Beam Position Monitor issues

M. Tejima

KEKB beam monitor group

2005.2.21

Contents

1. Diagnosis of BPM data
2. Check the BPM consistency during the measurement
   - Imperfect contact of connector
   - BPM signal cable breaks
3. Diurnal variation of BPM data
4. Movement of BPM chamber.
   - BPM of HER arc section
   - Reinforcement of support
   - BPMs of LER local correction
5. Summary

Diagnosis of BPM data

Consistency check among four positions of three electrodes

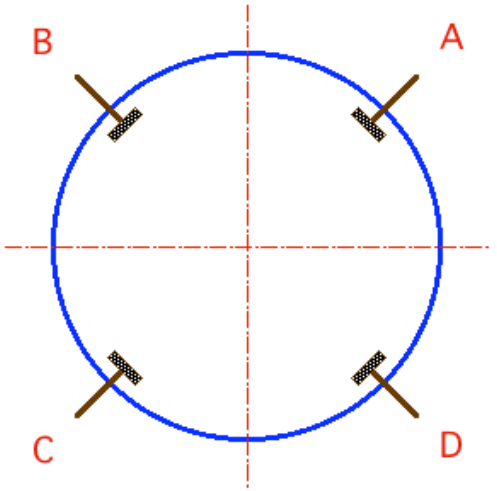
Beam positions are calculated from the four electrode outputs.

$$\begin{cases} X = F_X(H,V) \\ Y = F_Y(H,V) \end{cases} ,then\ H = \frac{(A-B-C+D)}{A+B+C+D}, V = \frac{(A+B-C-D)}{A+B+C+D}$$

The position can be obtained from only three electrode outputs also.

$$\begin{cases} X1 = F_X^{ABC}(H1,V1) \\ X2 = F_X^{BCD}(H2,V1) \\ X3 = F_X^{ACD}(H2,V2) \\ X4 = F_X^{ABD}(H1,V2) \end{cases}, \quad \begin{cases} Y1 = F_Y^{ABC}(H1,V1) \\ Y2 = F_Y^{BCD}(H2,V1) \\ Y3 = F_Y^{ACD}(H2,V2) \\ Y4 = F_Y^{ABD}(H1,V2) \end{cases}$$

$$then \quad H1 = \frac{A-B}{A+B}, H2 = \frac{D-C}{D+C}, V1 = \frac{B-C}{B+C}, V2 = \frac{A-D}{A+D}$$



If all electrode signals are correct, the results from combinations of (ABC), (BCD), (CDA), (DAB) should coincide with each other.

