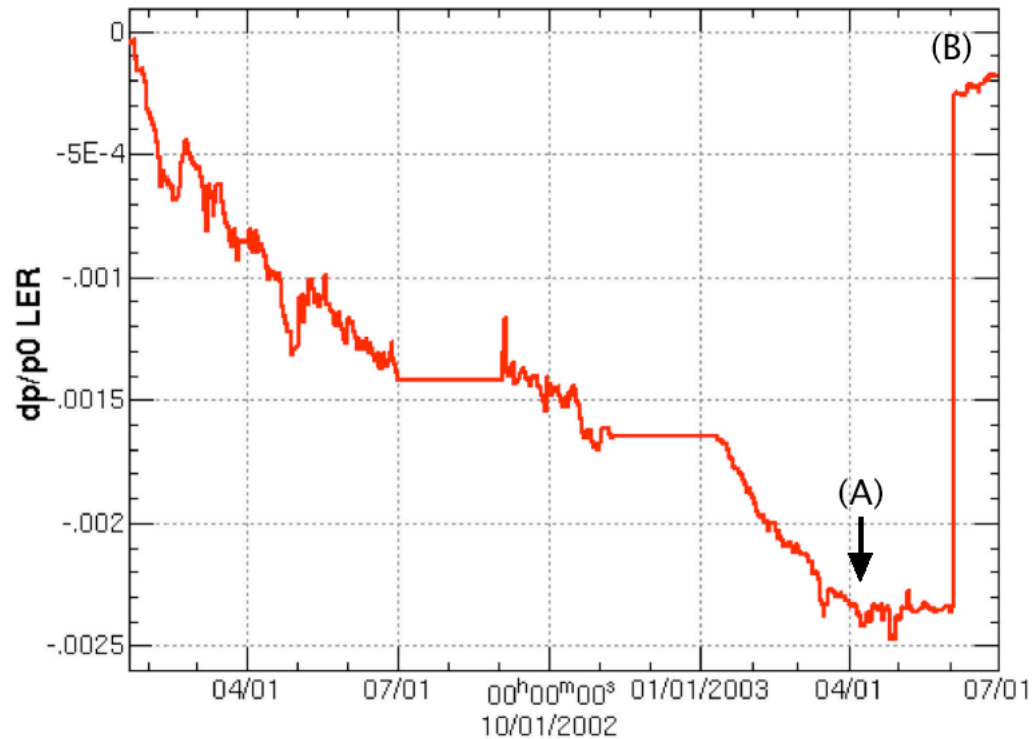
Y. Suetsugu, et al.

