First Observation of Beam Collision in KEKB

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Beam Collision

1.Finding of Beam Collision

1)Logitudinal

Observables

- Beam timing

Tuning Tool

- RF Phase

2)Transverse

Observables

- Beam-Beam deflection
- Beam-Beam Tune shift
- Luminosity monitor

Tuning Tool

- Orbit bump

2.Maintenance of Beam Collision

1)Logitudinal
2)Transverse

Conclusion and Future Plan

Conclusion

1. Fine tuning on the collision position was done by measuring a timing of two beams. An error of the tuning was considered to be less than 3mm (10psec).

2. A horizontal orbit offset at IP was measured by scanning RF phase of LER. An offset of 1.5mm was removed by making an orbit bump in LER.

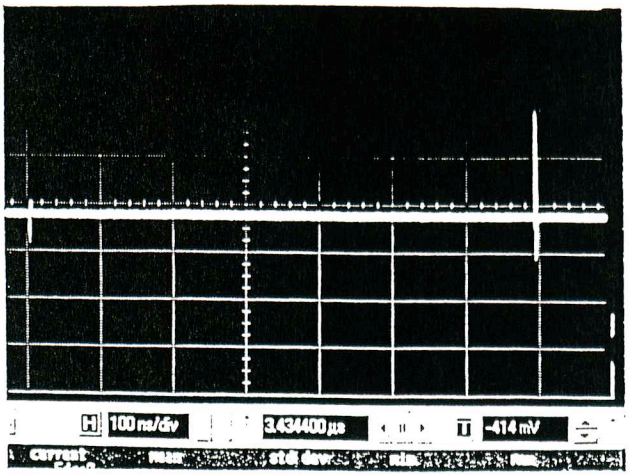
3.The first beam collision was observed by a vertical beam-beam scan. The beam collsion was also confirmed by a luminosity monitor.

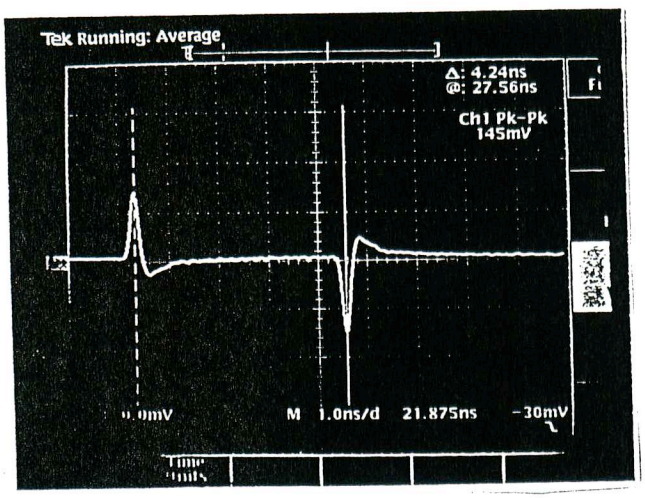
Future Plan

1. We need to observe continuously the timing of the two beam near IP. If necessary, we will construct a feedback system for the RF phase.

2. We used a few shifts for the beam-beam collision. This was just a demonstration. We have to start the study for the maintenance of the beam collsion condition onec found.

3. We will do more precise analysis on the beam-beam deflection including a self-consistent orbit change and a dynamic beta change due to a beam-beam effect.