Here we defined the “consistency” by the standard deviations of four positions

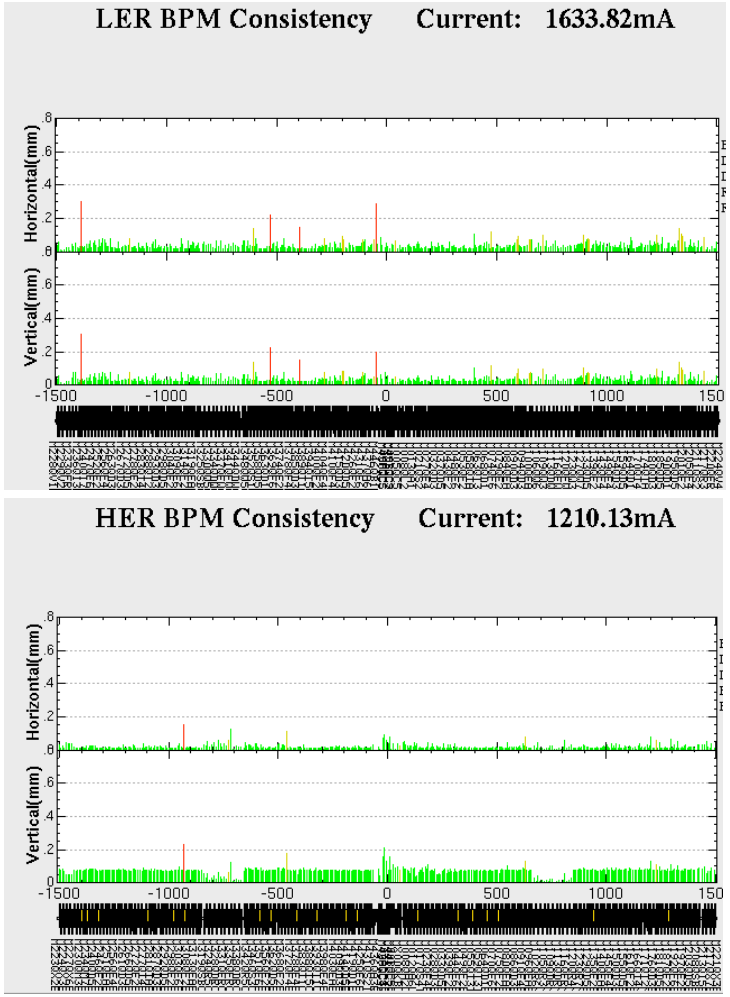
$$\begin{cases} Consistency\_X = STDDV(X1,X2,X3,X4) \\ Consistency\_Y = STDDV\ (Y1,Y2,Y3,Y4) \end{cases}$$

Check the BPM consistency during the measurement

To reject incorrect data,
BPM software always check the BPM consistency during the measurement

- Usually, consistency of BPMs expected to be less than 0.1mm (Four signals are correct)
- But the consistency of some BPMs have increased by various causes.

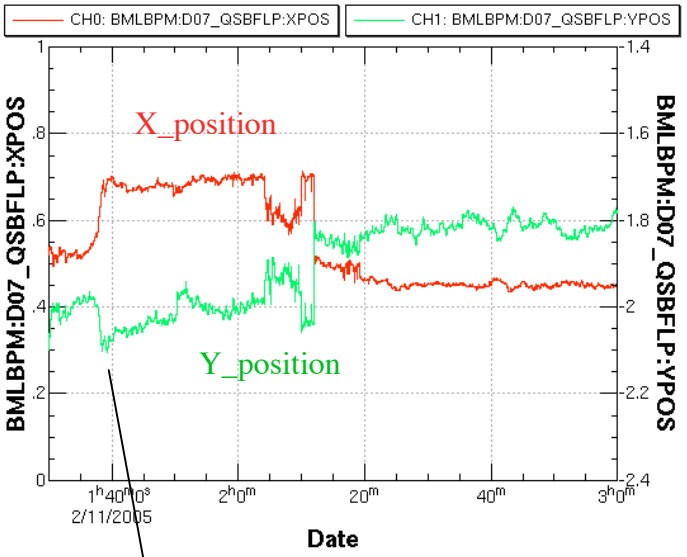
1. Irregular connection of BPM cables
2. Imperfect contact of connectors
3. BPM signal cable breaks
4. Drift of cable impedance of transmission line



Red line means an increase of consistency more than 0.1mm from initial value.

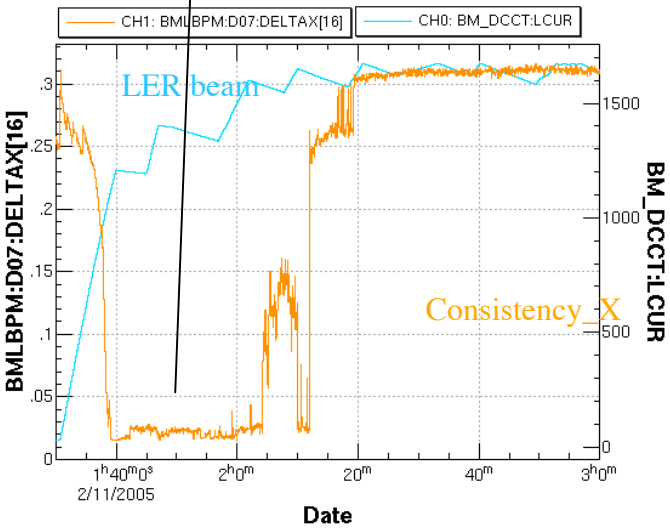
Diagnosis of imperfect contact of connectors