Improvements

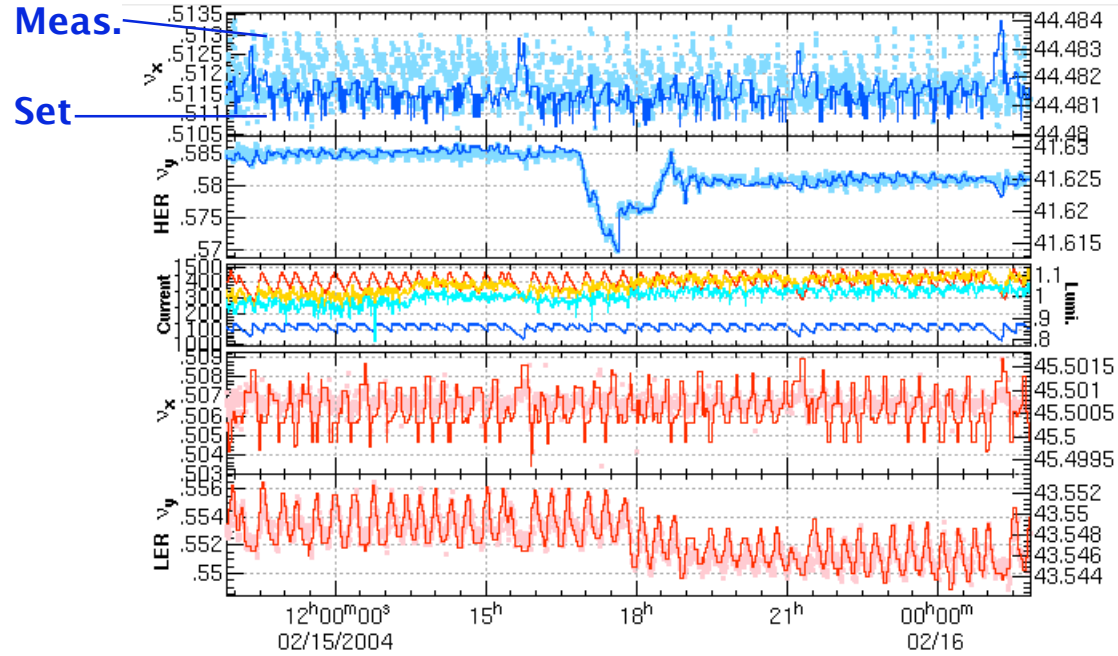
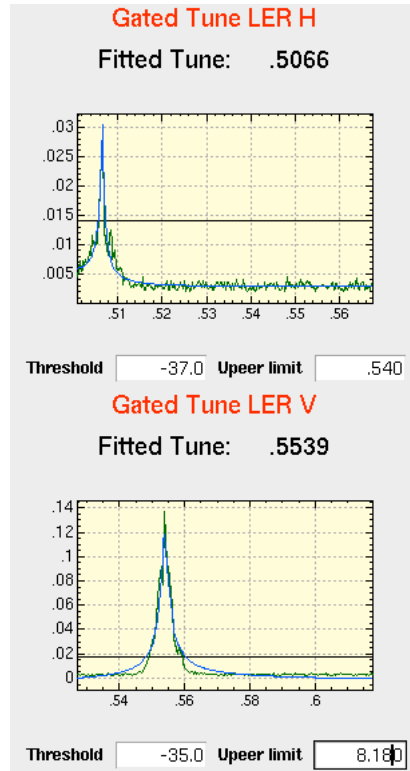
- **New 2 ARES cavities in HER D4**
- **New IR cambers QC1RE QC2RE QC2LP/E**
 - Wider vertical aperture 58 -> 76 mm @QC1RE
 - Reinforced cooling system
- **New masks (longer type) in HER D9,D12**
- **New septum chambers with new type fingers**
 - Baking was necessary.
- **Removed ante-chamber, made test station in LER D6**
- **Installed a new ante-chamber**
- **New BPMs at 4 skew quads. in HER**
- **One-pass BPMs 21/ring**
- **More solenoids and permanent magnets in LER**