H 100 ns/div
3.434400 µs
-414 mV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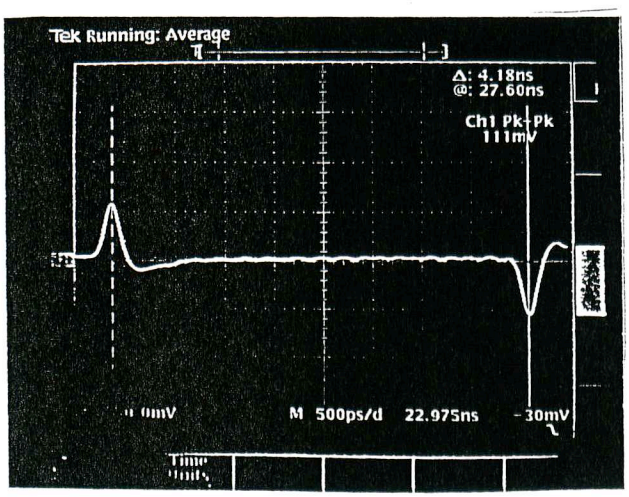
145mV
M 1.0ns/d 21.875ns -30mV
Time Units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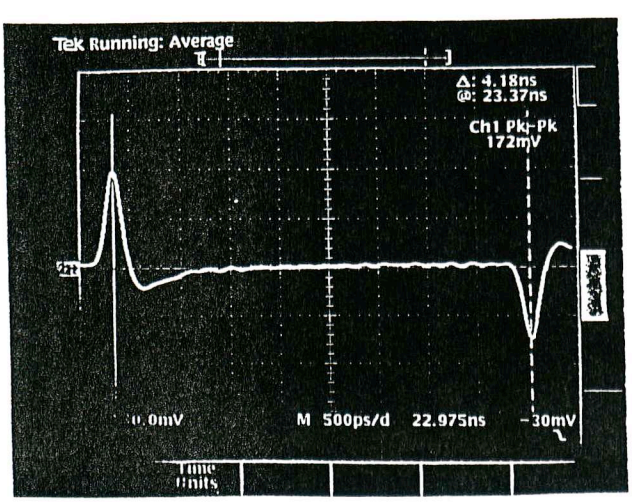
Time Units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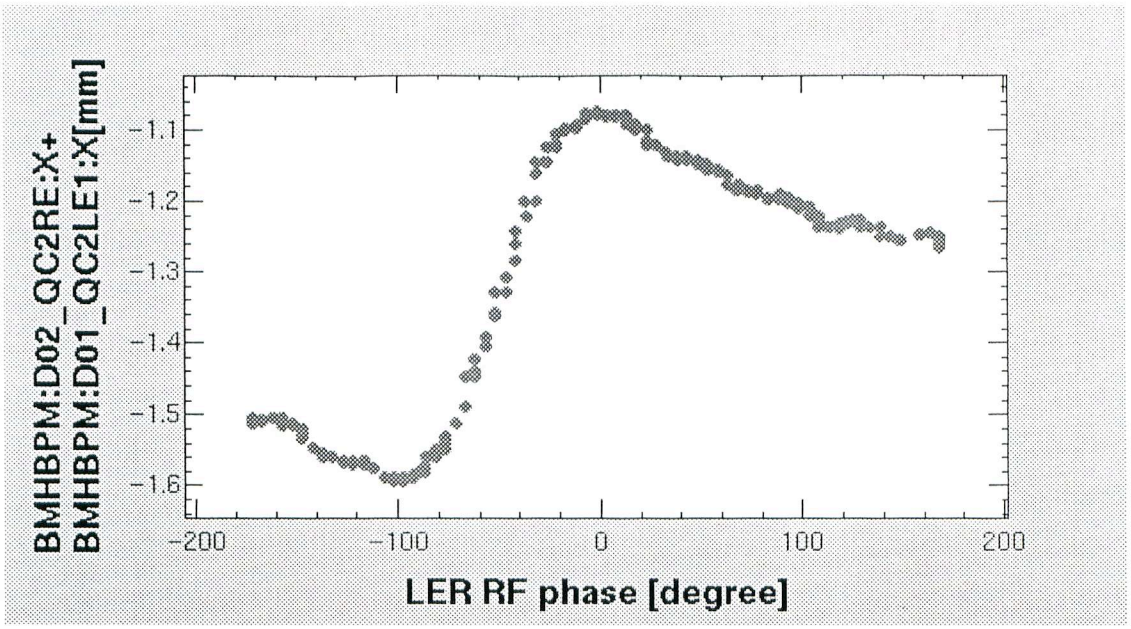
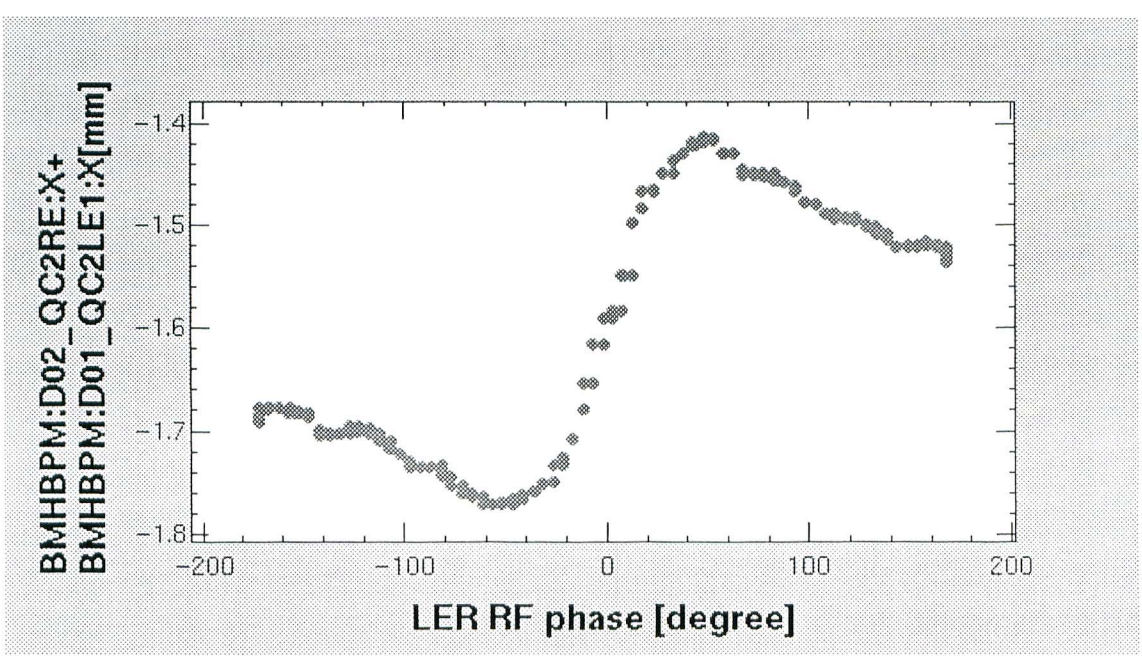
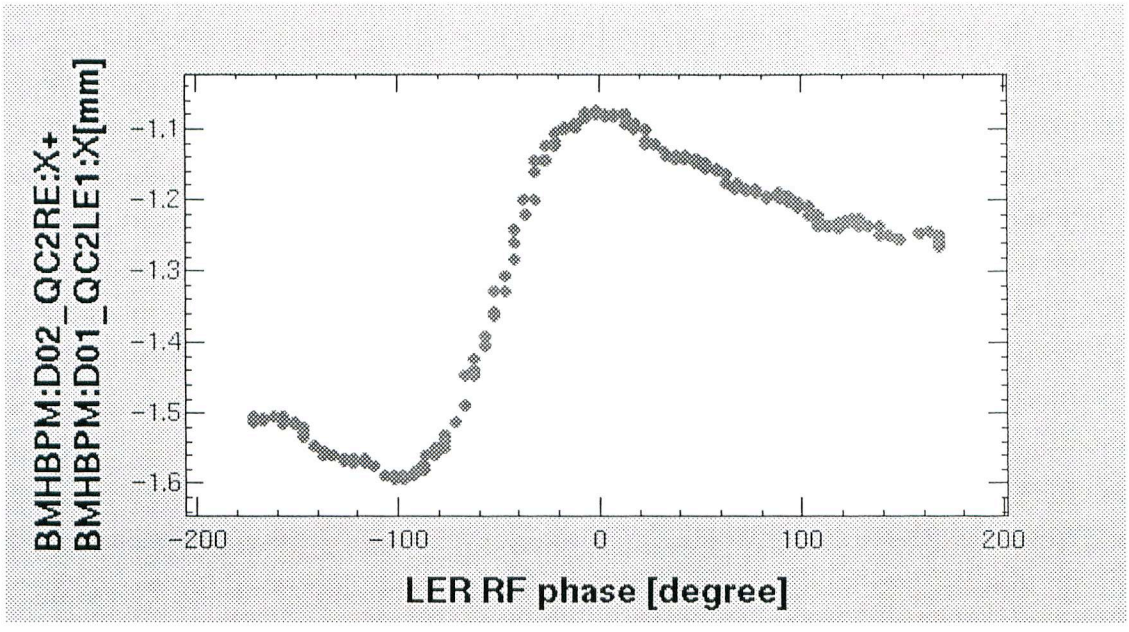
Time Units

