

Luminosity Tuning and Operation Statistics at KEKB

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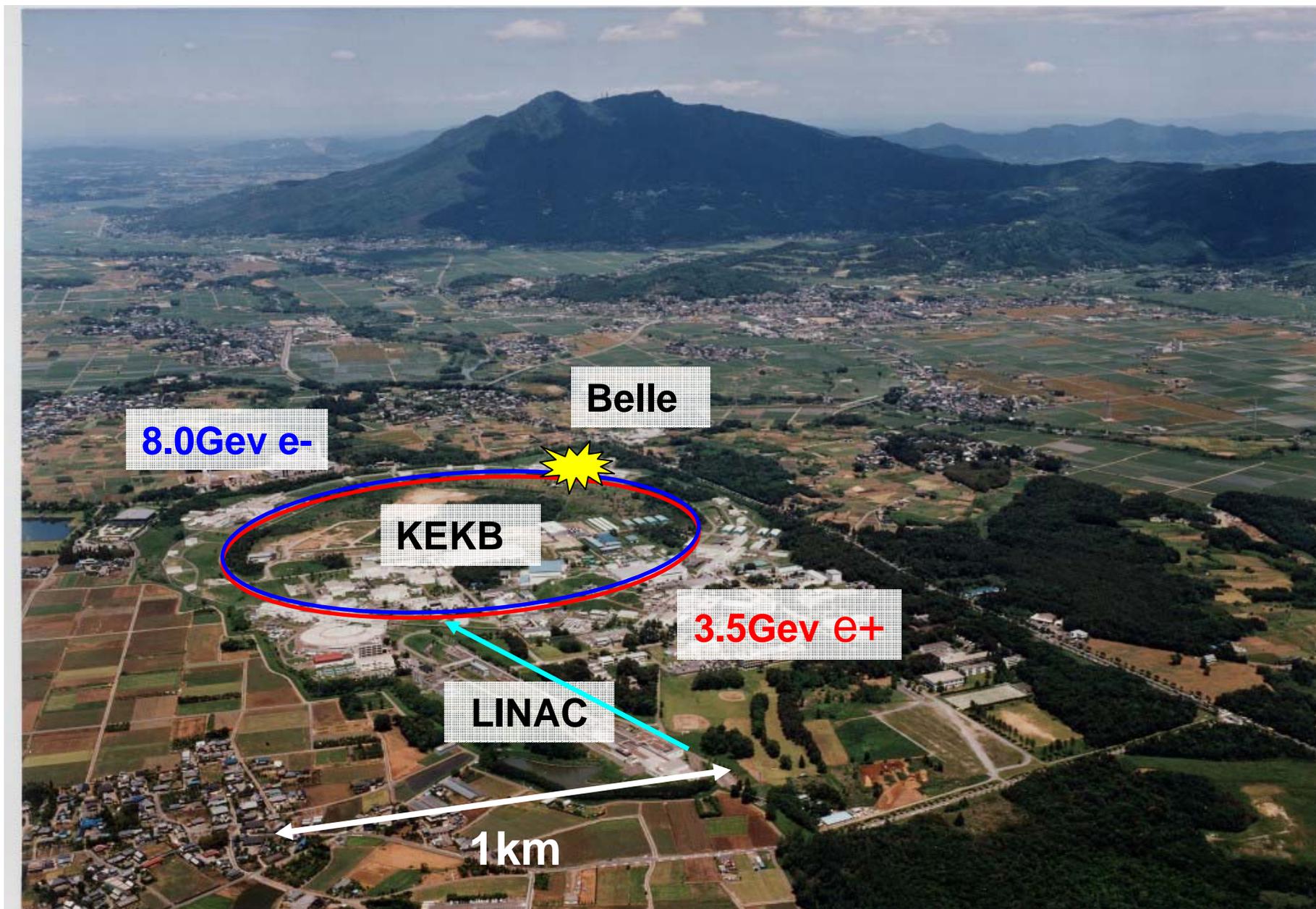
High Energy Accelerator Research Organization (KEK)

Contents

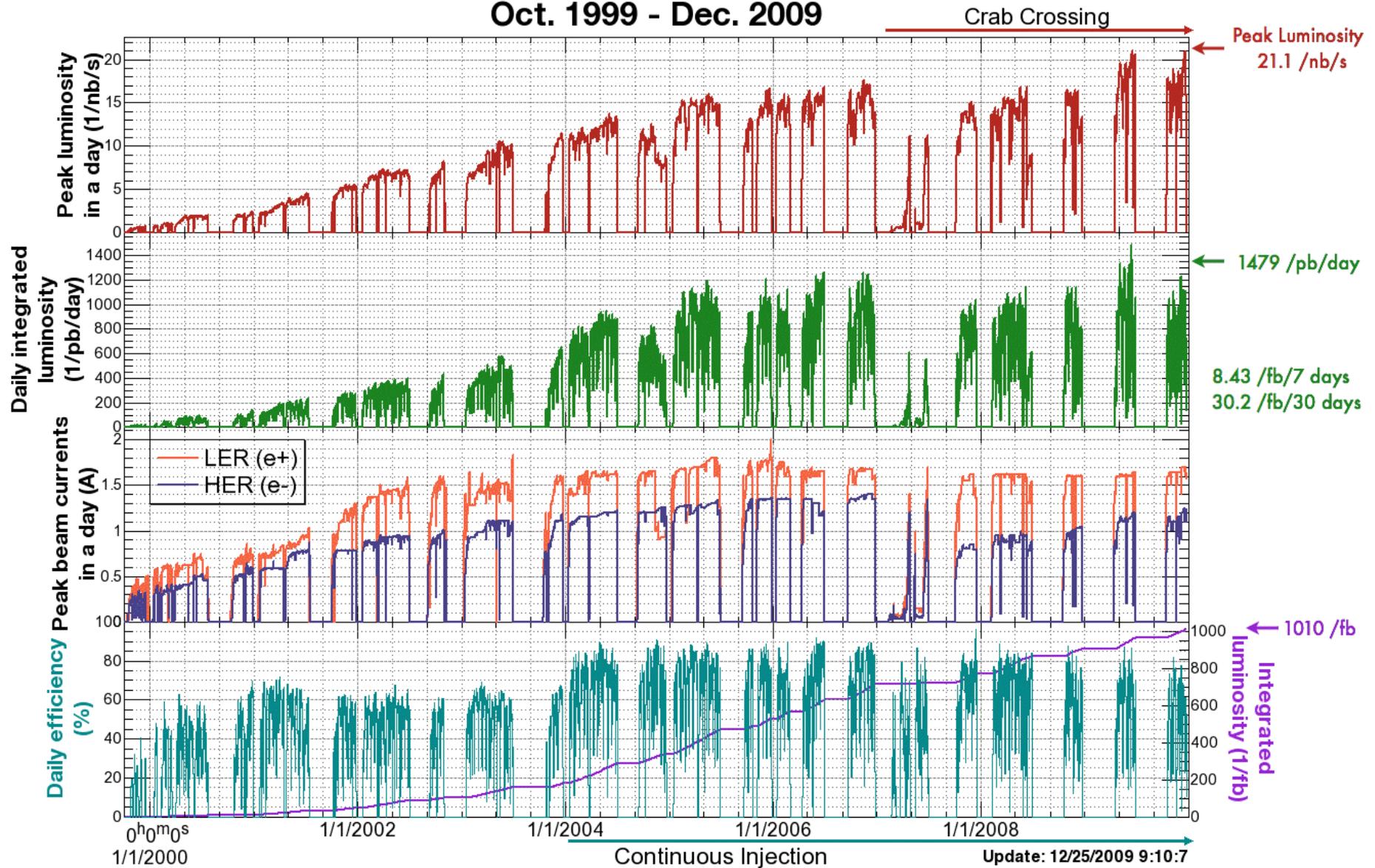
- **Introduction**
- **Injection method**
- **Orbit correction at collision point**
- **Knob tuning**
- **Crab cavities**
- **Skew sextupole magnets**

Contents

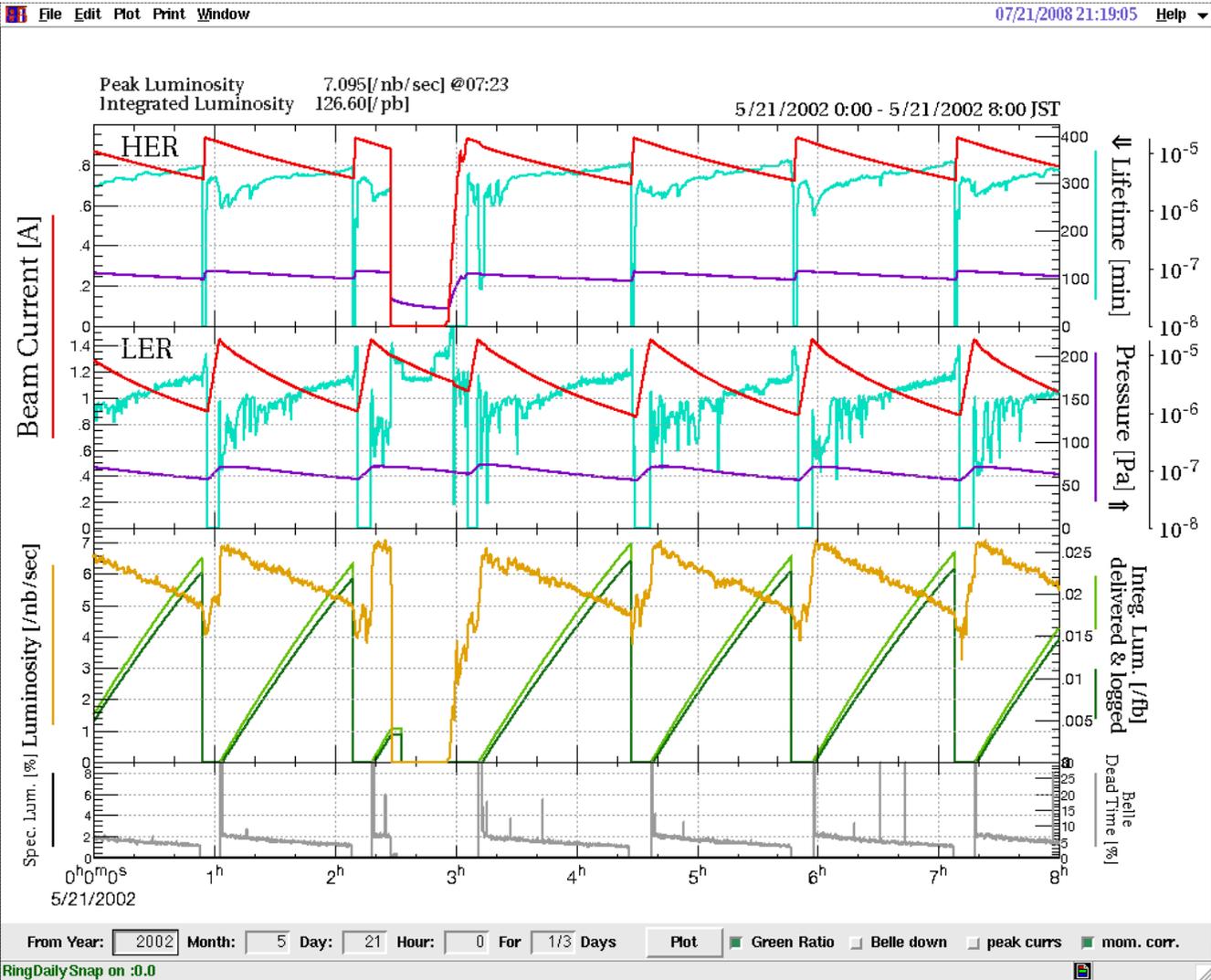
- **Operation period**
- **Integrated and peak Luminosity**
- **Summary**