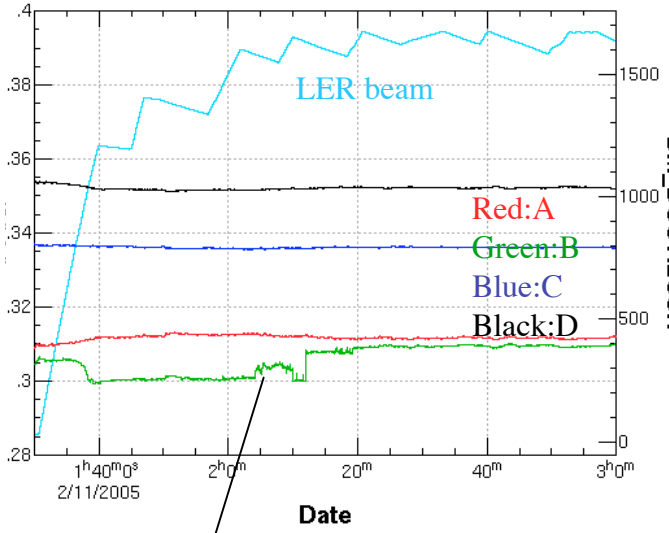
Output of C_electrode is unstable

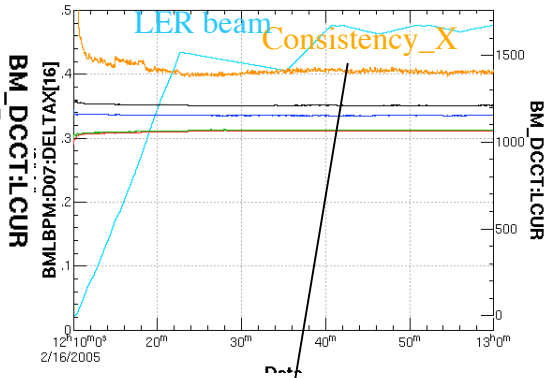


BPM consistency change remarkably during injection of LER beam.