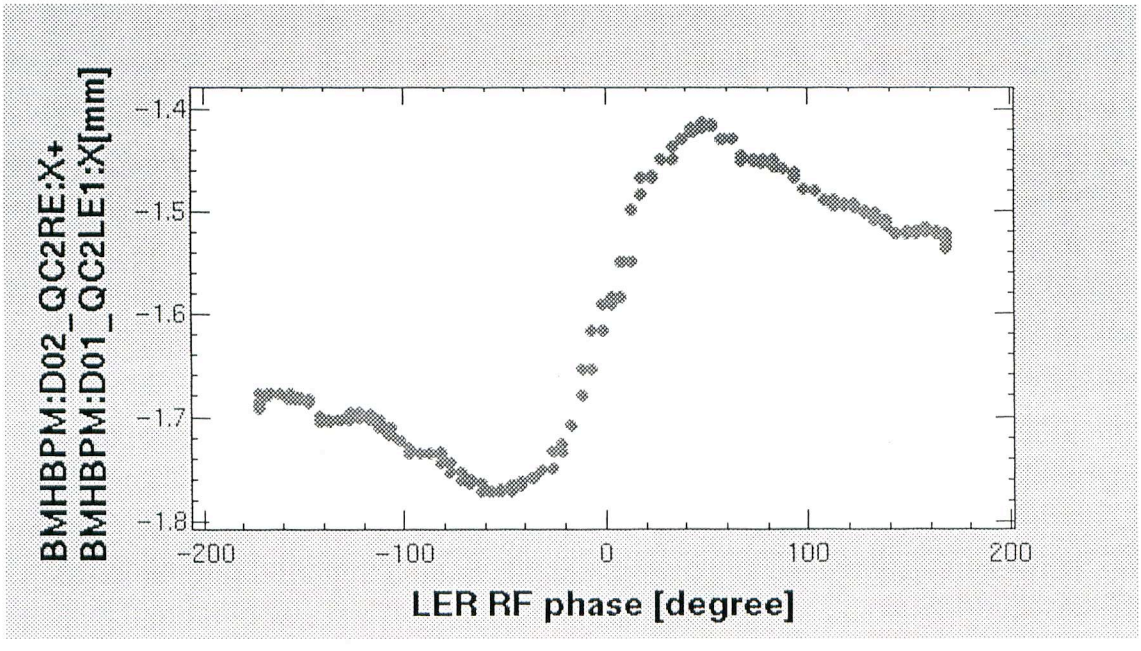
Beam-Beam Deflection (Horizontal)





