Low-Q IP BPM

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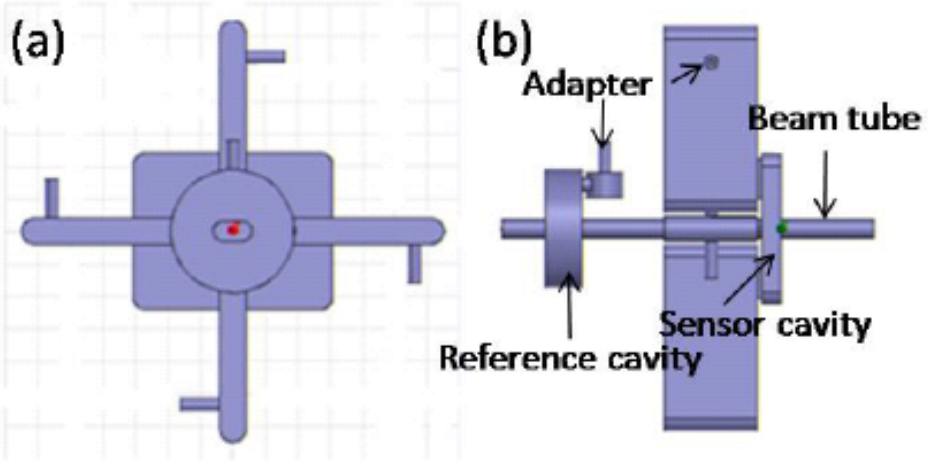
Low-Q IP BPM

Structure of the low-Q cavity BPM



Design parameters for low-Q IP BPM [

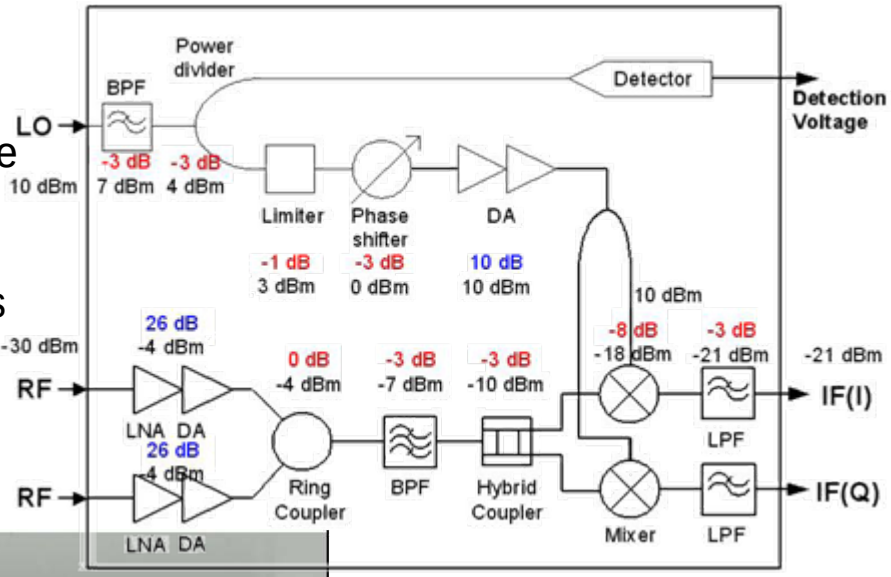
	X	Y	Reference
f (GHz)	5.712	6.426	6.426
β	8	9	0.0117
Q_0	5900	6020	1170
Q_{ext}	730	670	100250
τ (ns)	20.35	16.60	2484.19

We have developed a low-Q cavity BPM in order to achieve shorter timing resolution with a high position resolution. The developed low-Q cavity BPM consists of a one-cell sensor cavity and a one-cell reference cavity.