Luminosity of KEKB Oct. 1999 - Dec. 2009

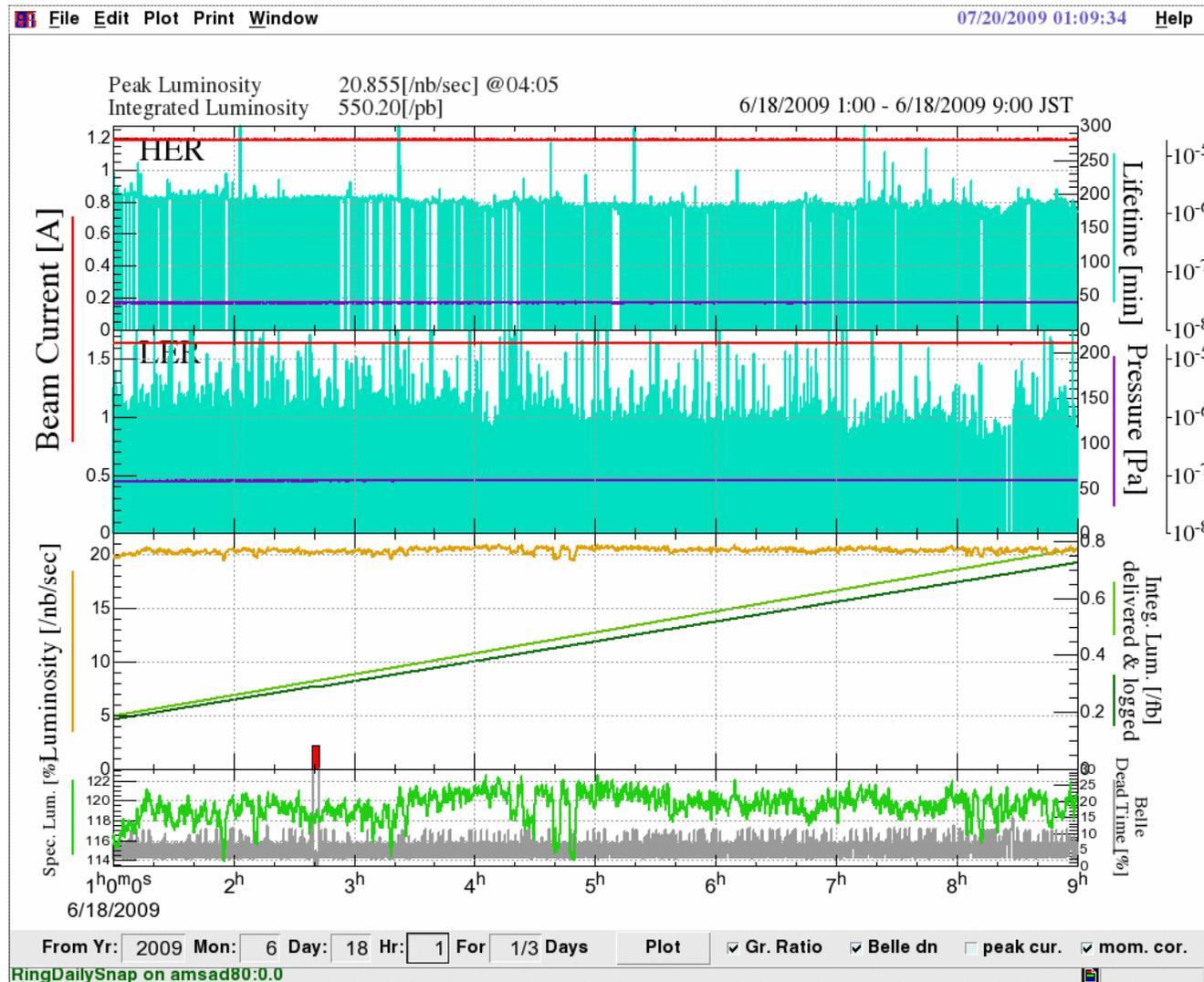


Injection method



Before the continuous injection mode

Injection method



The present simultaneous injection

Orbit correction at collision point

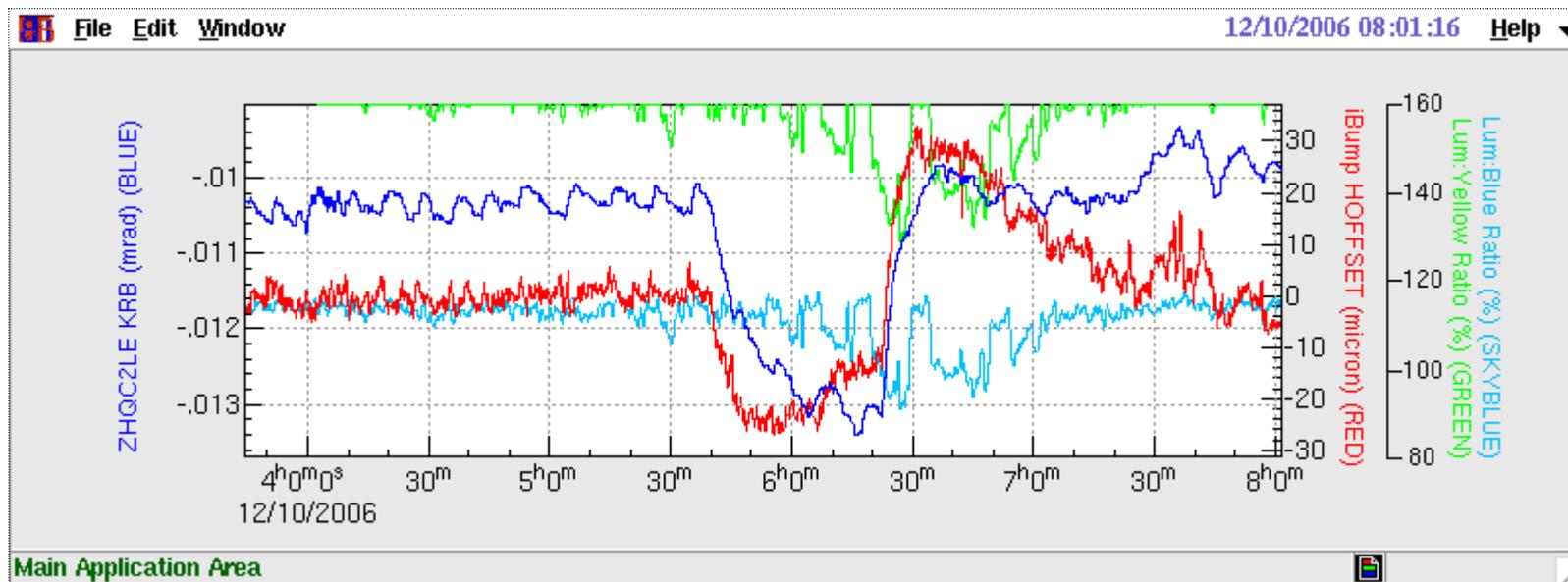
- **Make a bump**
Near the interaction point (IP) of HER
with steering magnets of HER
- **Called “ iBump feedback “.**
- **Best adjust**
→ **The difference of position (Offset)**
and angle (crossing angle) to 0

Orbit correction at collision point

- **Offset and crossing angle in the vertical**
→ **Adjusted to 0**
- **Horizontal crossing angle (22mrad)**
→ **No feedback**
- **The horizontal offset ??**
→ **Used two kinds of feedbacks**
Easy feedback & Beam Size feedback

Orbit correction at collision point

- **Easy feedback**
Feedback to keep the ratio
between the read value of a kick angle of a
horizontal steering magnet and the height of
horizontal bump

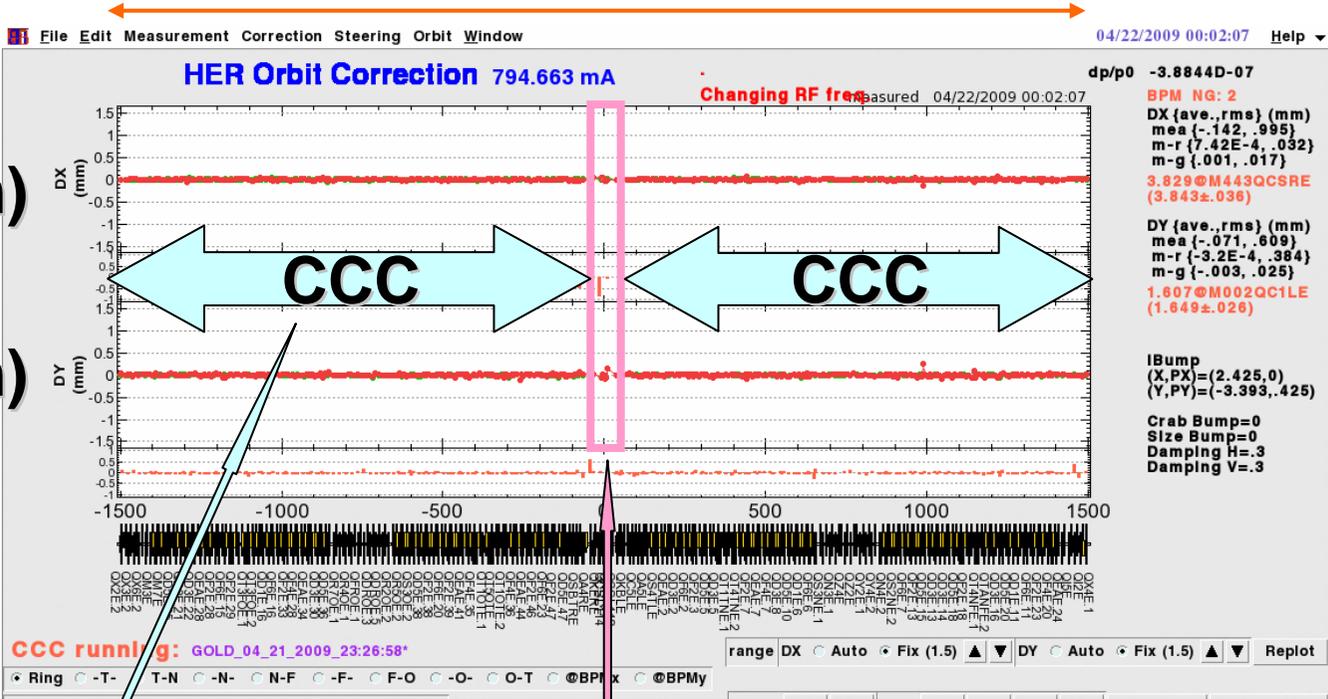


Orbit correction at collision point

- **Beam Size feedback**
Keep the LER beam size at some target value.
- **The feedbacks for the horizontal offset are not used with the crab cavity.**
→ **Keep the beam-beam kick at some target value.**

Knob tuning

3km



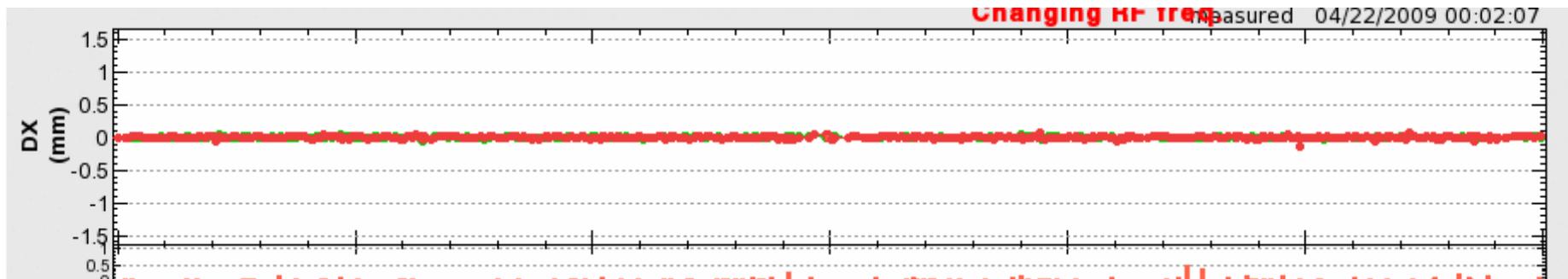
DX (mm)

DY (mm)

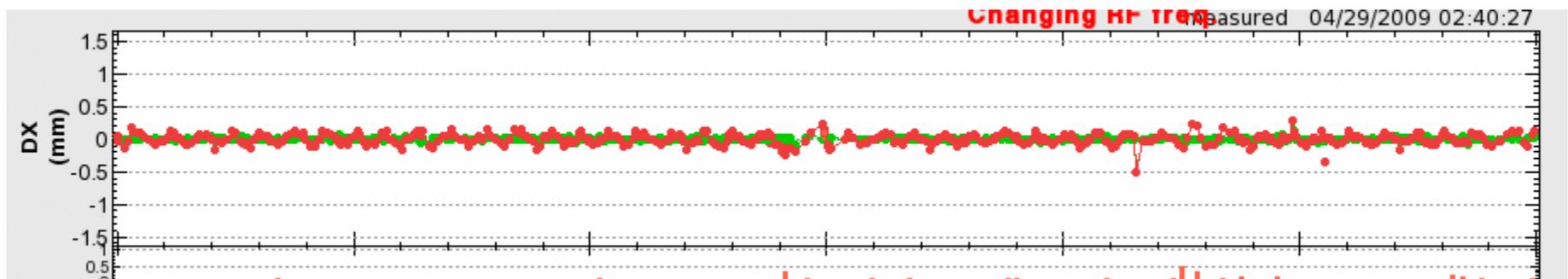
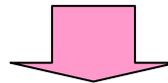
Only the collision point
→ iBump feedback (every 1s)

Orbit corrections of the rings
→ CCC (every 10s)

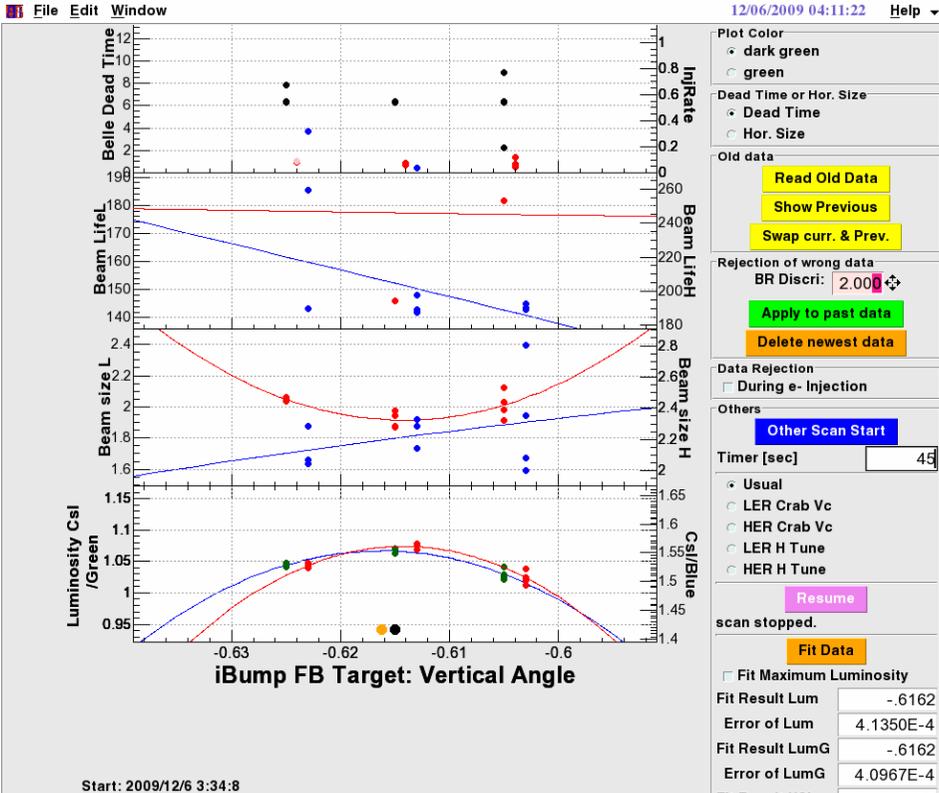
Knob tuning



- **When changed knobs
The orbits around the rings are distorted.**



Knob tuning



By fitting the knob set vs. luminosity curve with a parabolic function

Knob tuning

Tuning Knobs

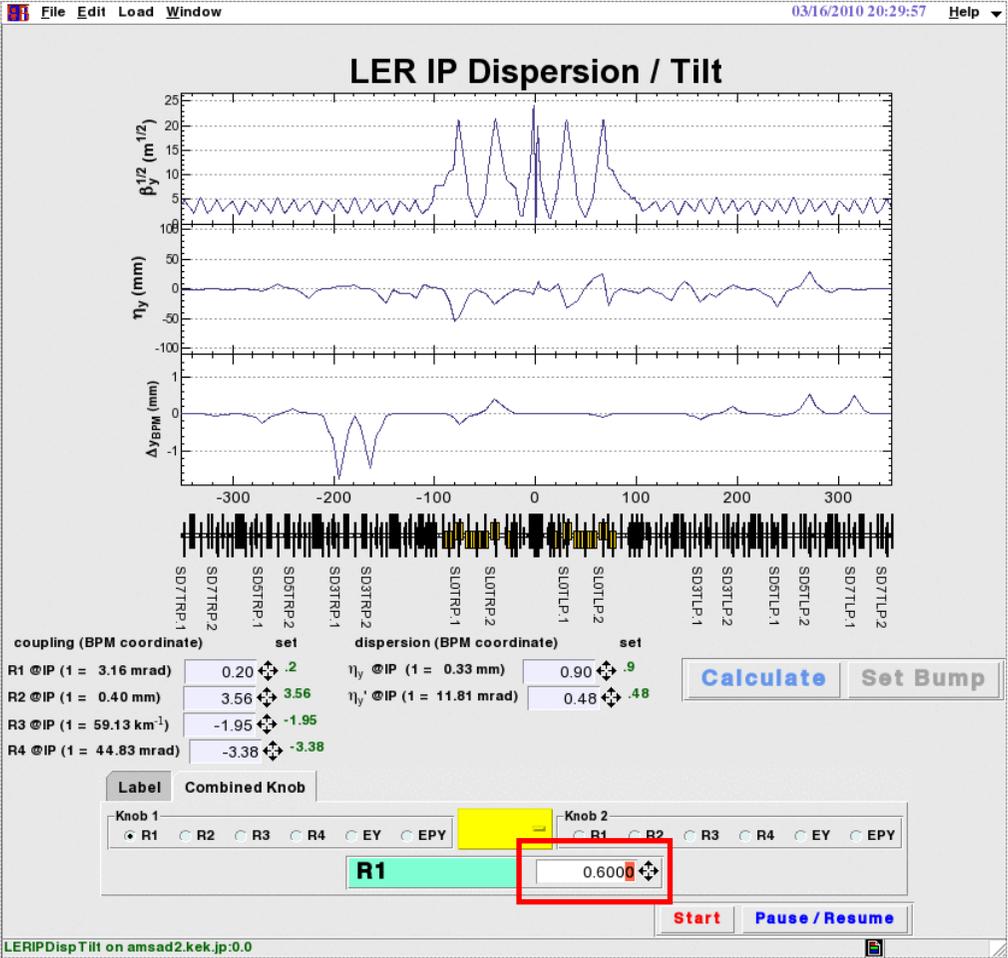
- **iBump feedback**

The target value of the horizontal offset, the vertical offset, and the vertical crossing angle are adjusted to the best value.