Beam-Beam Deflection (Horizontal)





Finding of Beam Collision (II) - Horizontal

Observables

- Beam-Beam deflection

We observed horizontal beam-beam deflection with scanning horizontal orbit offset at IP. Scan was done by changing RF phase of LER (we have horizontal crossing angle of +- 11mrad).

Beam-Beam deflection was detected by measuring orbit change at BPM's beside QC2 magnets where betatron phase advances from IP are almost $\pi/2$.

To avoid an effect of orbit drift, we took sum of these two BPM's.

Tuning Tool

- Orbit bump

We found an horizontal offset of about 1.5mm. This offset was removed by making an orbit bump for LER.

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Tuning Tool

- Orbit bump

We found an horizontal offset of about 1.5mm. This offset was removed by making an orbit bump for LER.

Finding of Beam Collision (III) - Vertical

Observables

- Beam-Beam deflection

(• Signal from Luminosity Monitor)

We observed horizontal beam-beam deflection with scanning vertical orbit offset at IP. Scan was done by making orbit bumps for LER.

Beam-Beam deflection was detected by measuring orbit change at BPM's beside QC1 magnets where betatron phase advances from IP are almost $\pi/2$.

To avoid an effect of orbit drift, we took sum of these two BPM's.

Tuning Tool

- Orbit bump

Vertical Beam-Beam scan was done in combination of relatively large bumps and relatively precise scans. In trial and error methods, we obtained a deflection pattern which is characteristic of a beam-beam kick.

A vertical beam size which was obtained from a fit of the deflection pattern was around 3.4 μm. This corresponds to emittance coupling of about 3.2%.

ZDLM (luminosity monitor) also detected the beam collision. The monitor showed that the peak luminosity during the beam-beam scan was arount 1*10^30/cm^2/sec.

We observed a beam life reduction for the LER beam during the beam-beam scan.

Finding of Beam Collision (I) - Longitudinal

Observables

- Beam timing

Beam timing was observed by monitoring signals from BPM's nearest to the IP with an oscilloscope. The BPM's (which have 8 buttons) can detect timing of both beams. Resolution of the timing measurement was around 10 ~ 20psec.

Tuning Tool

- RF Phase

The collision point can be shifted by changing relative RF phase between LER and HER. We adjusted RF phase of LER so that relative timing of an LER bunch and an HER bunch at the BPM's agrees with a design value.