Beam position also change in the same time



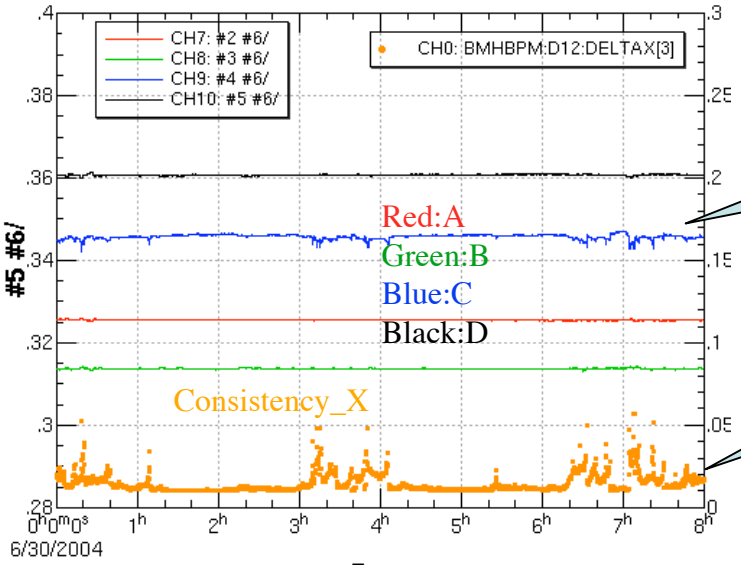




Irregular output of C electrode

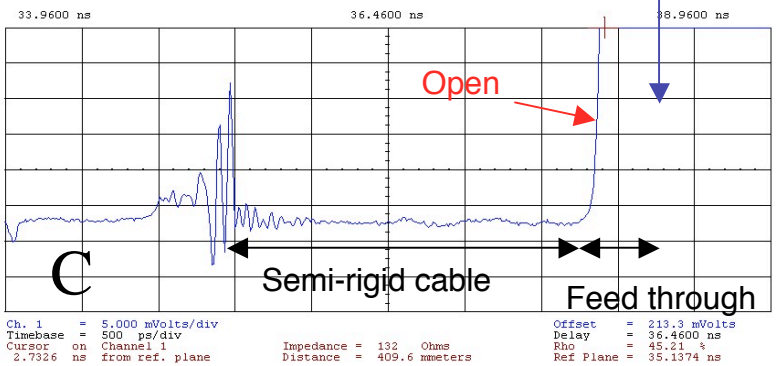
After change cable of C electrode, BPM consistency is stable

BPM signal cable breaks



Output of C electrode is unstable in comparison with other electrodes

BPM consistency scatters frequently



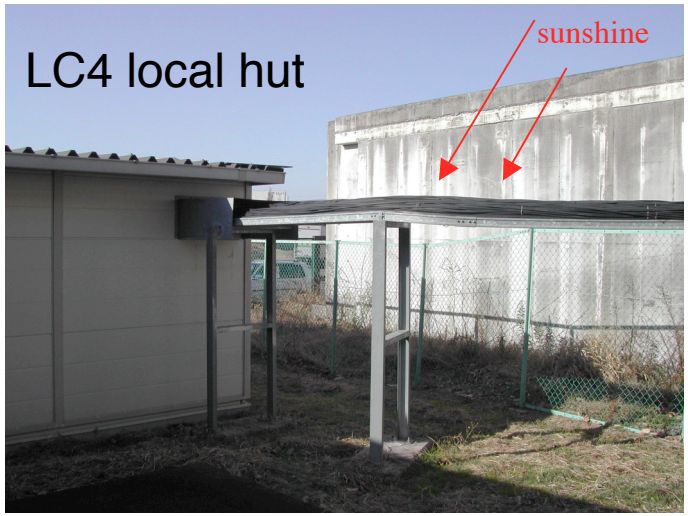
TDR check

Central pin was broken in N-type connector

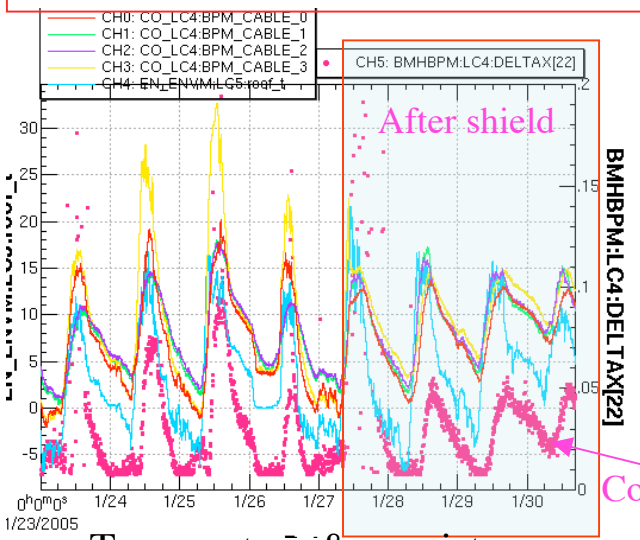
Diurnal variation of BPM consistency

Increasing the temperature made impedance of coaxial cable drift.

- BPM signal cables were installed from ground level to tunnel.
- Part of the total cable length are cabled in outdoor area.
- Effect of air temperature and sunshine caused the diurnal variation of BPM consistency.
- To avoid sunshine, cables are wrapped by the insulating sheet.