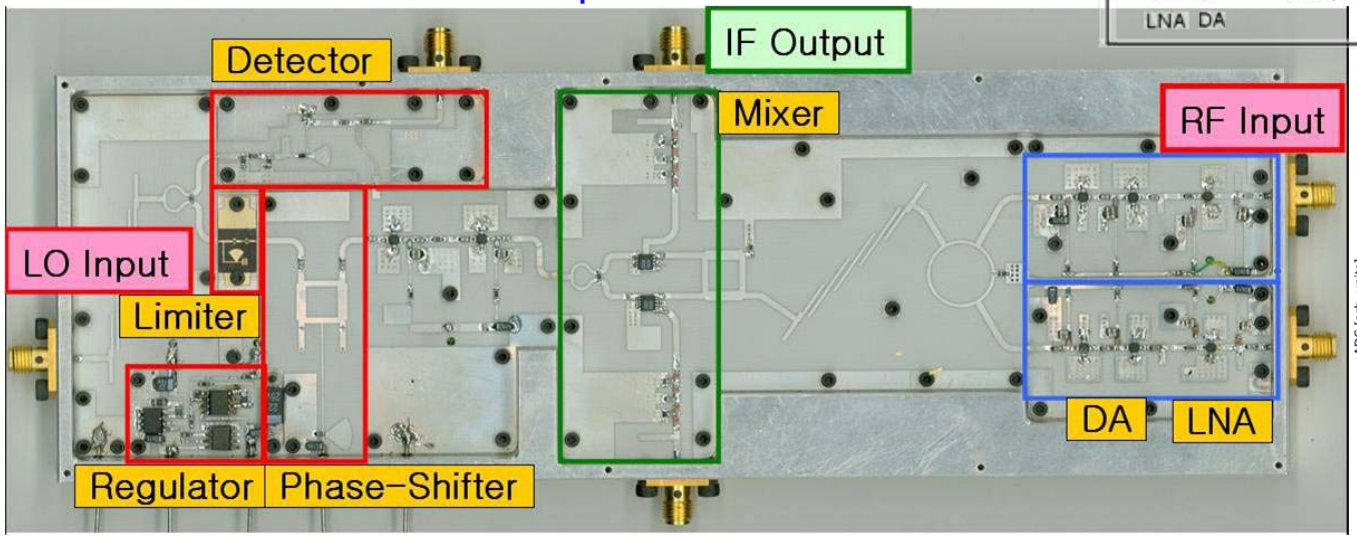
Low-Q IP BPM Electronics

- Main features of developed electronics
  - Single stage homodyne processor
    - By using 6.426 GHz LO, 6.426 GHz dipole mode signal is directly converted to DC.
  - Internal local oscillator
    - A timing reference signal of 6.426 GHz is given from reference cavity.
    - It is used as LO through limiter and amplifier.