- **Coupling, vertical dispersion**

The x-y couplings and the vertical dispersion are important tuning knobs.

Knob tuning



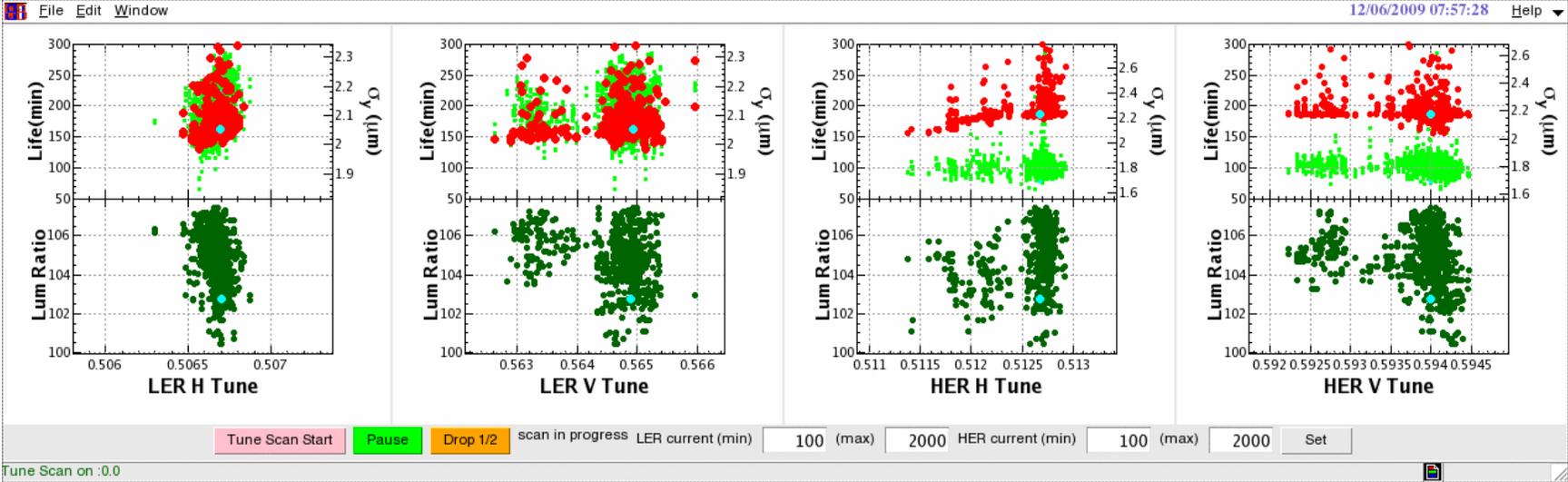
Coupling and vertical dispersion tuning panel

Knob tuning

Tuning Knobs

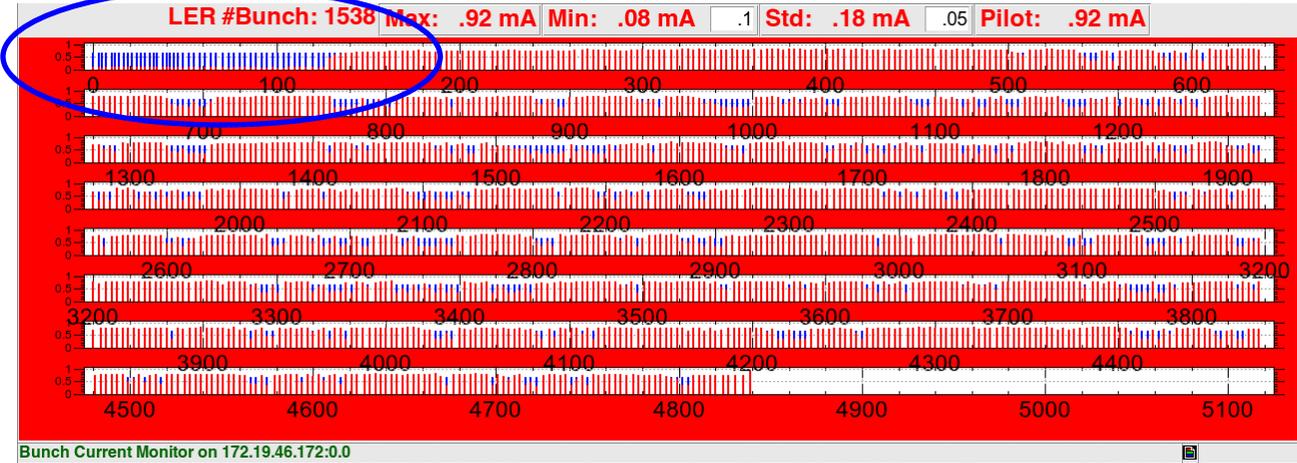
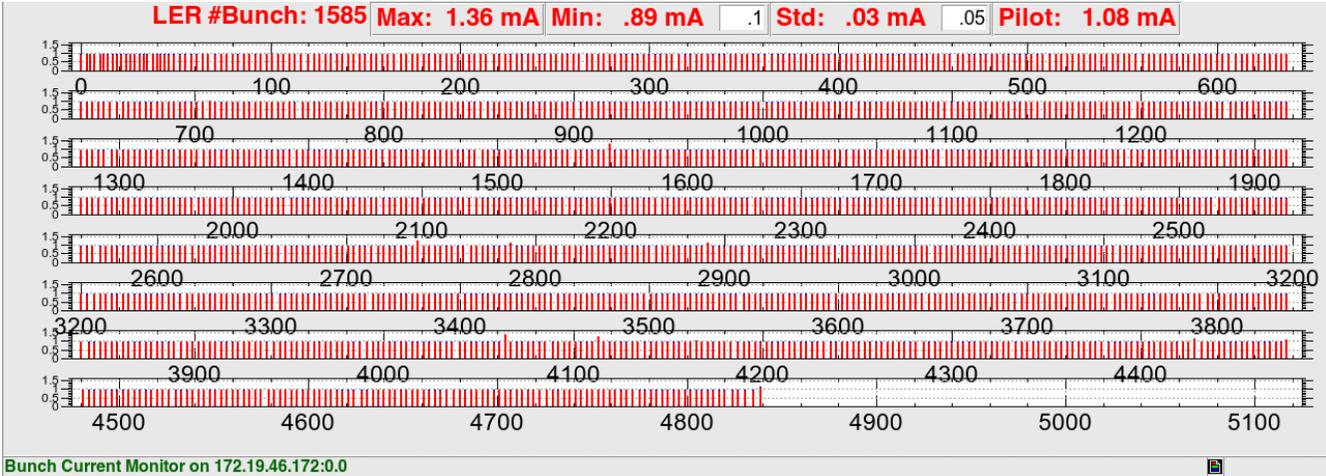
- **Waist**
The minimum position of the vertical beta function
- **Betatron-tune**
Tune of Horizontal and Vertical

Knob tuning



Betatron-tune plot chart

Knob tuning



Bunch Current Monitor

Knob tuning

Tuning Knobs

- **Vertex Point**

The RF phase of LER is adjusted by the program.

- **Chromaticity**

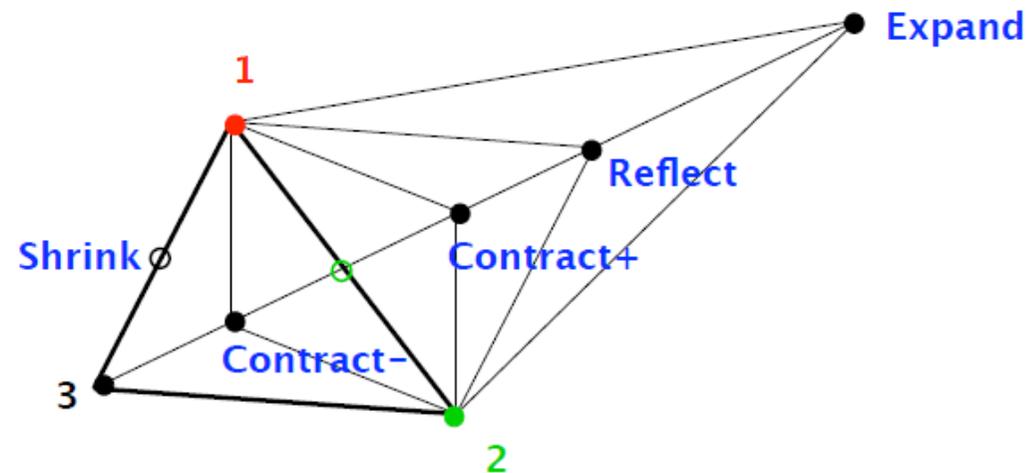
SX is adjusted and to extend beam life.

Knob tuning

Downhill Simplex Method

Method of Minimization

- $\{1, 2, 3\}$ 1(best) < 2(next-to-the worst) < 3(worst)
- Evaluate z_R
- If $z_R < 1$,
 - If $z_E < z_R$, $\{1, 2, z_E\}$: **Expand** , if not, $\{1, 2, z_R\}$: **Reflect**
- If $1 < z_R < 2$, $\{1, 2, z_R\}$: **Reflect**
- If $2 < z_R < 3$,
 - If $z_{C+} < z_R$, $\{1, 2, z_{C+}\}$: **Contract+** , if not, $\{1, 2, z_R\}$: **Reflect**
- If $3 < z_R$,
 - If $z_{C-} < 3$, $\{1, 2, z_{C-}\}$: **Contract-** , if not, $\{1, 2, z_S\}$: **Shrink**



Knob tuning

Downhill Simplex Method

File Edit Command Window 11/01/2009 15:42:55 Help

Optimize Load Simplex Load Vertex Settings

List View Graphic View

<< Double click each line to set knob >>

#	R1L	R2L	R3L	R4L	EYL	EPYL	R1H	R2H	R3H	R4H	EYH	EPYH	Green Ratio	Time
NEXT:	0.16	3.62	1.97	-0.49	0.54	-0.46	4.99	-17.29	4.63	-0.45	1.09	-5.97	---	15:39:25
SET:	0.16	3.62	1.97	-0.49	0.54	-0.46	4.99	-17.29	4.63	-0.45	1.09	-5.97	---	---
LAST:	0.81	4.67	2.73	-0.55	-0.12	-0.09	5.61	-16.51	5.99	1.27	1.03	-6.23	55.46	15:35:41
START:	0.20	3.49	1.94	-0.69	0.48	-0.81	5.00	-18.00	4.40	-1.25	1.33	-4.39	58.79	12:08:56
1	0.15	3.60	1.96	-0.49	0.52	-0.47	4.98	-17.30	5.95	-0.47	1.09	-4.66	61.45	15:30:12
2	0.44	4.41	2.86	-0.59	0.91	1.54	5.92	-16.99	5.32	0.07	1.15	-5.31	61.30	14:58:59
3	0.36	3.97	2.42	-0.93	0.69	-1.29	5.48	-17.25	4.88	1.08	1.55	-4.87	60.55	14:38:54
4	0.25	3.78	2.23	-0.72	0.66	-1.10	5.29	-15.71	4.69	-1.01	1.62	-4.68	60.26	14:05:21
5	0.64	4.40	3.31	-0.67	1.18	-0.38	3.11	-16.76	5.77	0.46	1.19	-5.76	59.86	15:06:02
6	0.29	3.90	2.35	0.66	0.62	-1.22	5.41	-17.13	4.81	-0.28	1.74	-4.80	59.77	14:16:45
7	0.57	4.71	3.16	-0.64	1.09	2.75	6.22	-16.84	5.62	0.33	1.18	-5.61	59.69	15:02:40
8	0.72	3.56	2.01	-0.52	0.43	-0.88	5.07	-17.55	4.47	-0.78	1.14	-4.46	59.68	14:51:07
9	0.48	4.24	2.69	-0.64	0.82	-1.56	5.75	-17.10	5.15	0.13	-1.19	-5.14	59.36	14:20:35
10	0.76	4.60	0.33	-0.71	1.35	-0.35	5.64	-16.62	6.05	0.69	1.22	-6.04	58.90	15:14:15
11	0.41	4.01	2.46	-1.21	0.75	-1.33	5.52	-17.25	4.92	1.50	1.85	-4.91	58.26	13:43:58
12	0.02	3.39	1.84	-0.59	1.66	-0.71	4.90	-17.50	4.30	-1.15	1.23	-4.29	58.26	13:36:21
13	-0.10	3.19	1.64	-0.39	0.18	-0.51	4.70	-17.58	4.10	-0.95	1.03	-6.89	57.96	13:05:07

Green Ratio (%)

Vertex

LER Current (mA)

HFR Current (mA)