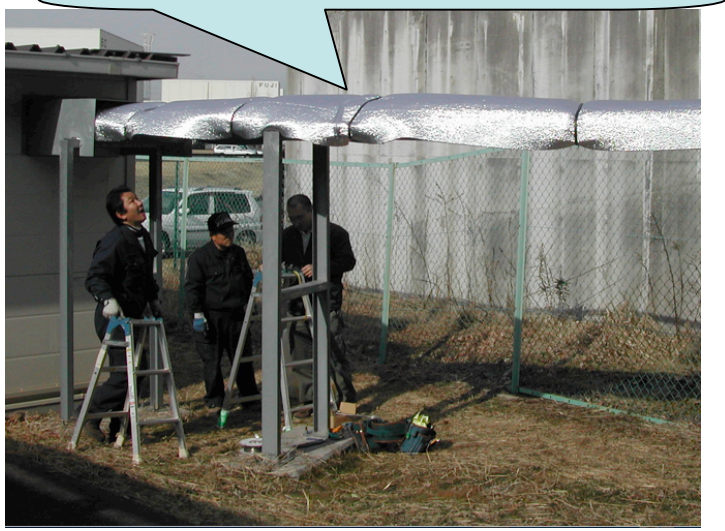
Yellow & red line: temperature over the cable rack
Blue & purple line: temperature under the cable rack



Consistency_X

Temperature & consistency

Wrapping by using insulating sheet

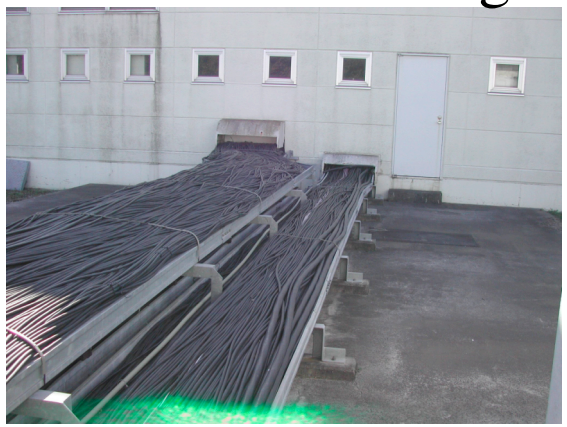


Sunshine and air temperature shielding plan

- The other three local buildings have also been cabling in outdoor.
- To intercept from sunshine and air temperature, we are planning on shielding completely this year.