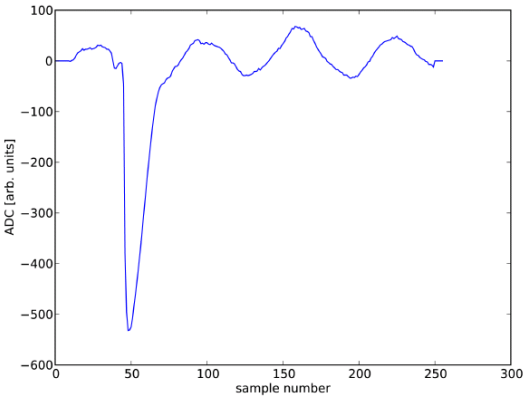
Layout of developed electronics



Picture of developed electronics

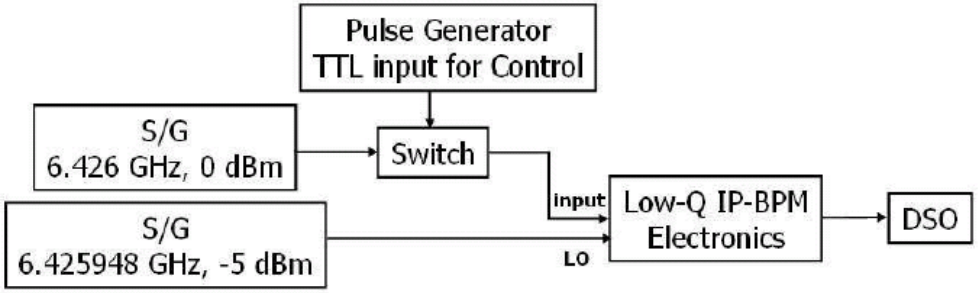


Low-Q IP BPM Electronics Output

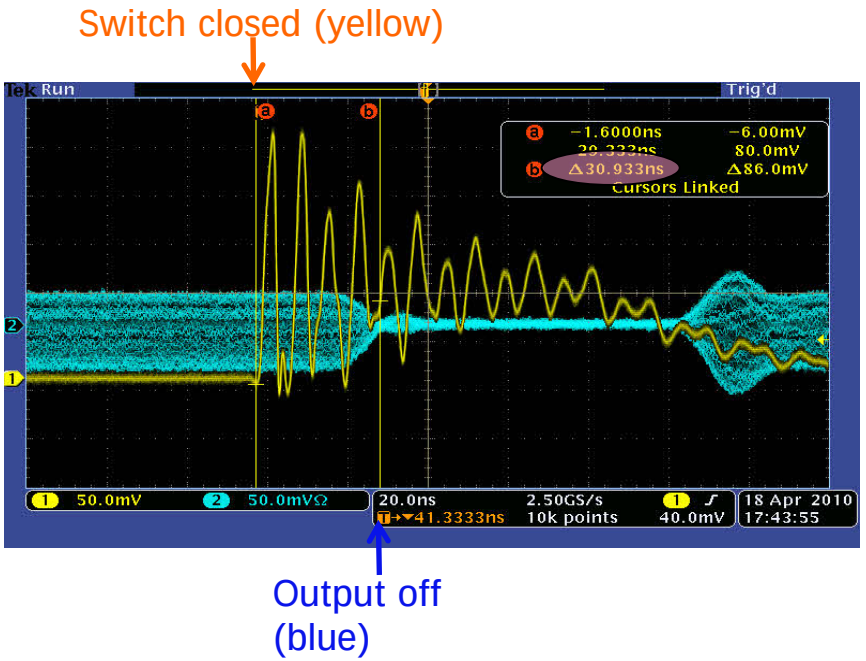


Low-Q IP BPM Electronics Latency

Block diagram



Waveforms on a digital oscilloscope



- Δt = 30 ns
- Switching time = 10 ns
- Cable delay = 3 ns
- Electronics latency = 17 ns

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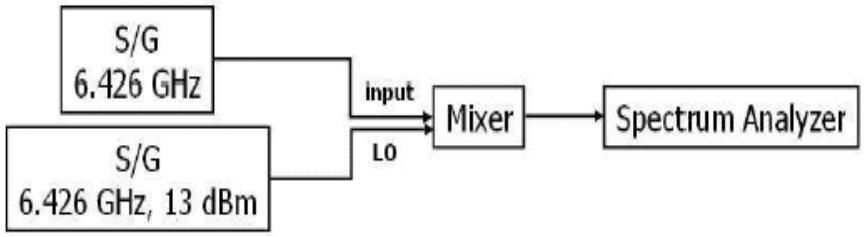
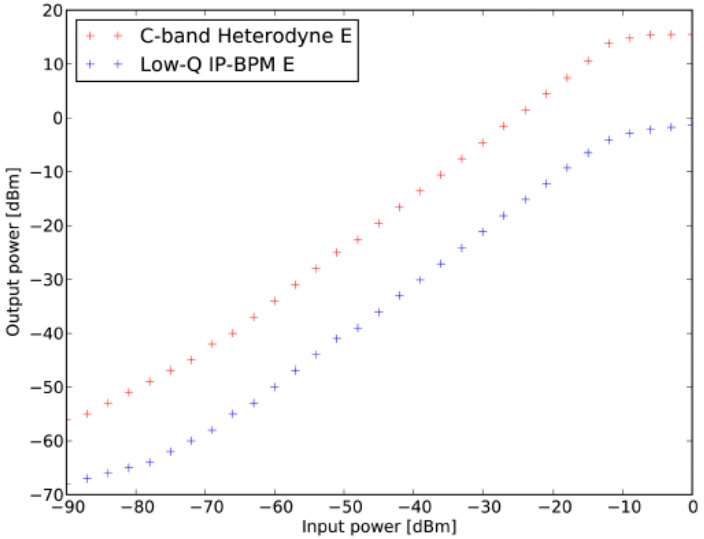
Low-Q IP BPM Electronics Linearity