15:30m0s 32m 34m 36m 38m

Initialize Simplex

Stop

Knob Ready

Simplex: **Contract-**

Set Knob for the next point

Start Data Taking

Green Ratio (%): 55.4581

Accept Data

Hold Auto Accept

Cancel & Restart Data Taking

Set Knob Again

Set Best Knob

Set Start Knob

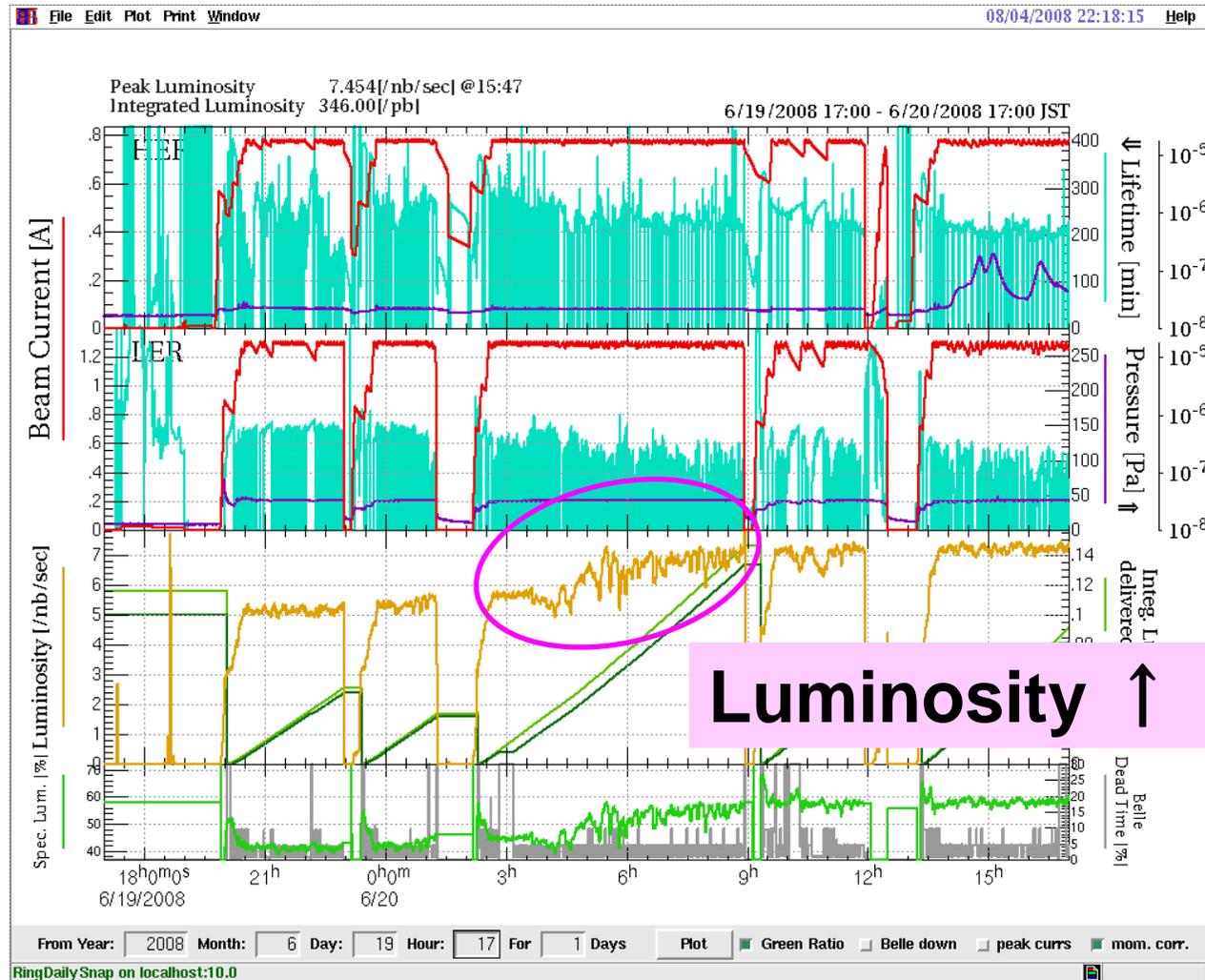
Set Center of Mass

Simplex Volume

1.89E-4

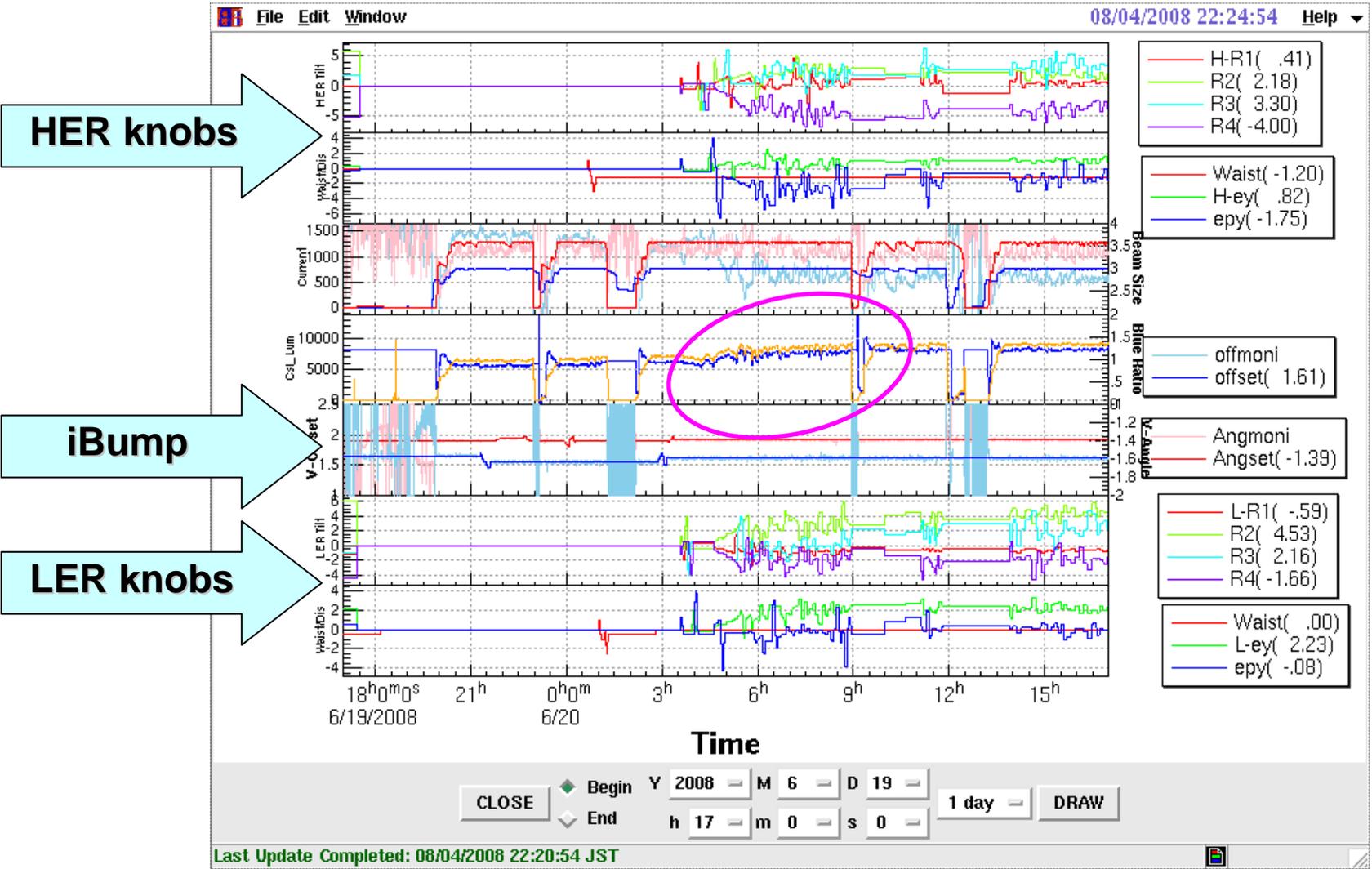
Start Data Taking?

Knob tuning



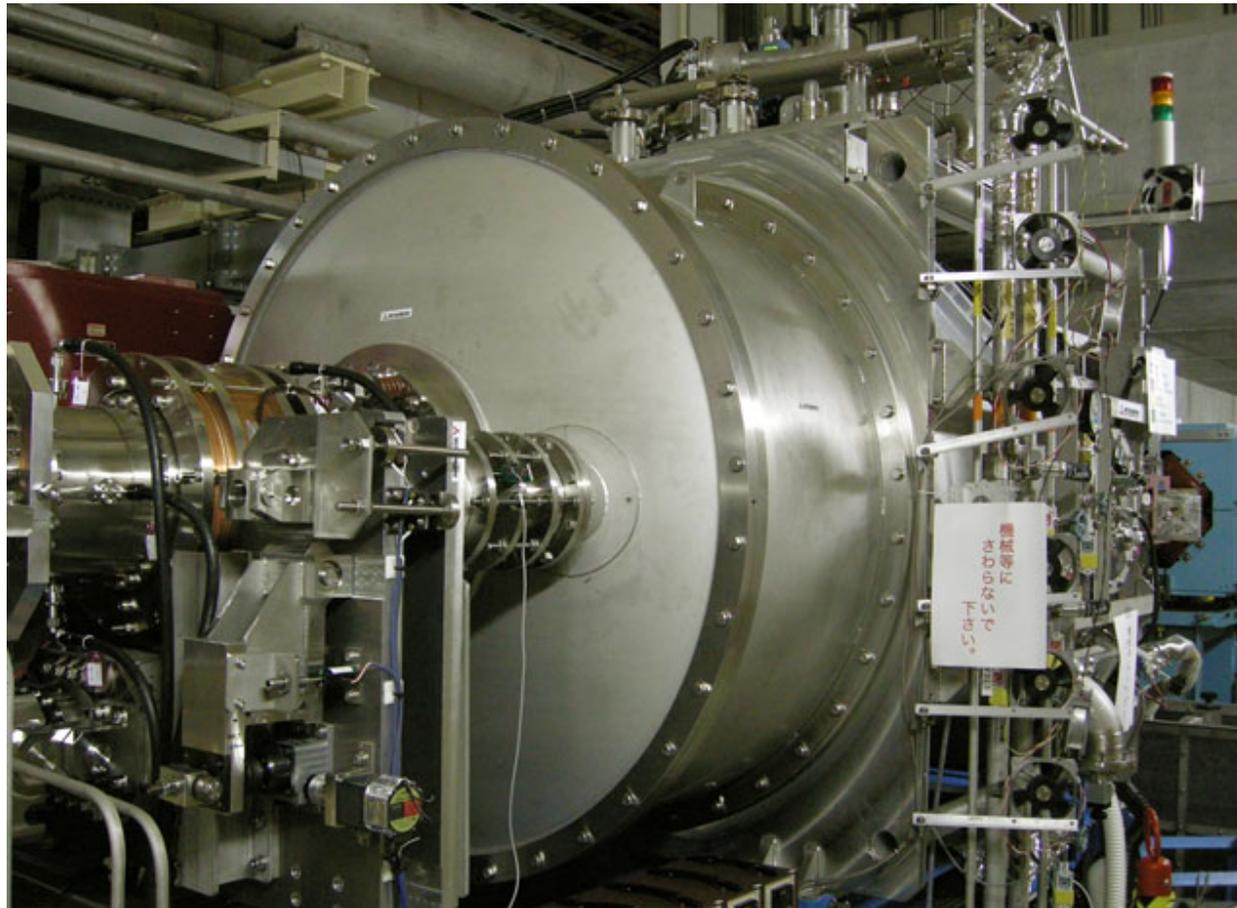
Knob scanning by DSM

Knob tuning

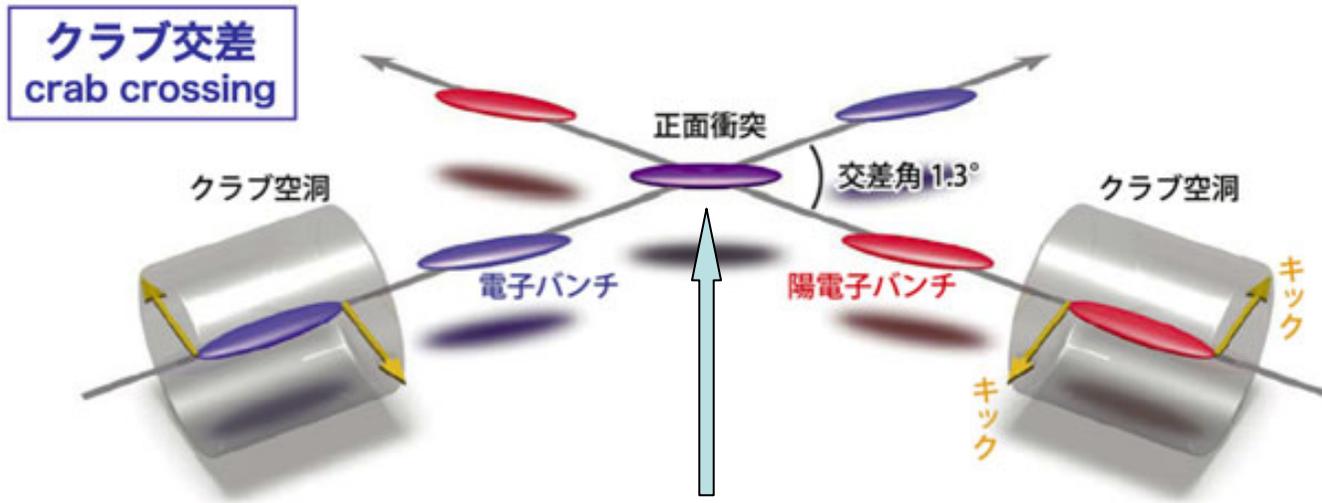
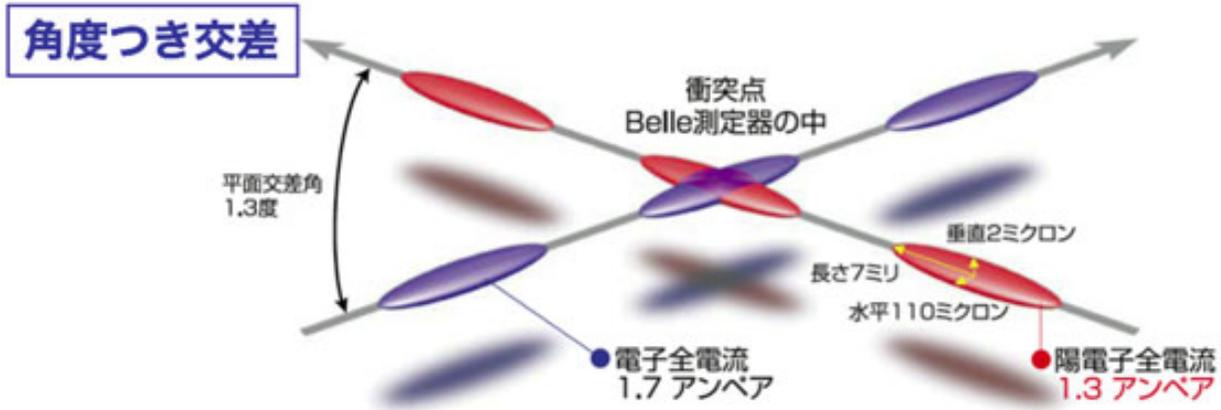