D06 local building

D03 local building

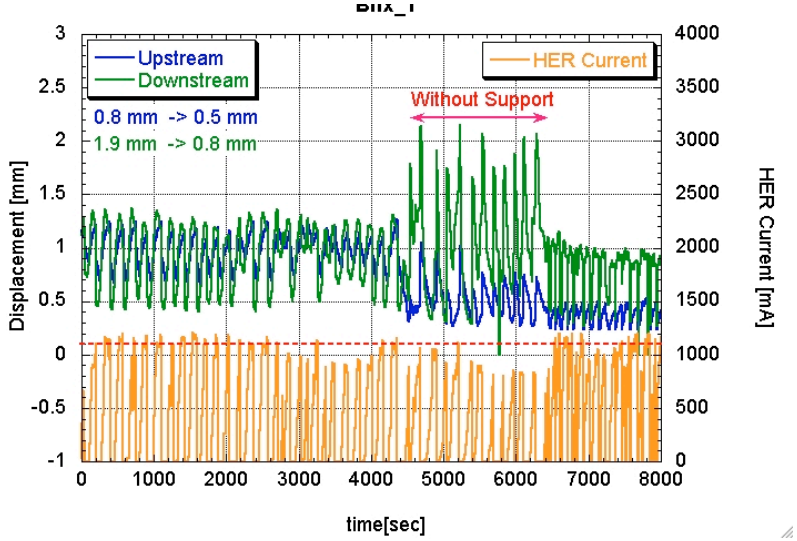


D12 local building

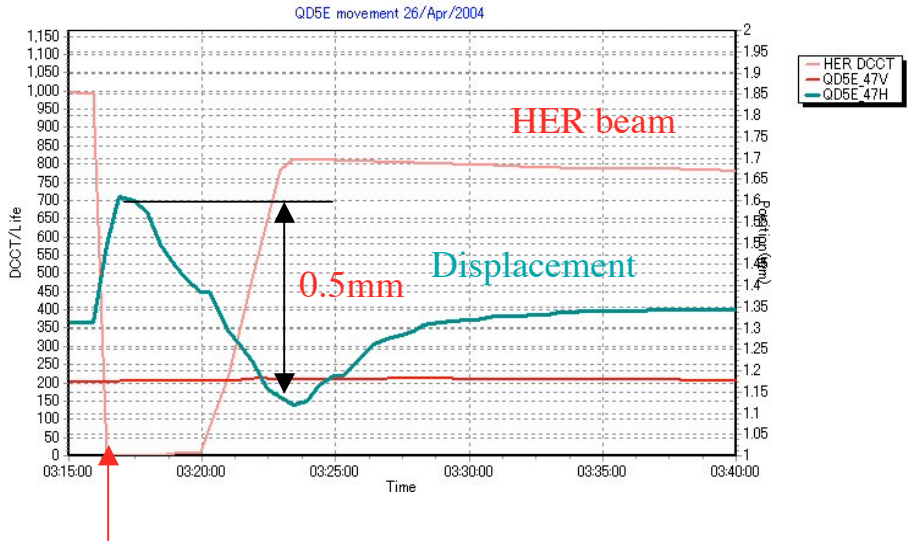
Movement of BPM chamber due to heat up by beam intensity.

How to prevent mechanical movement of BPM is serious problem for Super KEKB

- The movement of a BPM chamber is measured by displacement meter.
- BPM chambers were moved a several hundred μm from the setting position due to the heating up of vacuum chamber.