Block diagram



Results



- Conversion Gain
  - Low-Q IP BPM : 10 dB
  - C-band heterodyne : 30 dB
- Low-Q IP BPM Electronics sensitivity ≈ -80 dBm
  - Expected Resolution : 10 nm
- Desired resolution : 2 nm

More development is required!

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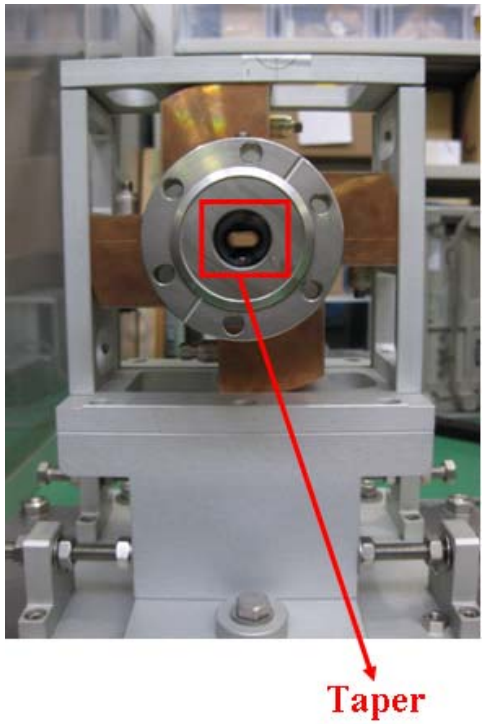
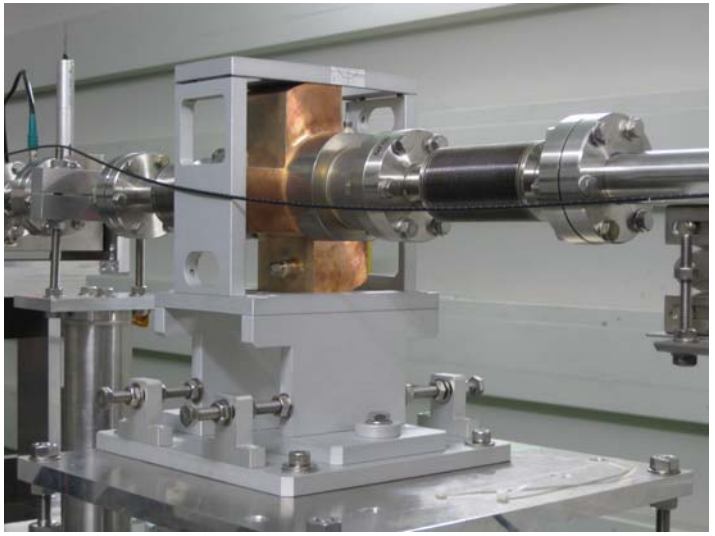
Low-Q IP BPM Installation