Movement of knobs at DSM

Crab cavities



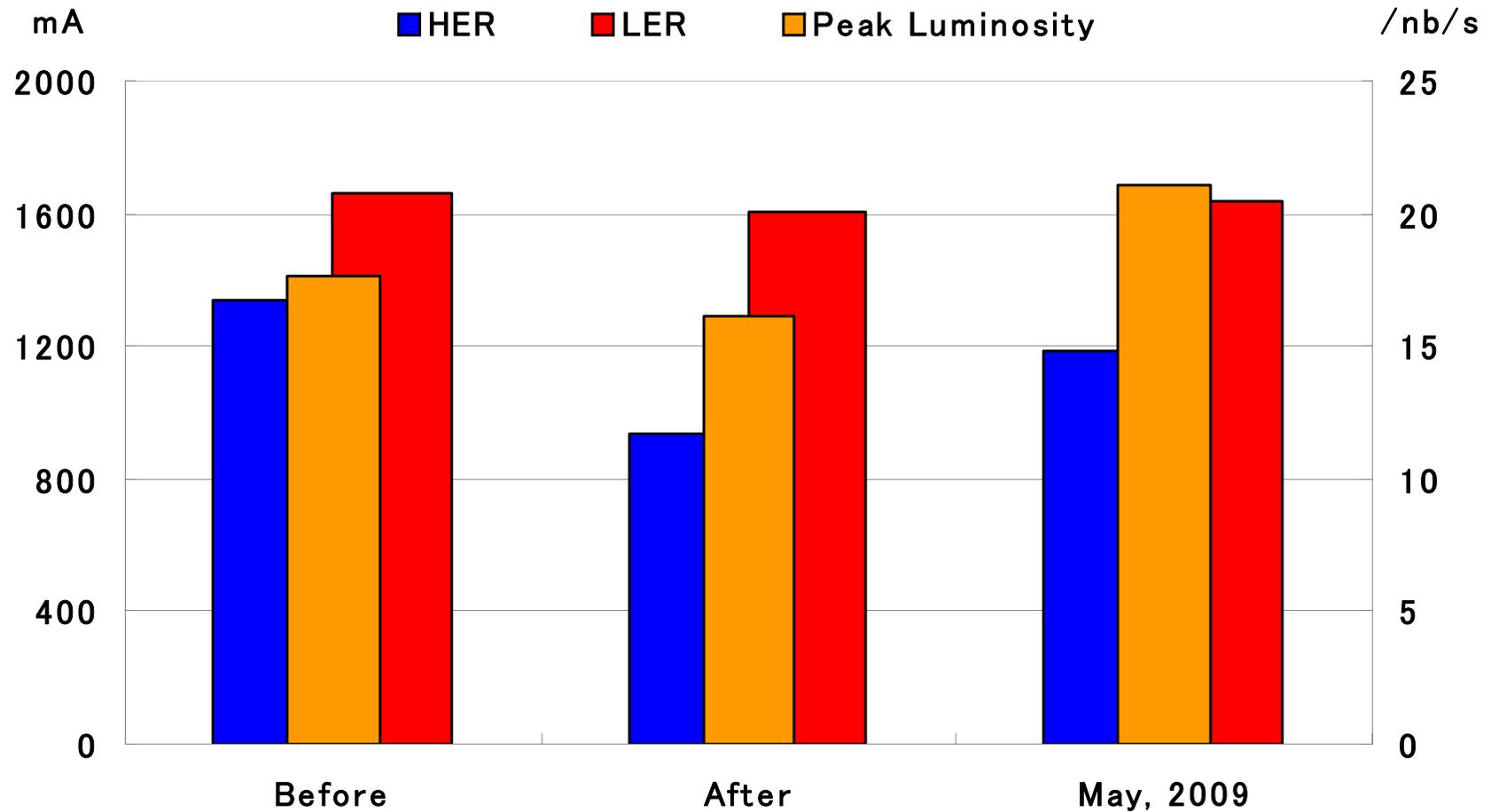
Crab cavities



Head-on collision

Crab cavities

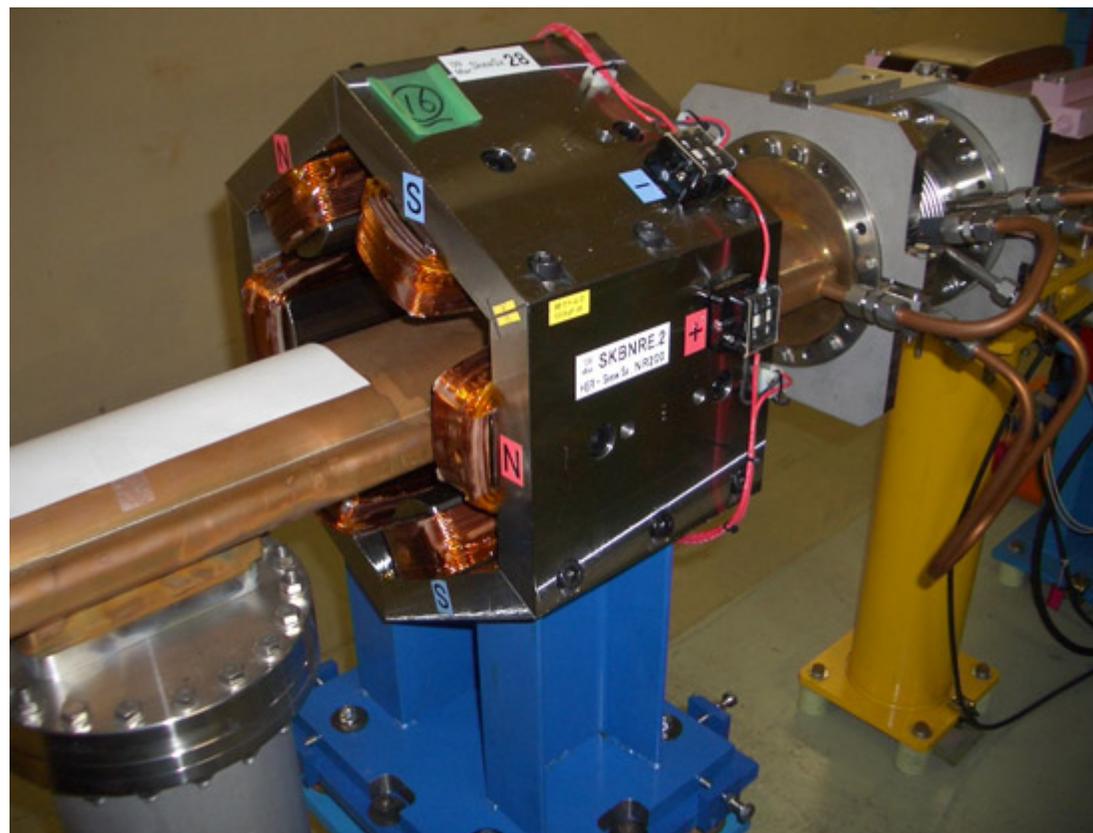
KEKB operation with crab cavities



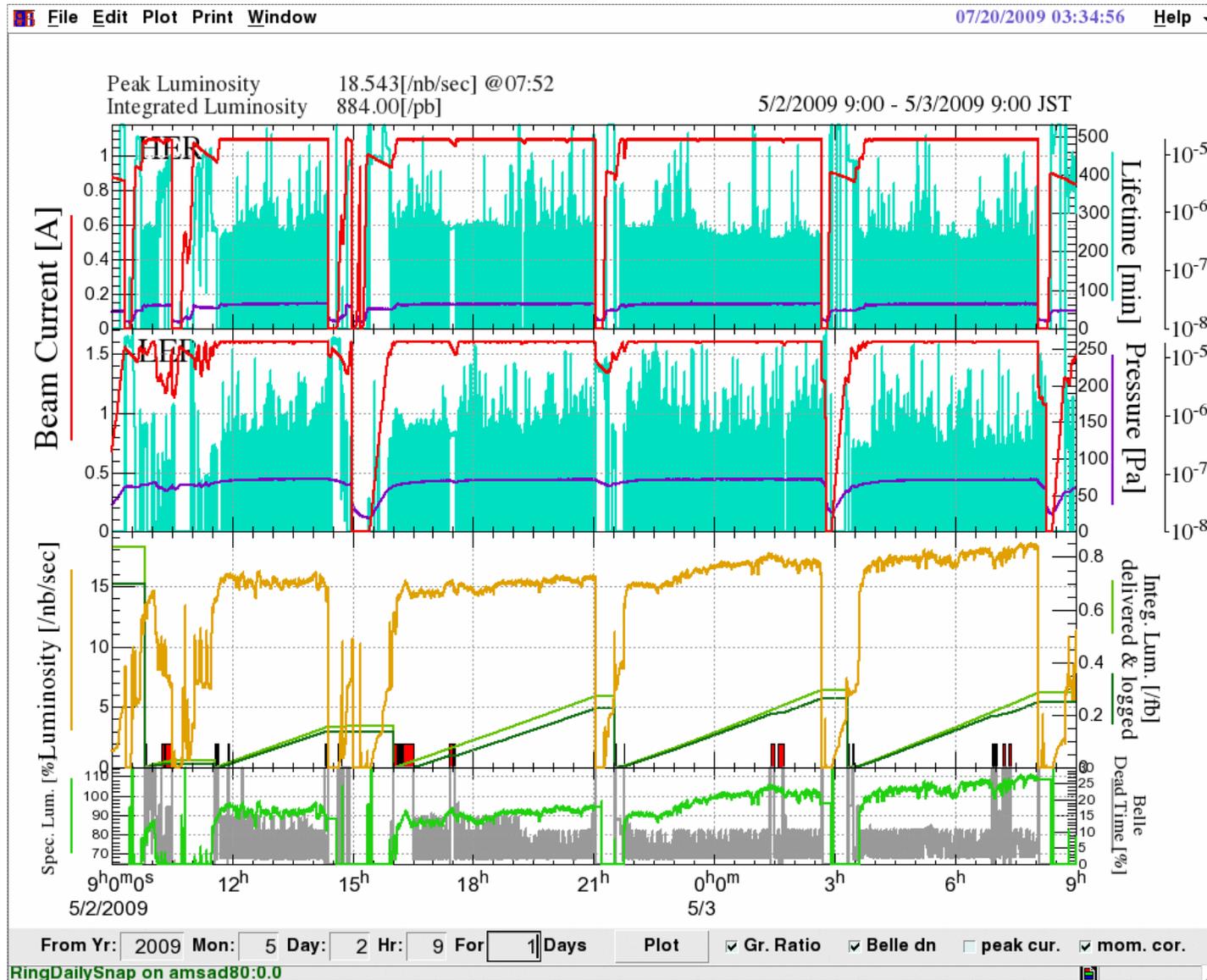
Crab cavities

- **Why HER beam current was able to be increased ?**
 1. **The aperture was extended near the LER crab cavities by the Optics change.**
 2. **The β_x in the collision point was loosened.**