Movement of bending chamber



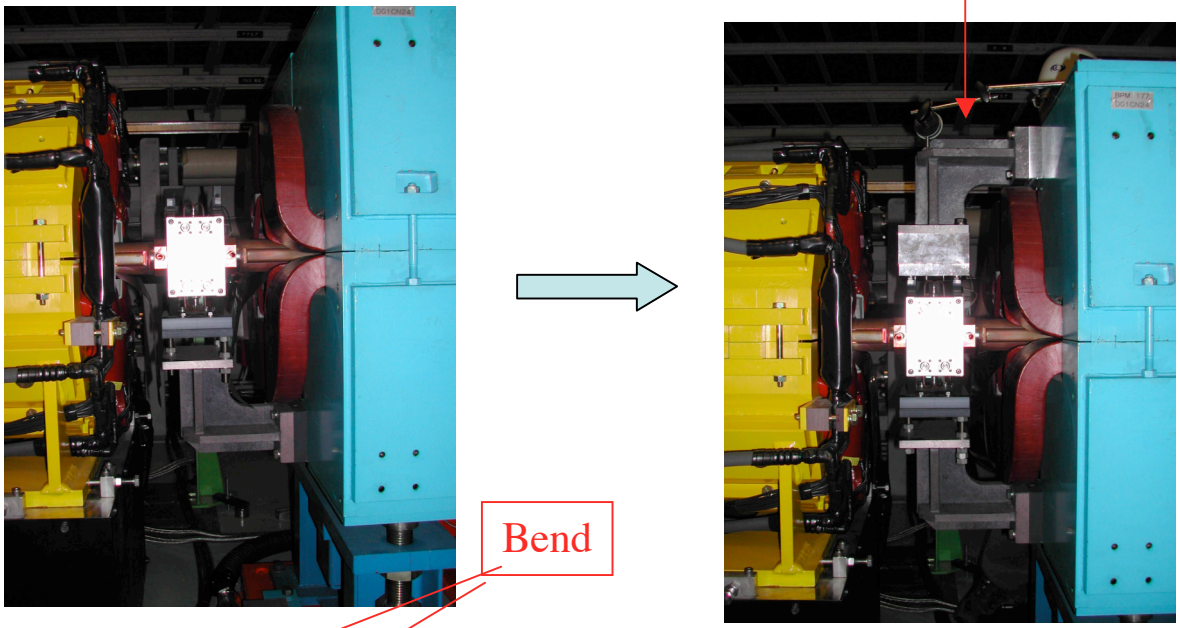
Abort

Movement of BPM head

KEKB BPMs

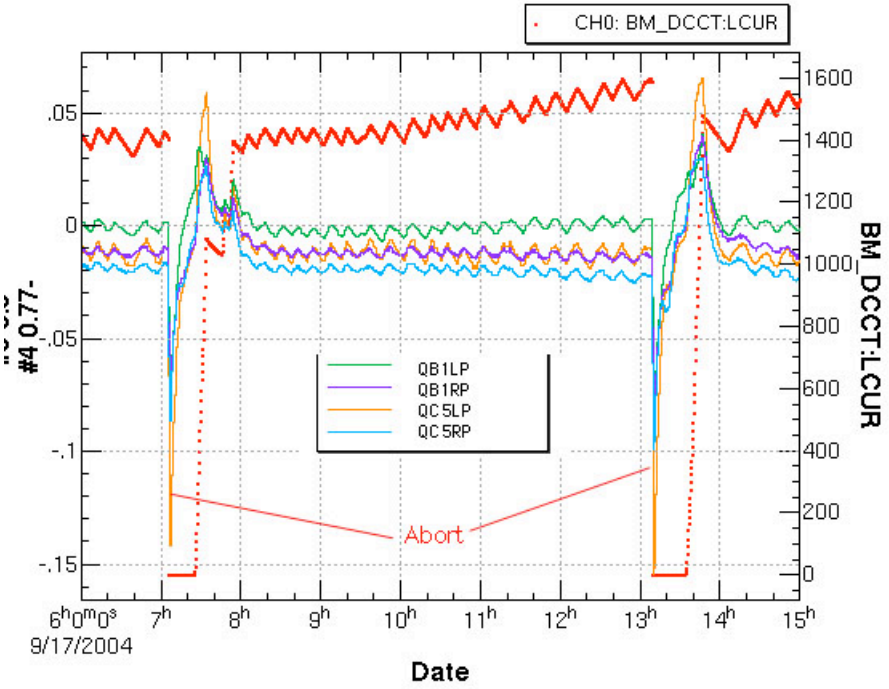
Reinforcement of support

- 21 BPMs of HER located just downstream at the twin bends, have been fixed more firmly with additional upper support on a each quadrupole magnet.
- The movements decreased less than 0.05mm