Improvements

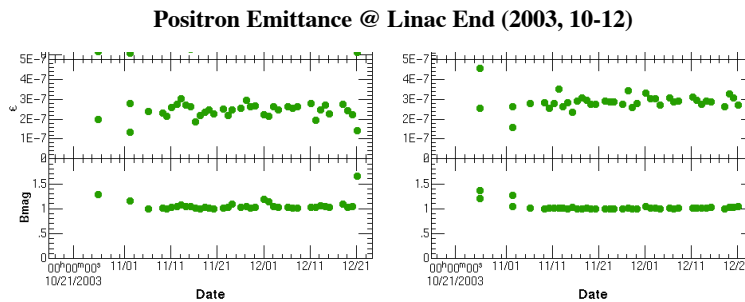
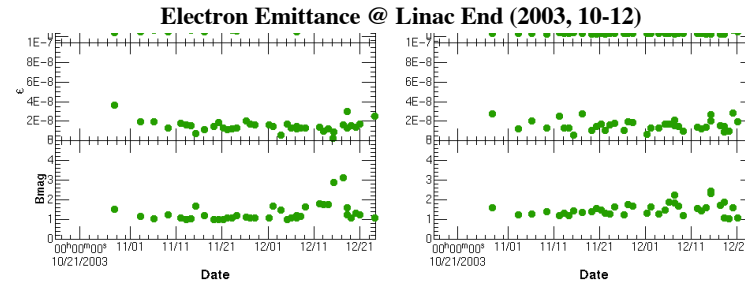
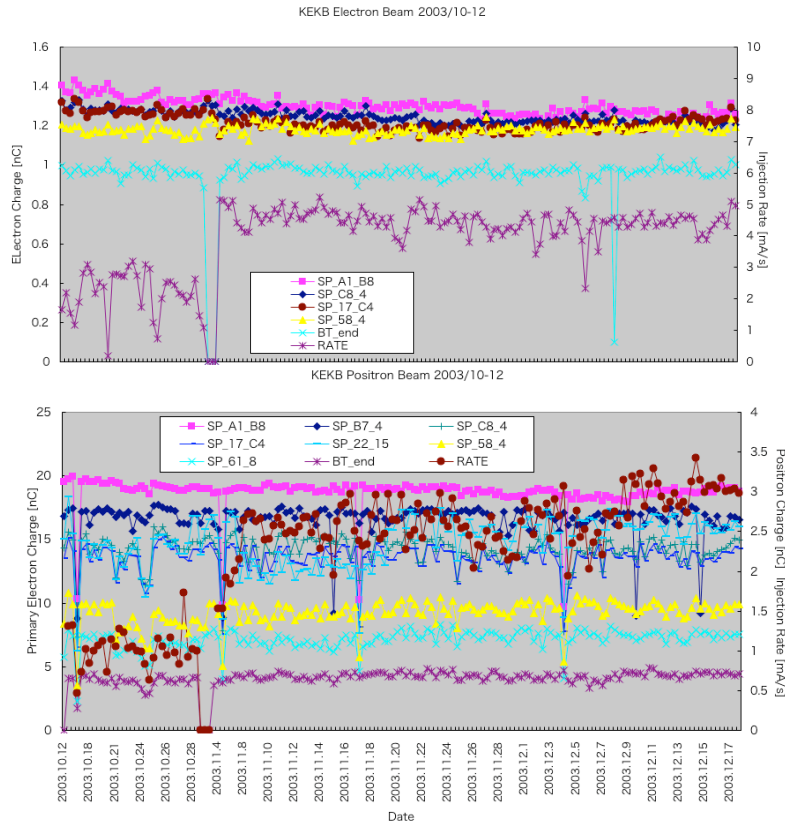
- Corrected inadequate algorithm in orbit correction. Orbit and energy drift were reduced.
- Beam-based mapping of BPM. Consistency errors were reduced (<.3 mm).



Tune Feedback



Injector Performance



Y. Ogawa, et al.

- 2 bunch/pulse e⁺ injection scheme are always applied.
- The beams from Linac are stable and the injection rate have been improved. Records: e⁺ 3.72mA/s, e⁻ 5.53mA/s

Plans

Higher Currents

- HER current is gradually being increased.
 - 1100 -> 1184 mA Dec. 2003
 - 1100 -> ~1140 mA Jan. 2004 line-out D10C
 - ...->1200mA
- LER current -> 1800mA
 - Limit depends on luminosity performance

Higher Specific Luminosity

- Smaller β_x^* in both rings
 - 60 -> 40 cm (10~20%)
- Better choice of tunes
 - HER tunes are set close to LER (20~30%)
 - Momentum compaction may have to be adjusted to avoid the synchro-betatron resonance $2\nu_x + \nu_s = \text{integer}$ ($\nu_x = .511@14$ MV)

Plans (cont'd)

More Bunches

- 3.5 spacing

Next Milestone before Installation of Crab Cavities

- **Total integrated luminosity > 500/fb**
- **1/fb/day**
 - $13/\text{nb/s} \times 1 \text{ day} = 1.12/\text{fb/day}$
- **24/fb/month**
 - $= 0.8/\text{fb/day} \times 30 \text{ days}$
- **>200/fb/year**