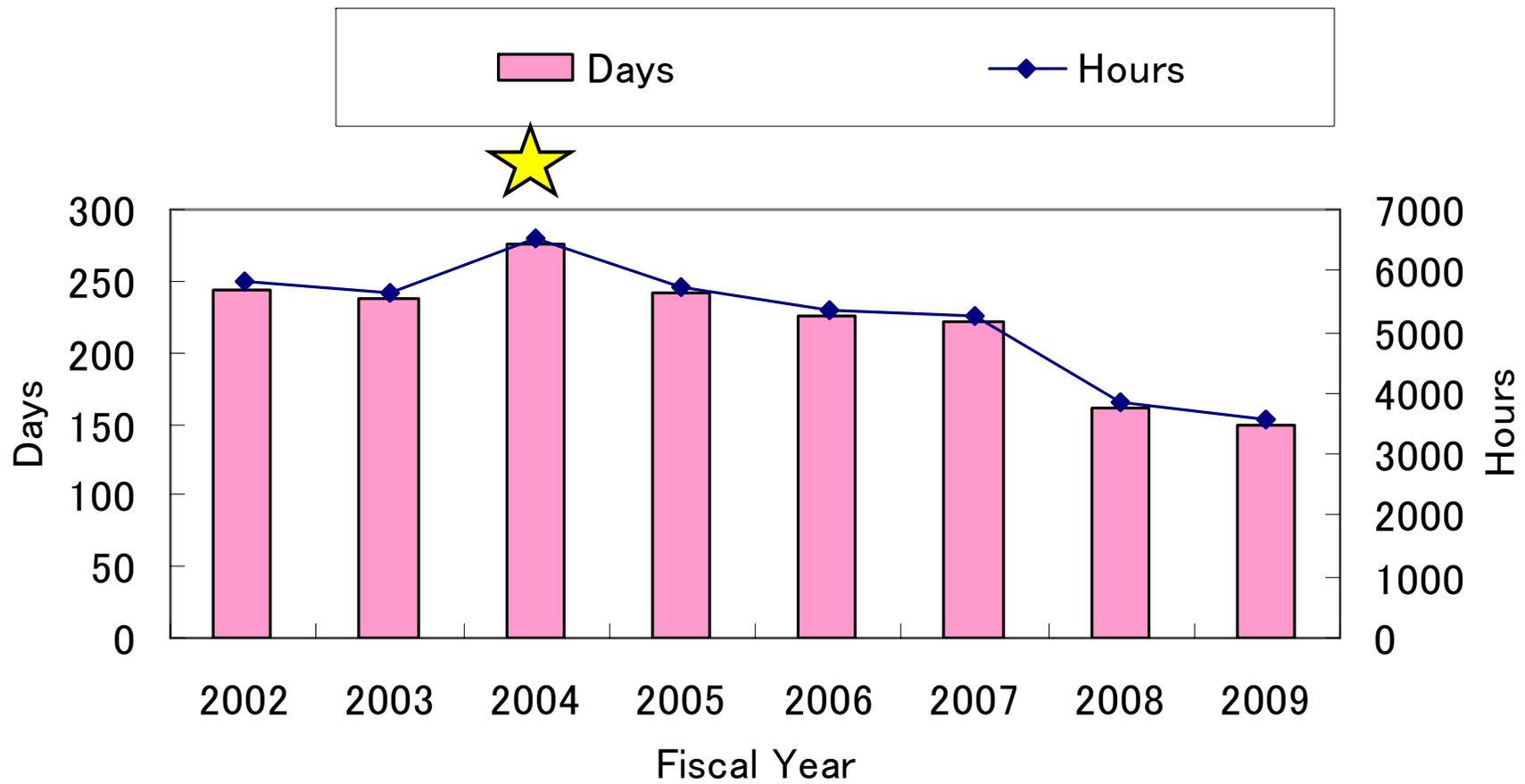
Skew sextupole magnets



Skew sextupole magnets

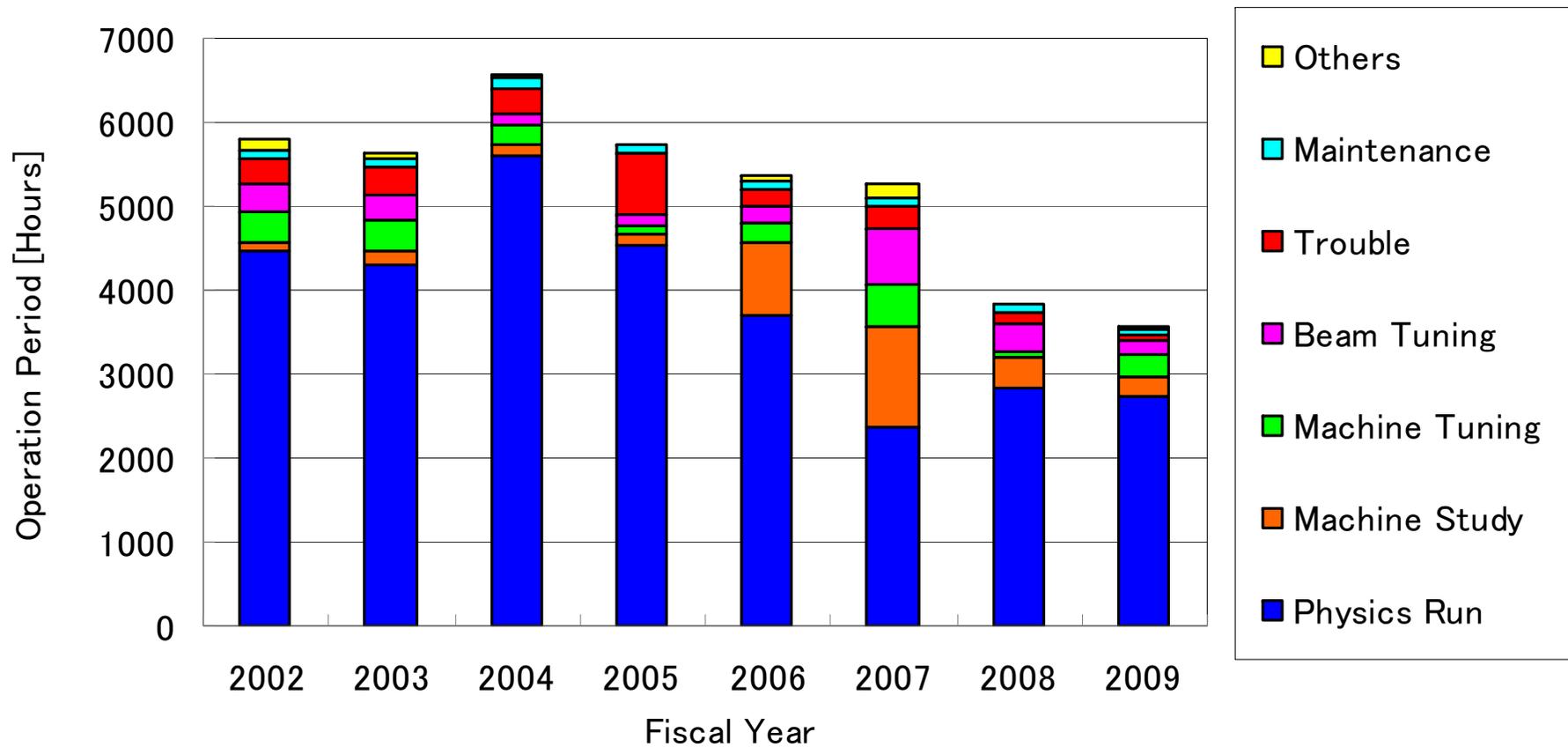


Operation period



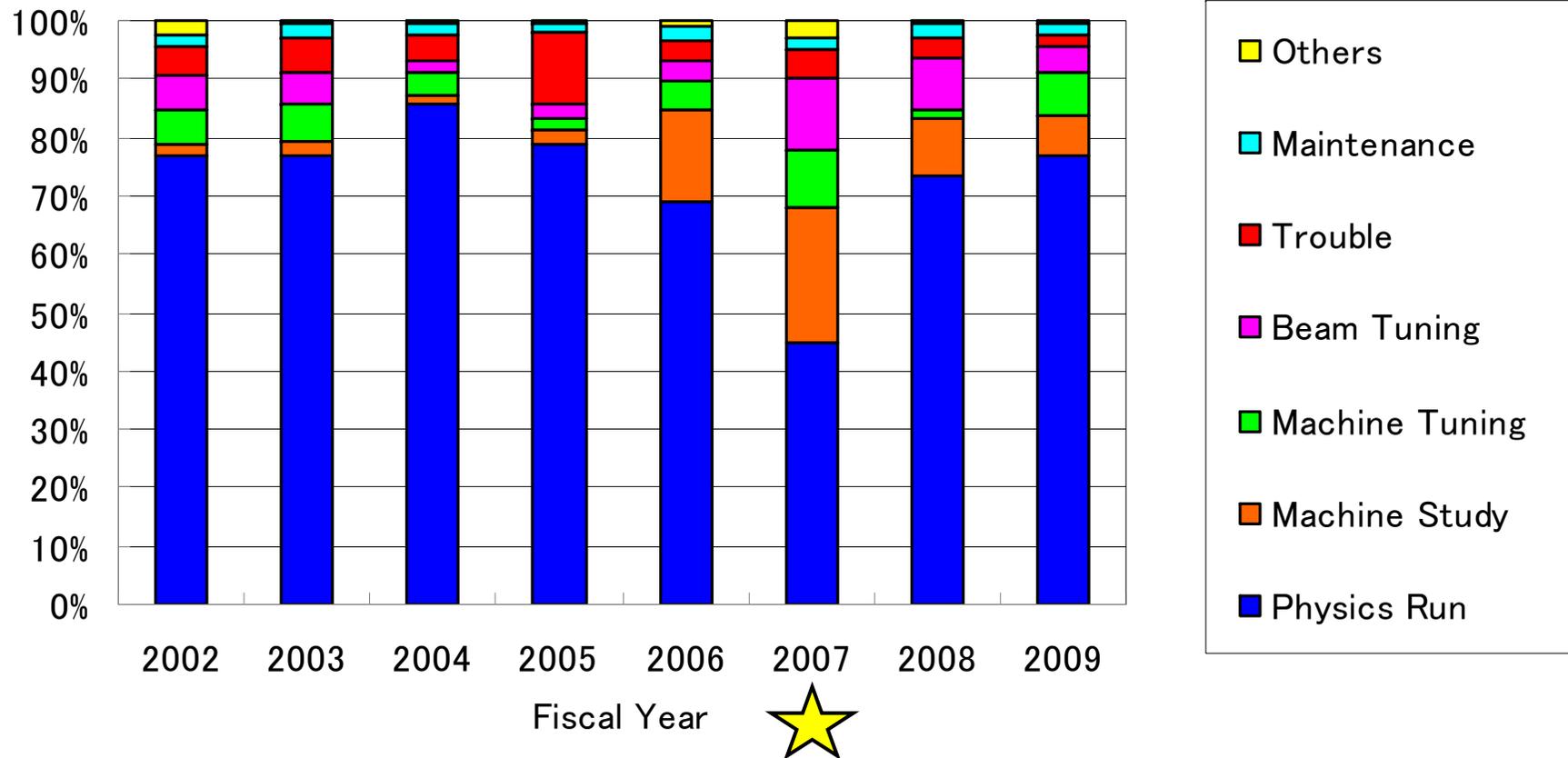
Operation period

The operation time and contents

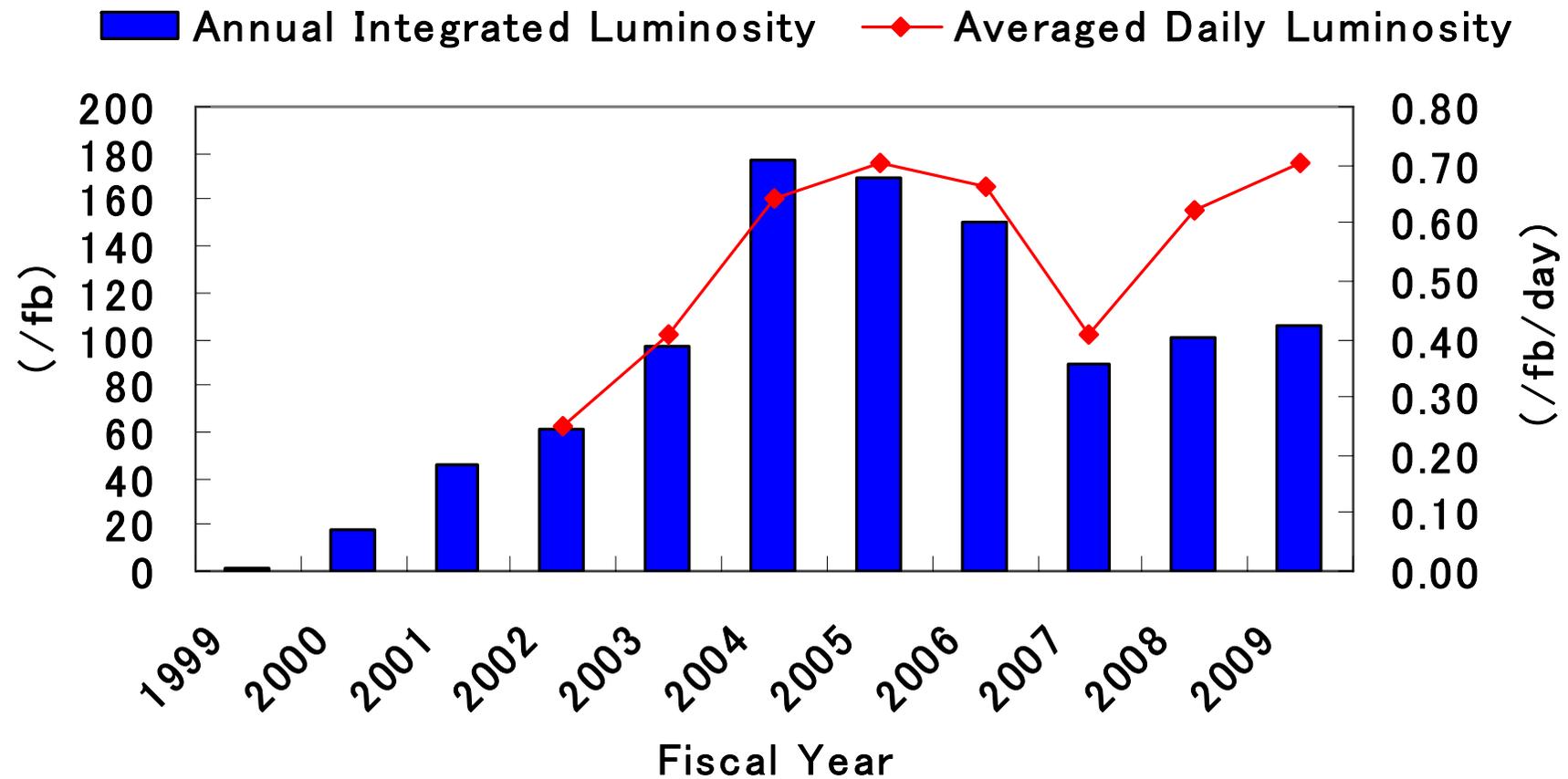


Operation period

The operation utilization rates



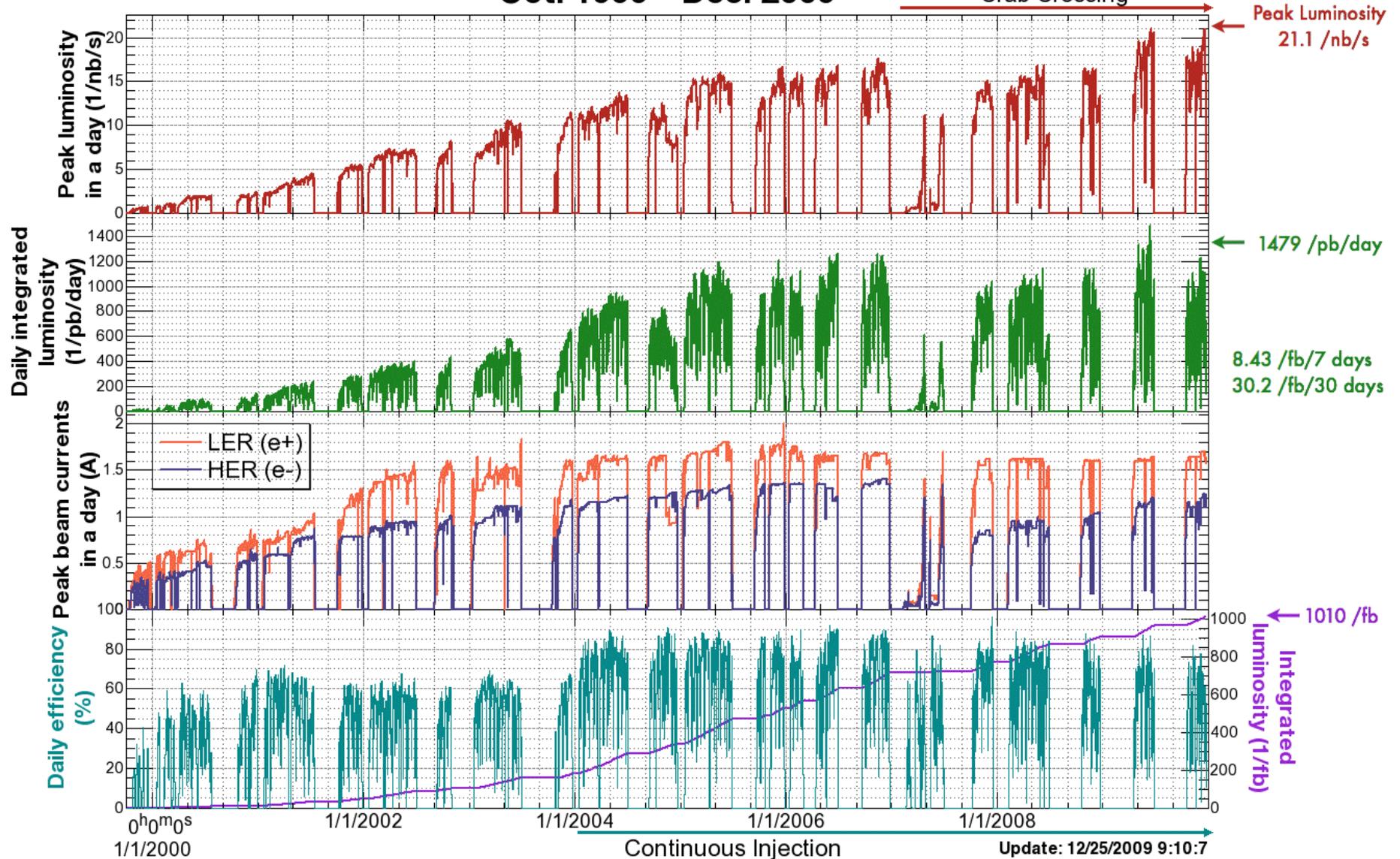
Integrated and peak Luminosity



Summary

Oct. 1999 - Dec. 2009

Crab Crossing

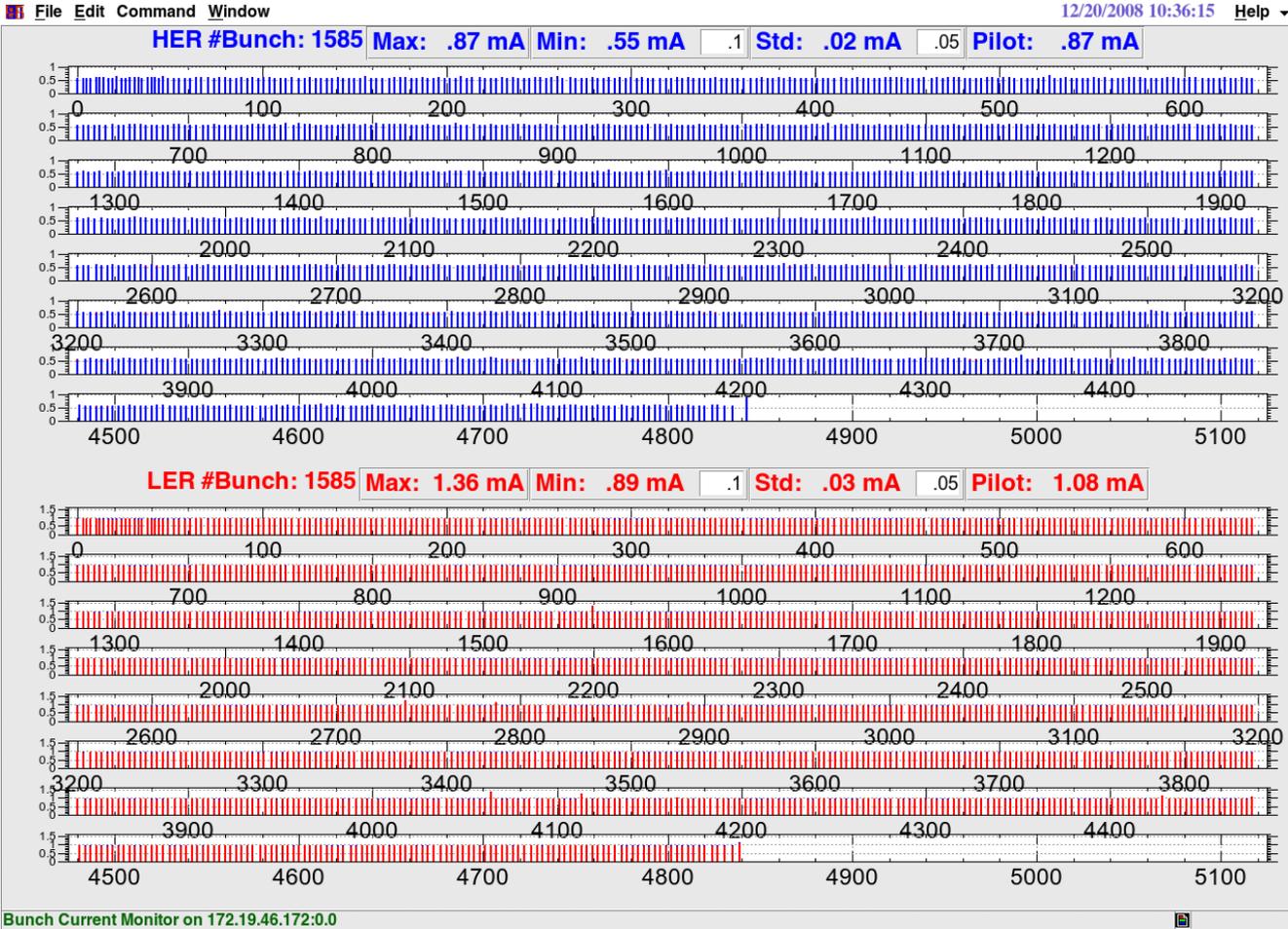


Acknowledgements