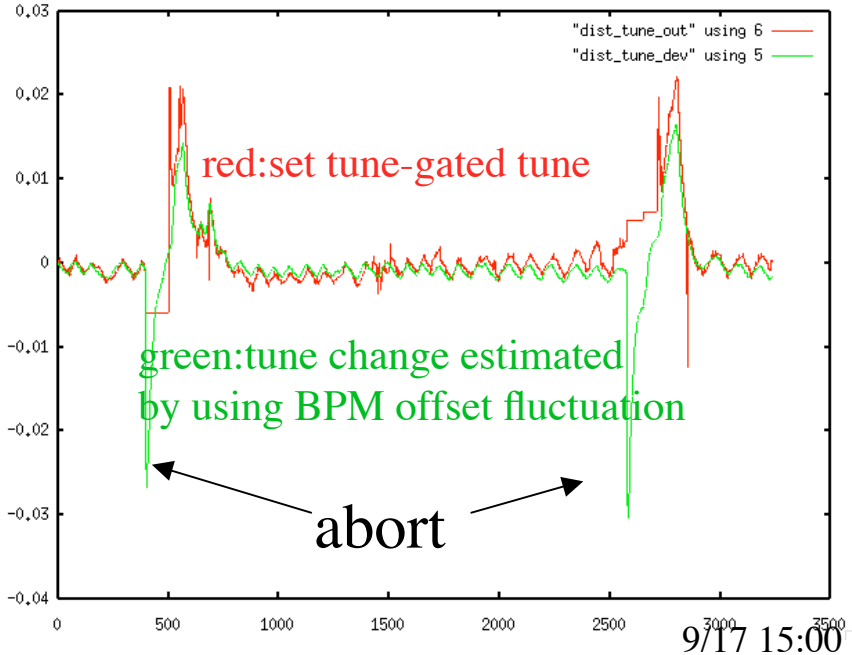


Movement of BPM chambers at LER local correction section

- LER V tune changes due to the movement of BPM chambers in sextupole magnets at the local chromaticity correction section.
- These movements are compensated in the beam position data by these displacement measurements.



Movement of BPMs offset

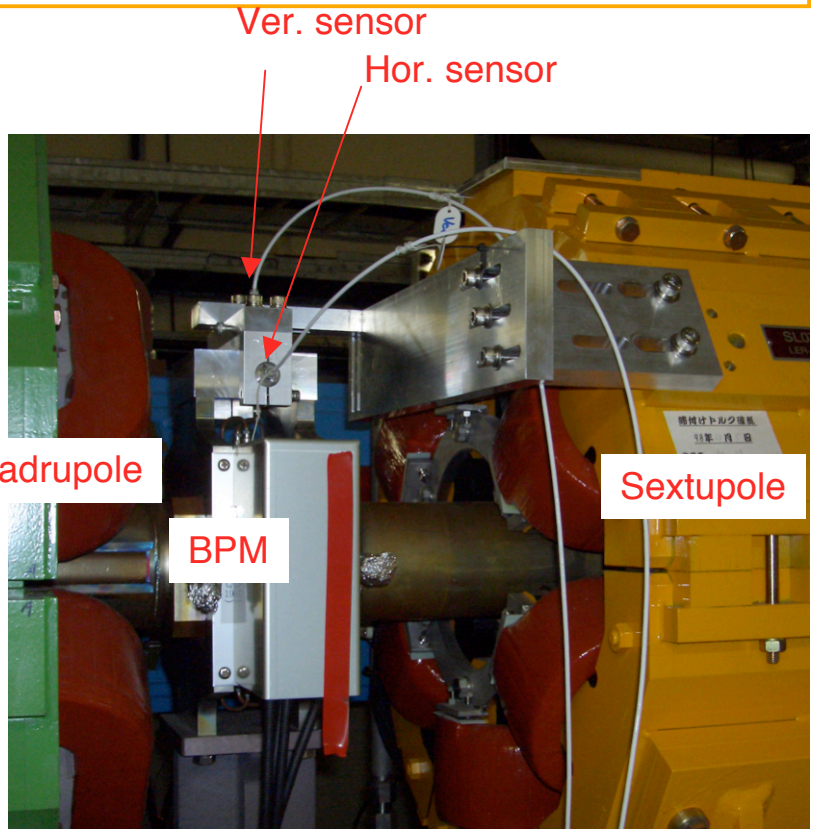


LER Vertical tune change

9/17 15:00

Development of displacement sensor for super-KEKB

- Requirement
  - Free from magnetic field
  - Radiation resistance
  - Resolution less than 1μm
- Such as sensor is electrostatic monitor.
- Commercial displacement sensor is too expense. ($5,000/unit)
- We started development of the inexpensive displacement sensor, because Super-KEKB needs a lot of sensors.



Displacement sensor attached to sextupole magnet

Summary

- BPM consistency check during the measurement is important to guarantee the COD data.
- BPM data are affected by the signal cable temperature caused by sunshine and air temperature variation.
- Movement of BPM chamber due to thermal stress at Super-KEKB will be serious problem.

END