Taper

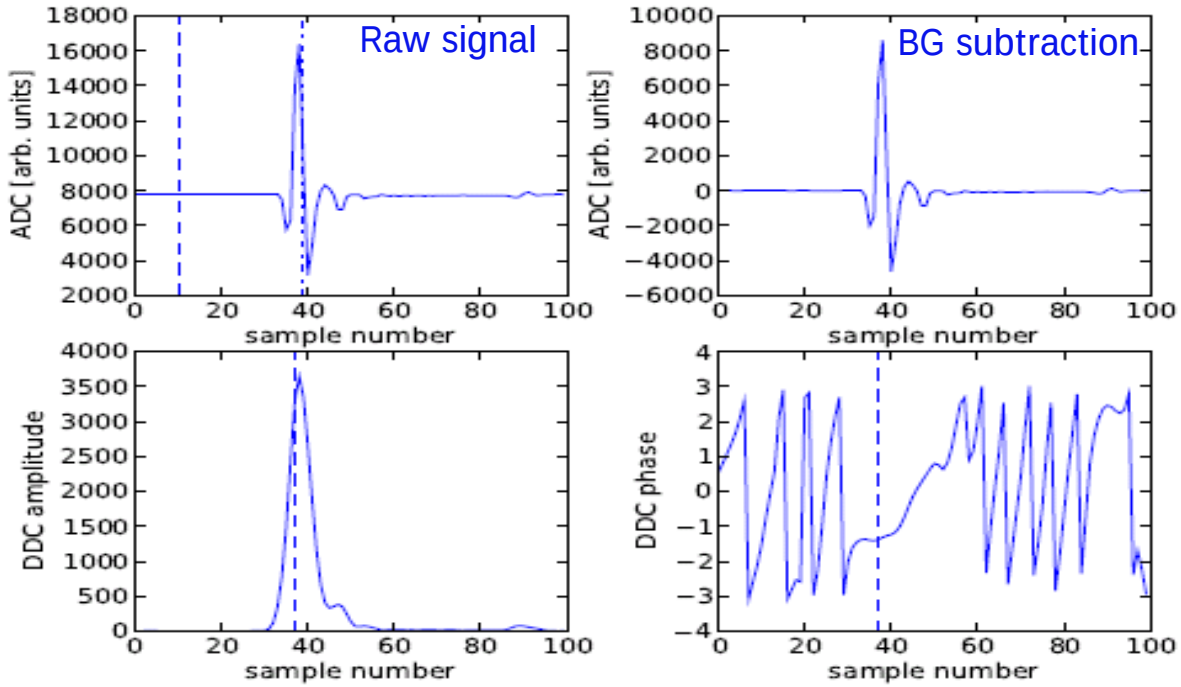


Installed in the Ext beam line



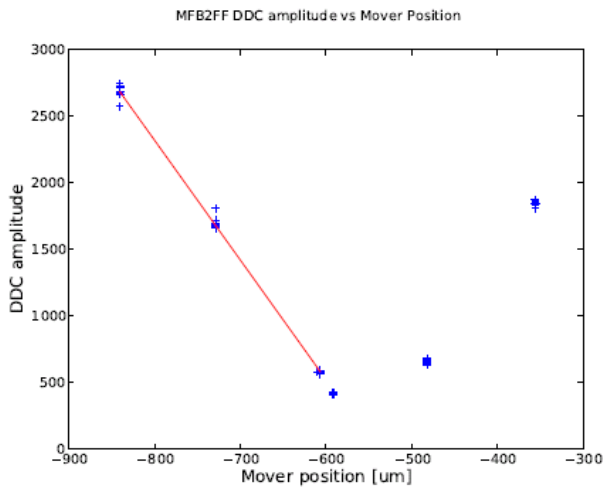
- Used the C-band heterodyne electronics
  - Want to measure the low-Q IP BPM intrinsic resolution
  - Higher sensitivity, higher gain
  - Even though decay times are different, the y signal frequency is same.