Thank you

Spare slides

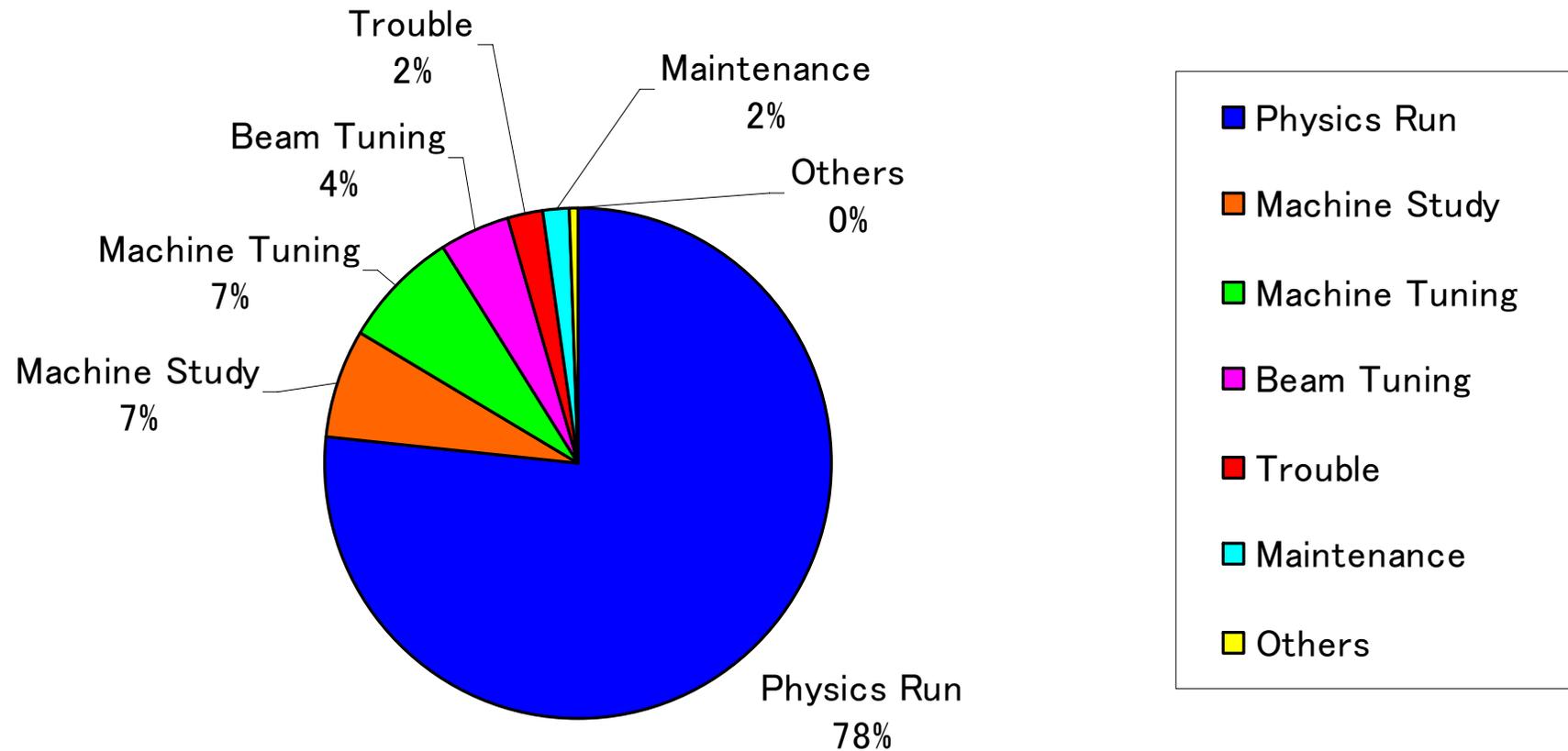
Knob tuning



Bunch Current Monitor

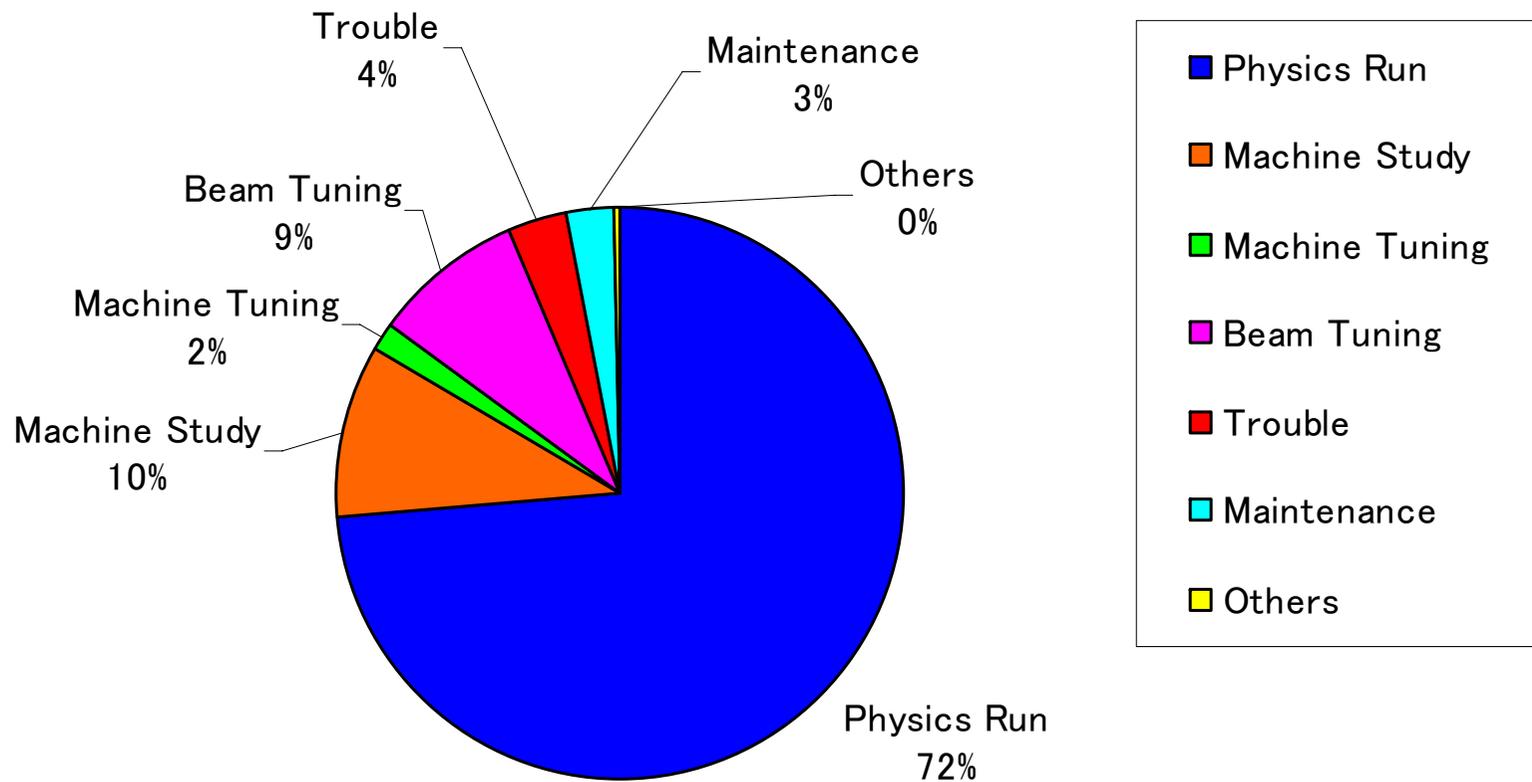
Operation period

Detail content of operation in 2009



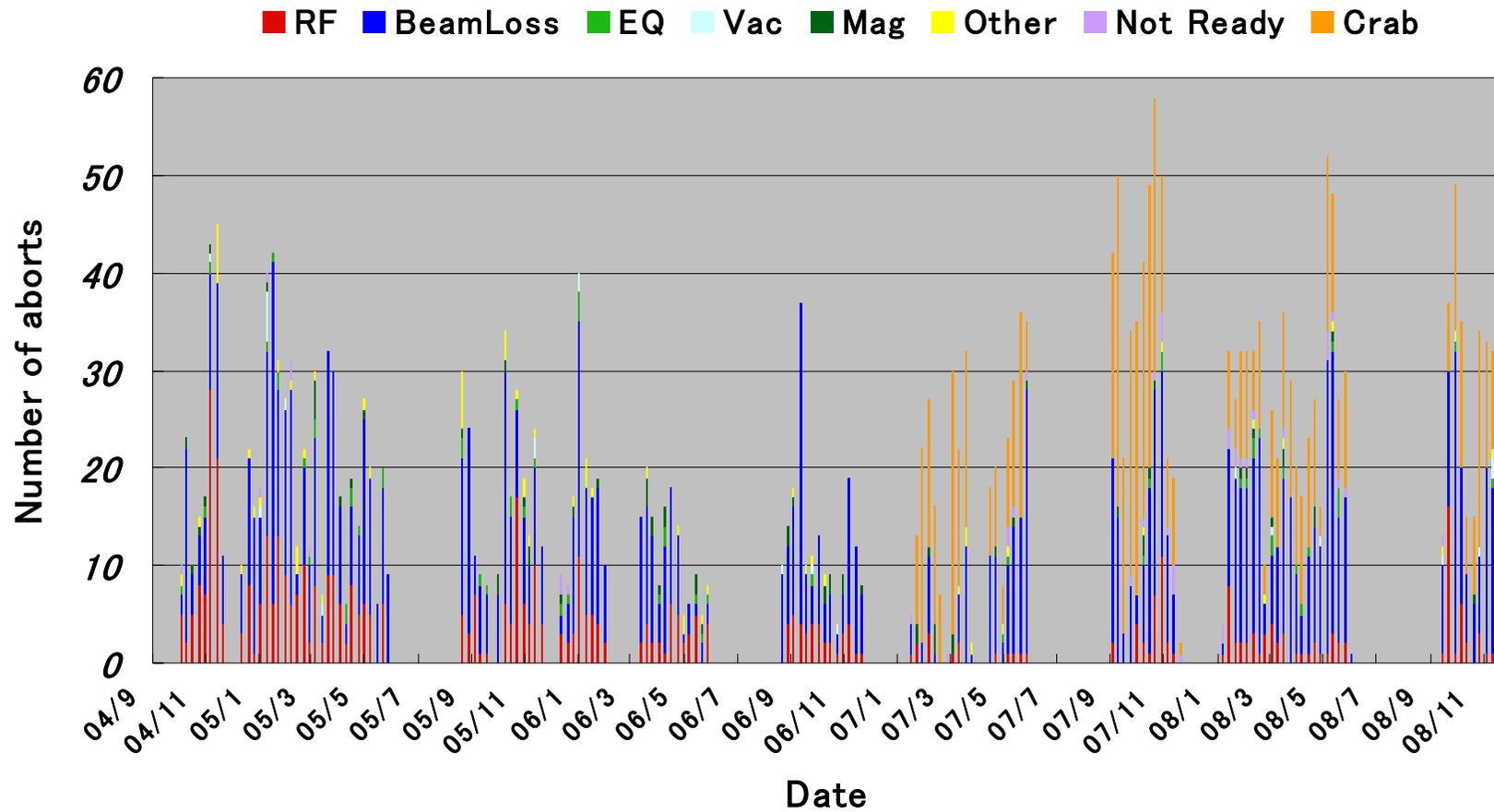
Operation period

Detail content of operation in 2008



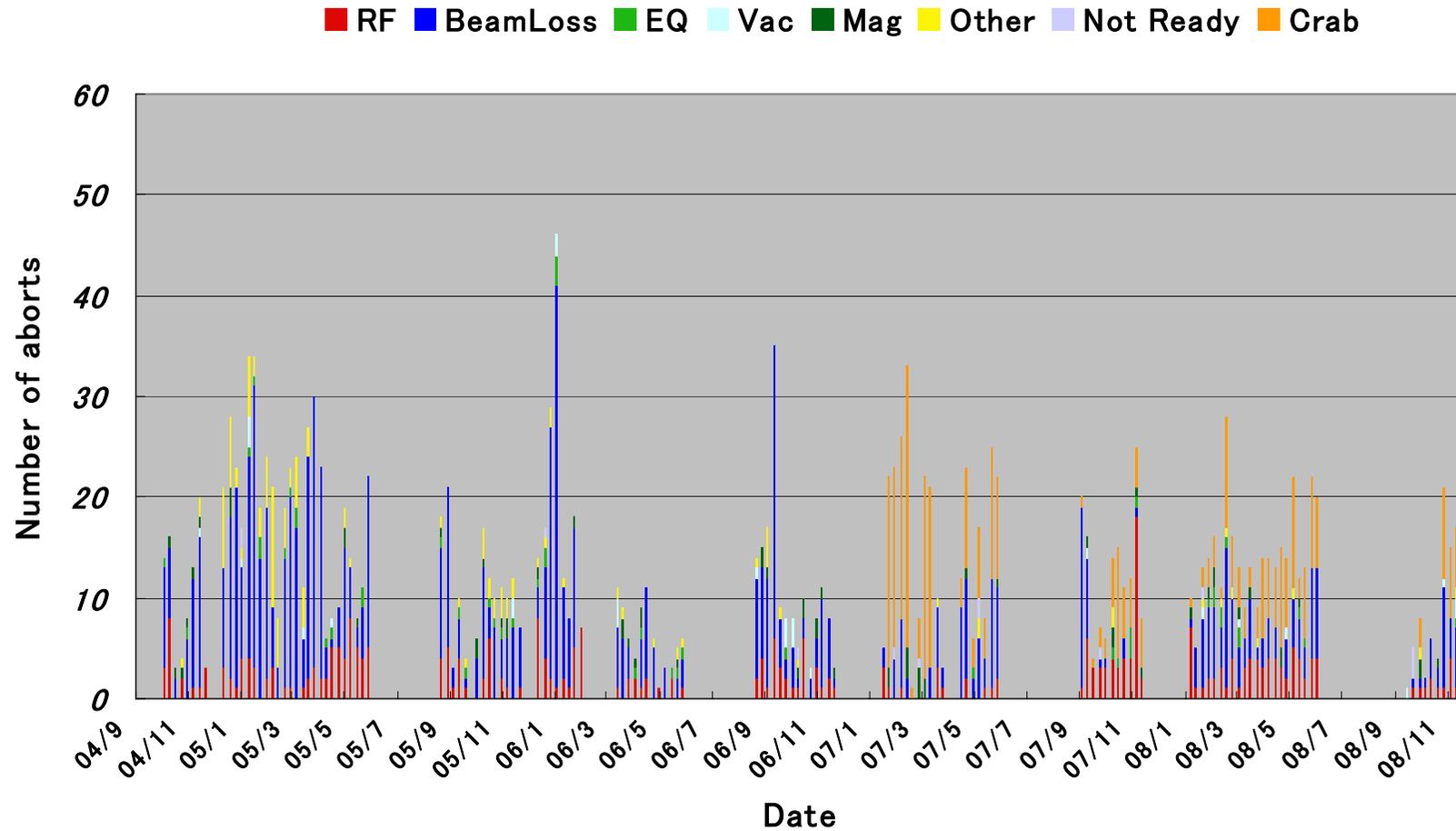
Beam abort

HER Weekly Abort 2004/10 ~ 2008/12



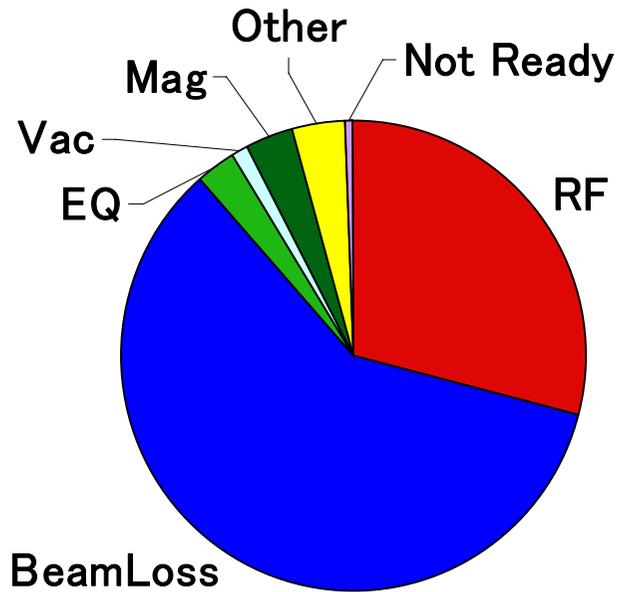
Beam abort

LER Weekly Abort 2004/10 ~ 2008/12

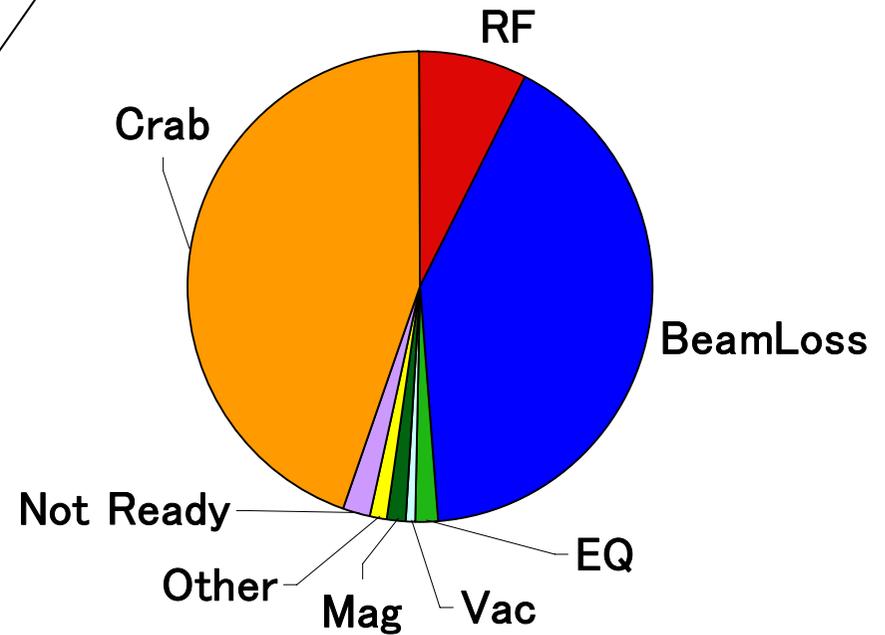


Beam abort

Before Crab Operation



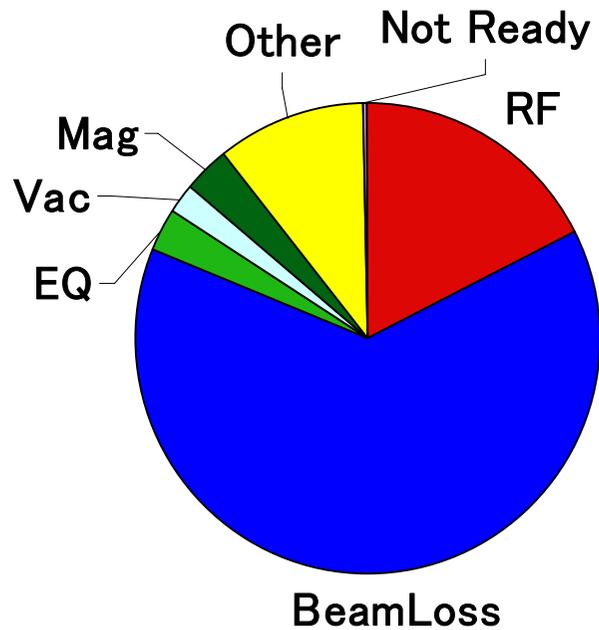
Crab Operation



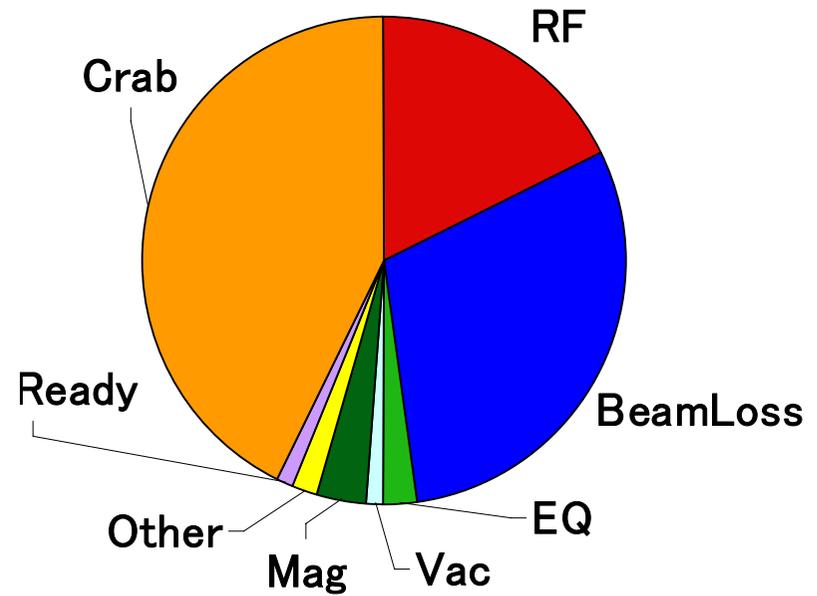
HER Weekly Abort 2004/10 ~ 2008/12

Beam abort

Before Crab Operation



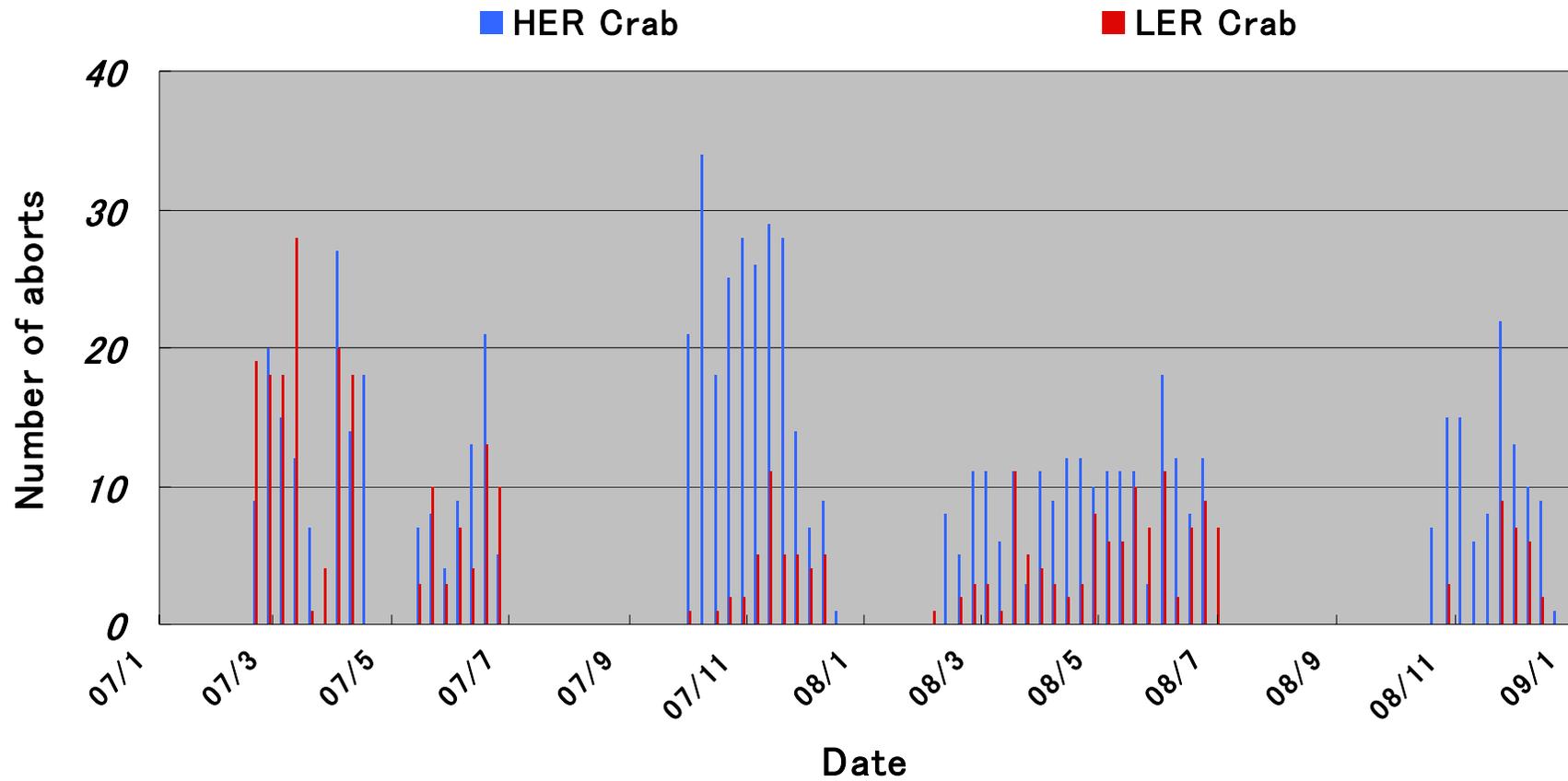
Crab Operation



LER Weekly Abort 2004/10 ~ 2008/12

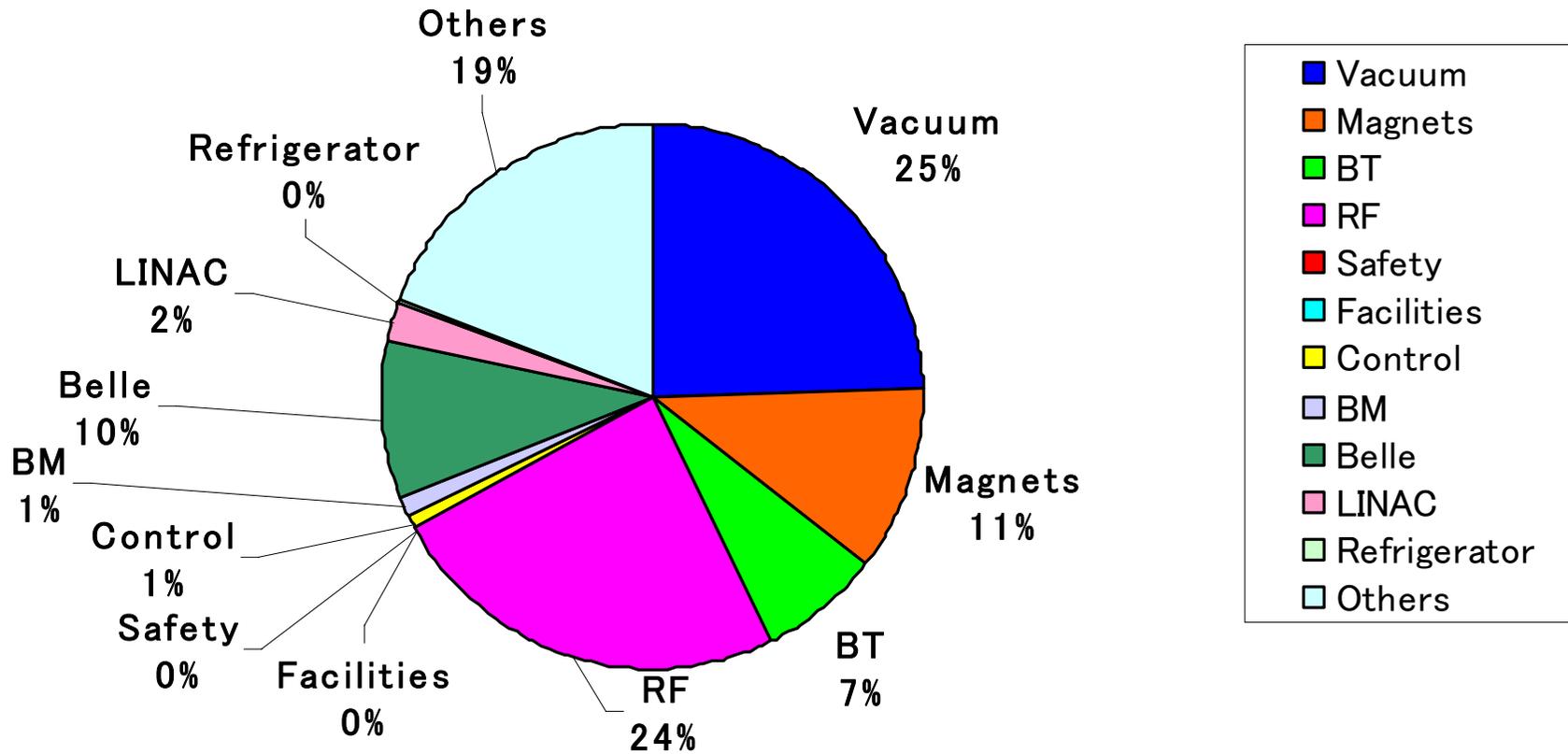
Beam abort

HER & LER Crab Abort 2004/10 ~ 2008/12



Breakdown time

Trouble details in fiscal year 2008



Breakdown time

Trouble details in fiscal year 2009