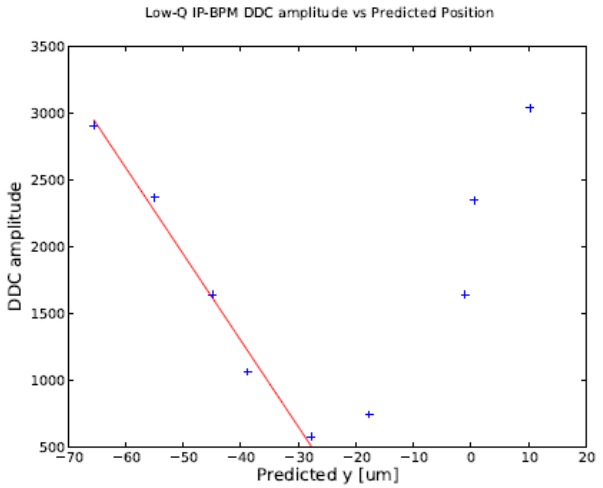
Raw Signal Processing



- The digital down-conversion algorithm was used
- The raw waveform from the low-Q IP BPM was digitized and then multiplied by a complex Lo of the same frequency
- The signal was filtered using a gaussian time domain filter with 10 MHz bandwidth

Position Sensitivity of low-Q IP BPM





- Used two C-band BPMs with no attenuator
  - These C-band BPMs' resolution below 50 nm
- DDC amplitude get from the signal processing
- Calculated predicted y position of low-Q IP BPM
  - The predicted position was interpolated between two C-band BPMs
- Low-Q IP BPM gradient is larger 6 times than MFB2FF

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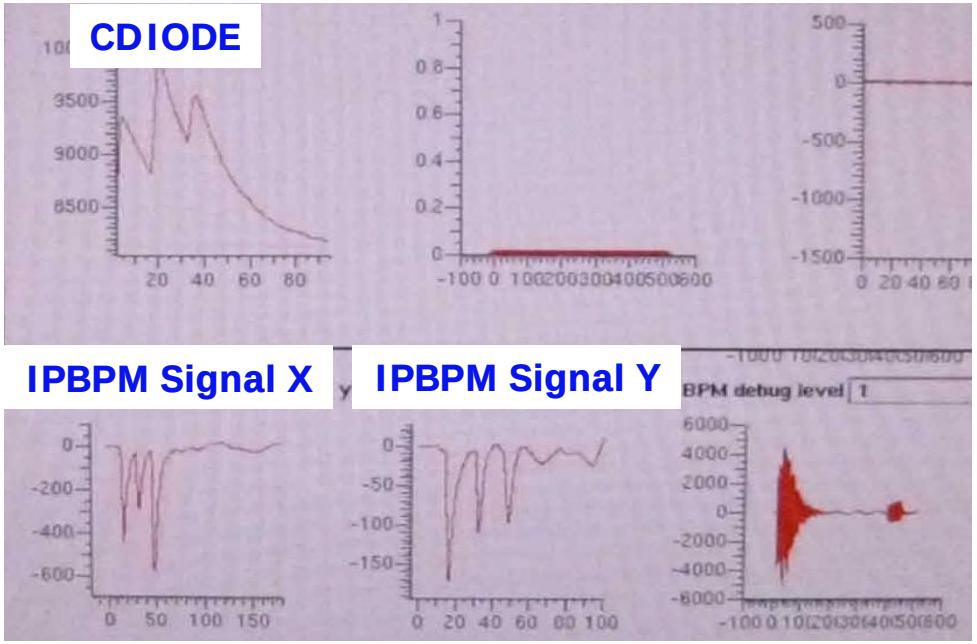
Low-Q IP BPM : 1 bunch 3 trains



- Normal C-band cavity signal : lots of overlapping signals
- Low-Q IP BPM will be used for Feedback (FONT) so need fast response
- Clear bunch separation

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Summary

- Low-Q IP BPM electronics
  - latency : 17 ns
  - Sensitivity : -80 dBm
  - Expected resolution : 10 nm
  - Desired resolution : 2 nm
  - More development is required
- Position sensitivity : 64.7 DDC/μm

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